56. Jahrestagung der Deutschen Gesellschaft für Neuroradiologie e.V.

Virtuelle Konferenz

Wissenschaftliche Leitung

Prof. Dr. med. Jennifer Linn (Dresden)

Dieses Supplement wurde von der Deutschen Gesellschaft für Neuroradiologie finanziert.
### Inhaltsverzeichnis

#### Abstracts

<table>
<thead>
<tr>
<th>Abstract</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>S4</td>
</tr>
<tr>
<td>2</td>
<td>S5</td>
</tr>
<tr>
<td>22</td>
<td>S5</td>
</tr>
<tr>
<td>23</td>
<td>S6</td>
</tr>
<tr>
<td>28</td>
<td>S7</td>
</tr>
<tr>
<td>33</td>
<td>S7</td>
</tr>
<tr>
<td>39</td>
<td>S8</td>
</tr>
<tr>
<td>45</td>
<td>S8</td>
</tr>
<tr>
<td>48</td>
<td>S9</td>
</tr>
<tr>
<td>51</td>
<td>S10</td>
</tr>
<tr>
<td>54</td>
<td>S11</td>
</tr>
<tr>
<td>57</td>
<td>S12</td>
</tr>
<tr>
<td>61</td>
<td>S13</td>
</tr>
<tr>
<td>64</td>
<td>S13</td>
</tr>
<tr>
<td>65</td>
<td>S13</td>
</tr>
<tr>
<td>80</td>
<td>S14</td>
</tr>
<tr>
<td>82</td>
<td>S14</td>
</tr>
<tr>
<td>88</td>
<td>S15</td>
</tr>
<tr>
<td>89</td>
<td>S16</td>
</tr>
<tr>
<td>90</td>
<td>S17</td>
</tr>
<tr>
<td>98</td>
<td>S17</td>
</tr>
<tr>
<td>108</td>
<td>S17</td>
</tr>
<tr>
<td>109</td>
<td>S18</td>
</tr>
<tr>
<td>110</td>
<td>S20</td>
</tr>
<tr>
<td>111</td>
<td>S20</td>
</tr>
<tr>
<td>113</td>
<td>S20</td>
</tr>
<tr>
<td>117</td>
<td>S21</td>
</tr>
<tr>
<td>122</td>
<td>S22</td>
</tr>
<tr>
<td>126</td>
<td>S23</td>
</tr>
<tr>
<td>127</td>
<td>S24</td>
</tr>
<tr>
<td>129</td>
<td>S25</td>
</tr>
<tr>
<td>132</td>
<td>S25</td>
</tr>
<tr>
<td>134</td>
<td>S25</td>
</tr>
<tr>
<td>138</td>
<td>S26</td>
</tr>
<tr>
<td>140</td>
<td>S27</td>
</tr>
<tr>
<td>142</td>
<td>S27</td>
</tr>
<tr>
<td>144</td>
<td>S28</td>
</tr>
<tr>
<td>145</td>
<td>S28</td>
</tr>
<tr>
<td>151</td>
<td>S28</td>
</tr>
<tr>
<td>152</td>
<td>S29</td>
</tr>
<tr>
<td>153</td>
<td>S29</td>
</tr>
<tr>
<td>154</td>
<td>S29</td>
</tr>
<tr>
<td>162</td>
<td>S30</td>
</tr>
<tr>
<td>163</td>
<td>S30</td>
</tr>
<tr>
<td>168</td>
<td>S31</td>
</tr>
<tr>
<td>177</td>
<td>S31</td>
</tr>
<tr>
<td>181</td>
<td>S32</td>
</tr>
<tr>
<td>183</td>
<td>S32</td>
</tr>
<tr>
<td>186</td>
<td>S33</td>
</tr>
<tr>
<td>189</td>
<td>S33</td>
</tr>
<tr>
<td>190</td>
<td>S37</td>
</tr>
</tbody>
</table>
Autorenverzeichnis
Einfluss der Charakteristika von Vergleichskollektiven auf die automatische Hirnatrophieschätzung – wie viele Vergleichssubjekte sind notwendig?

Christian Rubbert1, Luisa Wolf1, Bernd Turowski1, Dennis Hedderich2, Christian Gaser3, Robert Dahnke3, 4, 5, Julian Caspers1

1Heinrich-Heine-Universität Düsseldorf, Medizinische Fakultät, Institut für Diagnostische und Interventionelle Radiologie, Düsseldorf, Deutschland
2Abteilung für Diagnostische und Interventionelle Neuroradiologie, Klinikum rechts der Isar der Technischen Universität München, München, Deutschland
3Klinik für Neurologie, Klinik für Psychiatrie, Universitätsklinikum Jena, Jena, Deutschland
4Lehrstuhl für Psychologie, Friedrich-Schiller-Universität Jena, Jena, Deutschland
5Center of Functionally Integrative Neuroscience, Aarhus University, Aarhus, Dänemark

Hintergrund: Softwarebasierte Ansätze zur Hirnatrophieschätzung halten zunehmend Einzug in die neuroradiologische Diagnostik. Hierbei werden MRTs mit einem Normalkollektiv (NK) verglichen. Der Einfluss des NK auf die Ergebnisse ist nicht hinreichend untersucht.

Wir untersuchten die folgenden Fragen: 1) Wie viele Vergleichssubjekte sind für eine konsistente Atrophieschätzung notwendig? 2) Führen unterschiedliche NKs bei der Abschätzung regionaler Atrophie zu unterschiedlichen Ergebnissen?

Methoden: Im ersten Schritt wurden die folgenden NK in einem NK-kombiniert: HCP-A, IXI, Rockland sowie die gesunden Kontrollen (GK) von PPMI und ADNI (n=3579). Als Probanden für die Atrophieschätzung wurden 43 Patienten mit Morbus Alzheimer (AD) aus ADNI selektiert (T1 3-D-Schichtdicke ≤1 mm sowie ≥100 alters- und geschlechtsspezifische Vergleichssubjekte im NK-komb verfügbar). Die voxelweise Abweichung des Volumens der grauen Substanz wurde anhand von Vergleichskollektiven mit 2–100 zufällig aus NK-komb ausgewählten Vergleichssubjekten mittels der automatisierten und frei verfügbaren Software veganbagel unter Einsatz von CAT12/SPM12 errechnet. Der Mittelwert der voxelweisen Standardabweichung (mSD) dieser z-Werte wurde über 100 Wiederholungen berechnet (Abb. 1). Die mSD wurde gegen die Anzahl der Vergleichssubjekte aufgetragen. Die Kniepunkte dieser Kurven wurden als die Minimalanzahl notwendiger Vergleichssubjekte in einem NK definiert. Abschließend wurden alle AD-Patienten und zusätzlich aus ADNI gematchten GK bestimmt, für die in den einzelnen NK mindestens die etablierte Minimalanzahl an Vergleichssubjekten vorlag. Für diese wurden mittels jedes einzelnen NK Atrophiekarten berechnet, und die mesiotemporale Atrophie wurde qualitativ durch 2 Radiologen bestimmt, um AD und GK zu differenzieren.

Ergebnisse: Der mittlere Kniepunkt lag über alle Altersstufen bei 11,5 ± 0,9 Vergleichssubjekten (Abb. 2). Für 18 AD/18 GK lagen in den NK genügend Vergleichssubjekte vor. Die beiden Radiologen stimmten in allen Fällen in der Diagnose AD/GK überein (Kappa für das Ausmaß der Atrophie: 0,98). Sensitivität und Spezifität betragen für HCP-A: 92,3 %/72,7 %, IXI: 91,7 %/69,6 %, PPMI: 92,3 %/72,7 % und Rockland: 100 %/73,9 %.

Fazit: Für eine konsistente Atrophieschätzung müssen mindestens 12 alters- und geschlechtsspezifische Vergleichssubjekte vorliegen. Eine qualitative Abschätzung regionaler Atrophie ist verlässlich und mit ei-
[20] Improved detection of cavernous sinus invasion of pituitary macroadenomas via ultra-high-field 7 T MRI

Felix Eisenhut1, Manuel Schmidt1, Elisabeth Heynold1, Soheil Arirad1, Sven-Martin Schlaffer2, Michael Buchfelder2, Arnd Dörfler1

1Radiologisches Institut, Universitätsgesundheitsklinik Freiburg, Klinik für Neurologie, Freiburg im Breisgau, Germany
2Abteilung für Neurochirurgie, Universitätsklinikum Erlangen, Abteilung für Neuroradiologie, Erlangen, Germany

Background: To compare 7 T magnetic resonance imaging (MRI) of pituitary gland (PG) macroadenomas with standard MRI and intraoperative findings regarding lesion detection, intrasellar adenoma localization and invasion of the cavernous sinus (CS).

Methods: Patients with a clinically suspected PG lesion (e.g. due to bitemporal hemianopsia) underwent preoperative 1.5 T or 3 T and 7 T MRI. Evaluation of image quality (IQ) regarding overall IQ, anatomical parameters (border between the PG and the CS; border between anterior and posterior PG; optic nerve/oculomotor and trigeminal nerve differentiation) and artefacts as well as a qualitative (lesion detection, lesion location, CS invasion) and quantitative (lesion size, extent of cavernous sinus invasion using the Knosp score) analysis of the datasets was performed and compared to intraoperative findings.

Results: A total of 39 patients underwent preoperative 1.5 or 3 T and 7 T MRI; in 9 patients both 1.5 or 3 T and 7 T MRI allowed the detection of a macroadenoma. Overall IQ of 7 T MRI was rated higher than IQ of 1.5 and equal to 3 T MRI (IQoverall right = 2.00 ± 0.71, IQoverall left = 2.80 ± 0.45; IQoverall right = 3.00 ± 0.0, IQoverall left = 3.0 ± 0.0). IQ of each evaluated anatomical parameter was rated higher in 7 T MRI than in 1.5 T and higher or equal than in 3 T MRI. There was no significant image IQ difference regarding susceptibility or motion artefacts. There was complete congruence regarding intrasellar lesion localization between 1.5/3 T and 7 T MRI (nright = 3; nmedial = 3; nleft = 3) and a strong correlation regarding lesion size determination. 7 T MRI showed better agreement with intraoperative findings than 1.5 or 3 T MRI regarding a CS invasion with a correct radiologic assessment in 66.6% of all patients via 7 T MRI versus a correct radiologic assessment in 55.6% of all patients via 1.5/3 T MRI.

Discussion: Whereas both standard 1.5 or 3 T MRI and 7 T MRI equally allowed macroadenoma detection and correct intrasellar localization with a strong correlation regarding intra- and suprasellar lesion size determination, ultra-high-field 7 T MRI depicts significantly better the invasion of the CS with high correlation to intraoperative findings. In consequence, 7 T MRI can help to improve neurosurgical resection because of its detailed delineation of tumour boundaries with possible preservation of healthy tissue.

Conclusion: In addition to granting exact localization and size of PG macroadenomas, 7 T MRI yields more accurate information regarding a CS invasion with better agreement with intraoperative findings than 1.5 or 3 T MRI.

[22] Diffusion microstructure imaging in progressive supranuclear palsy: reduced axonal volumes in the superior cerebellar peduncles, dentatorubrothalamic crossing, ventromedial thalami and frontomesial white matter

Alexander Rau1, Wolfgang Jost1, Elias Kellner2, Theo Demeurath1, Marco Reisert2, Horst Urbach1

1Universitätsklinikum Freiburg, Klinik für Neuroradiologie, Freiburg im Breisgau, Germany
2Universitätsklinikum Freiburg, Medizinphysik, Freiburg im Breisgau, Germany

Background: The differentiation between Parkinson’s disease (PD) and atypical Parkinson syndromes such as progressive supranuclear palsy (PSP), multiple system atrophy (MSA) and corticobasal degeneration is challenging in clinical practice. We evaluated whether diffusion microstructure imaging (DMI; calculation of diffusivities and volume fractions of intra- and extra-axonal and csf-compartments based on multishell-DWI) enables the identification of PSP patients within a cohort of suspected atypical parkinsonism.

Methods: In a retrospective study, DMI parameters were analyzed in patients with clinically suspected atypical parkinsonism syndromes and healthy controls (HC). Between 2018 and 2020, an exploration cohort was used to identify voxel- and region-based differences and to calculate cut-off values in a receiver operating characteristic analysis. Afterwards, the accuracy was tested on a single subject level.

Results: In the exploration cohort, 52 PSP patients were compared to 20 PD, 26 MSA, and 7 corticobasal syndrome patients, as well as 25 HC. PSP patients showed widespread intraxonal volume loss in the superior cerebellar peduncles, the dentatorubrothalamic tracts, the ventromedial thalami and the frontal white matter (each $p<0.001$). Especially the ventromedial thalami showed a high area under the curve of 0.899 between PSP and others. The validation cohort ($n=25$) consisted of 12 PSP patients, eight with PD, four with MSA, while one patient had no final diagnosis of parkinsonism. The accuracy of the DMI approach in identifying PSP patients was confirmed in the thalamus and the frontal white matter (accuracy 0.96 each).

Discussion: DMI reveals a characteristic regional pattern of axonal degeneration in PSP patients. This fits well with published regions of specific changes in PSP in terms of atrophy and alterations in diffusion weighted imaging.

Conclusion: DMI might be used to identify PSP patients on an individual level in a collective with suspected atypical Parkinson syndromes.
Regionale Signatur des Normaldruckhydrozephalus in der [18F]FDG-PET

Alexander Rau1*, Lars Frings2, Ganna Blazhenets2, Nils Schröter3, Philipp Tobias Meyer2, Horst Urbach1

1Universitätsklinikum Freiburg, Klinik für Neuroradiologie, Freiburg im Breisgau, Deutschland
2Universitätsklinikum Freiburg, Klinik für Nuklearmedizin, Freiburg im Breisgau, Deutschland
3Universitätsklinikum Freiburg, Klinik für Neurologie und Neurophysiologie, Freiburg im Breisgau, Deutschland


Fazit: Patienten mit NPH weisen einen relativen vertexnahen Hypermetabolismus auf.

[28] Serielle CT-Perfusion zum Vasospasmus-Monitoring bei Patienten mit aneurysmatischer Subarachnoidalblutung

Ole Bettinger1, Olav Jansen1, Michael Synowitz2, Charlotte Flüh1, Nikolas Hagen2, Friederike Austein1, Naomi Larsen1

1Klinik für Radiologie und Neuroradiologie, Universitätsklinikum Schleswig-Holstein, Campus Kiel, Kiel, Deutschland
2Klinik für Neurochirurgie, Universitätsklinikum Schleswig-Holstein, Campus Kiel, Kiel, Deutschland


Methoden: Retrospektiv wurden alle Patienten eingeschlossen, bei denen intrakranielle SOP zusätzlich zur täglichen TCD eine CTP am standardisierten Tagen nach SAB (1, 5, 7, 10) durchgeführt wurde. Die Sensitivität und Spezifität der TCD und des CTP-Parameters Tmax mit 4 Schwellenwerten (4 s, 6 s, 8 s, und 10 s) wurden berechnet, und die beiden Monitoringmethoden TCD alleine vs. TCD + CTP verglichen. Als Goldstandard diente die DSA und CT- oder MR-Verlaufskontrollen.

Ergebnisse: Es entsprachen 29 Patienten mit insgesamt 106 Perfusionzeitpunkten den Einschlusskriterien. An 25/106 Messzeitpunkten bei 10/29 Patienten lagen Vasospasmen vor. Durch die serien CTPs wurden 9/25 Vasospasmen (36 %) bei 6/29 Patienten detektiert, die im TCD-Monitoring nicht erkannt wurden. TCD zeigte eine Sensitivität von 0,6 und Spezifität von 0,63 (AUC 0,615). Tmax >4 s wies eine Sensitivität von 0,927 und Spezifität von 0,8 auf (AUC 0,863). Tmax >6 s eine Sensitivität von 0,439 und Spezifität von 0,975 (AUC 0,707). Die kombinierte Monitoringmethode TCD + CTP wies eine signifikant bessere Detektion von Vasospasmen auf im Vergleich zu TCD alleine (p=0,008).


Fazit: Das Monitoring mit TCD und serieller CTP detektiert signifikant mehr Vasospasmen als TCD alleine und kann das Outcome schwerbetroffener SAB-Patienten potenziell verbessern. Der Schwellenwert Tmax >4 s liefert die höchste diagnostische Genauigkeit.

Literatur


Diskussion: Die Verwendung eines neuen, erweiterten multimodalen FDCT-Protokolls als First-line-imaging-Ansatz bei AIS-Patienten ist möglich und mit der multimodalen CT-Bildgebung vergleichbar. FDCT-Bildgebung könnte so den Workflow straffen, da sich der Patiententransport auf die Richtung von der Notaufnahme zur Angiosuite konzentriert.

Fazit: Das neue erweiterte FDCT-Protokoll ermöglicht eine diagnostische Bildgebung innerhalb der Angiosuite, einschließlich der Darstellung der zervikalen Gefäße. Die Zeitspanne von der ersten Bildgebung bis zur Schlaganfallbehandlung kann somit verkürzt werden.
[48] Additional use of a deep learning algorithm in detecting intracranial hemorrhages on emergency computed tomographies of a radiology and neuroradiology department with teleradiology

Almut Kundisch1, Alexander Hönning2, Sven Mutze1, Lutz Kreissl3, Johannes Lencke4, Maximilian Sitz5, Paul Sparenberg6, Leonie Götz3*,4

1Zentrum für Notfalltraining, BG Klinikum Unfallkrankenhaus Berlin gGmbH, Berlin, Germany
2Zentrum für klinische Forschung, BG Klinikum Unfallkrankenhaus Berlin gGmbH, Berlin, Germany
3Institut für Radiologie und Neuroradiologie, BG Klinikum Unfallkrankenhaus Berlin gGmbH, Berlin, Germany
4Institut für diagnostische Radiologie und Neuroradiologie, Universitätsmedizin Greifswald, Greifswald, Germany
5Klinik für Neurochirurgie, BG Klinikum Unfallkrankenhaus Berlin gGmbH, Berlin, Germany
6Klinik für Neurologie, BG Klinikum Unfallkrankenhaus Berlin gGmbH, Berlin, Germany

Background: As teleradiology continues to spread, diagnostic imaging of varying quality is increasingly bundled at big centers during any time of the day. This trend demands for prioritization and speediness of reporting in radiology. Deep learning algorithms could support radiologists in meeting these challenges [1]. This study analyzes the number of additionally detectable intracranial hemorrhages (ICH) by an approved artificial intelligence (AI) analysis software and evaluates reasons for false results at a (neuro)radiology department of a level 1 trauma center with teleradiology.

Methods: Retrospective cohort-study. (1) Analysis of consecutive emergency non-contrast head computed tomographies (hCT) by the AI. (2) Review of hCT with deviating results of the AI and the initial radiology report (RR) by a neuroradiologist (NR). (3) Evaluation of the number of additionally detected ICH using the AI and of reasons for false results.

Results: A total of 4946 hCT were included between 05/2020 and 09/2020 from 19 different CT scanners (Fig. 1). 205 reports (4.1 %) were classified as bleedings both by the RR and the AI. 162 (3.3 %) diverging reports were identified, 62 of these were confirmed as bleedings by a NR. The RR identified 33 ICH, analysis by the AI detected 29 ICH. 88 (1.8 %) hCT flagged by the AI as bleedings and 10 (0.2 %) positive RR were evaluated as incorrect findings by the NR. ICH missed by the AI were often located in the subarachnoid (SA) space (41.2 %) and immediately underneath the calvaria (47.1 %). 85 % of ICH missed by the RR but detected by AI occurred beyond regular working hours. Calcifications (39.3 %), beam hardening artifacts (18 %), tumors (15.7 %), and vessels (7.9 %) were the most common reasons for incorrectly positive flagged hCT. There was no significant
association between size of the ICH or image quality and probability of incorrect AI results.

**Discussion:** The disagreement rate between AI analysis and primary RR was 3.3%. 12.2% ICH were identified additionally by the AI. 1.8% hCT were falsely flagged by the AI often caused by calcifications. ICH missed by the AI were mainly located in the SA space or underneath the calvaria.

**Conclusion:** Combining radiological experience and an AI algorithm is a promising strategy for maximizing detection of ICH in high-volume radiology departments with teleradiology, especially during on-call duty.

**References**

**[51]** Hämodynamische Evaluation von Moyamoya-Patienten: Analyse von Resting-state-fMRT zur Abschätzung der zerebrovaskulären Reaktivität
Leonie Zerweck1*, Constantin Roder2, Till-Karsten Hauser1, Johannes Thurow1, Annerose Mengel1, Marcos Tatagiba2, Nadia Khan3, Philipp T. Meyer1, Ulrike Ernemann1, Uwe Klose1
1Universitätsklinikum Tübingen, Abteilung für Diagnostische und Interventionelle Neuroradiologie, Tübingen, Deutschland
2Universitätsklinikum Tübingen, Abteilung für Neurochirurgie, Tübingen, Deutschland
3Universitätsklinikum Freiburg, Abteilung für Nuklearmedizin, Freiburg, Deutschland


**Ergebnisse:** Sowohl beim Vergleich der 25 rs-fMRT- und bh-fMRT-Datensätze (Pearson’s r=0,71 ±0,13 [0,35–0,95]), als auch der 7 rs-fMRT- und [15O] water PET-Datensätze (Pearson’s r=0,80±0,19 [0,41–0,95]) zeigte sich eine gute Korrelation [4]. Die Maps eines Patienten mit hoher Korrelation und die zugehörigen Scatterplots sind in Abb. 1 und 2 dargestellt.
Fazit: rs-fMRT scheint eine vielversprechende Methodik für die hämodynamische Evaluation in der Moyamoya-Diagnostik zu sein, die gut verfügbar ist und kaum Mitarbeit der Patienten voraussetzt. Weitere Studien sind erforderlich.

Literatur

[54] Diversion-p64—results from an international, prospective, multicentre, single-arm post-market clinical follow-up study to assess the safety and effectiveness of the p64 flow modulation device

Alain Bonafé1, Marta Aguilar-Pérez2, Hans Henkes2, Pedro Llyyk1, Carlos Bleise3, Grégory Gascou1, Stanimir Sirakov4, Alexander Sirakov4, Luc Stockx4, Francis Turjman6, Andrey Petrov5, Christian Roth4, Ana Paula Narata4, Xavier Barreau10, Christian Loehr11, Ansgar Berlis12, Laurent Pierot13, Marcin Miś14, Antony Goddard15, Peter Schramm16

1Hôpital Gui de Chauliac (CHU Montpellier), France
2Klinikum Augsburg, Germany
3Hôpital Maison Blanche, France
4Zakład Radiologii Ogólnej, Zabiegowej i Neuroradiologii, Poland
5Leeds Teaching Hospitals NHS TRUST, United Kingdom
6Institut für Neuroradiologie, UKSH Universitätsklinikum Schleswig-Holstein Campus Lübeck, Lübeck, Germany

Background: The use of flow diversion to treat intracranial aneurysms has increased in recent years. We sought to assess the safety and angiographic efficacy of the p64 Flow Modulation Device.

Methods: Diversion-p64 is an international, prospective, multicentre, single-arm, study conducted at 26 centres. The p64 device was used to treat anterior circulation aneurysms between December 2015 and January 2019. The primary safety endpoint was the incidence of major stroke or neurologic death at 3–6 months with the primary efficacy endpoint being complete aneurysm occlusion on follow-up angiography.

Results: A total of 420 patients met the eligibility criteria and underwent treatment with the p64 Flow Modulation Device (mean age 55 ± 12.0 years, 86.2 % female). Mean aneurysm dome width was 6.99 ± 5.28 mm and neck width 4.47 ± 2.28 mm. Mean number of p64s implanted per patient was 1.06 ± 0.47 with adjunctive coiling performed in 14.0 % of the cases. At 1-year angiography (mean 375 ± 73 days), available for 343 patients (81.7 %), complete aneurysm occlusion was seen in 83.7 % (n=287) of patients. Safety data was available for 413 patients (98.3 %) at the first follow-up (mean 145 ± 45 days) with a composite morbimortality rate of 2.42 % (n=10).

Discussion: Diversion-p64 is the largest prospective study using the p64 Flow Modulation Device. The results of this study will be compared with similar devices available on the US and EU market. The results of Diversion-p64 demonstrate one of the lowest rates of morbimortality seen in any prospective study on flow diversion. Furthermore, the results seen in Diversion-p64 are better than those seen using more traditional techniques such as endovascular coiling or balloon assisted coiling.
Conclusion: The results of Diversion-p64 demonstrate that the device has a high efficacy and excellent safety profile that is comparable to other devices.

References

[57] Visual analysis of brain lesion load in patients with cerebral small vessel disease

Sarah Mittenentzwei1*, Alessandro Sciarra2, Falk Lüsebrink3, Merita Aruci3, Philipp Ulbrich2 4, Andreas Lemke5, Monique Meuschke1, Bernhard Preim1, Stefanie Schreiber2 4, Steffen Oeltze-Jafra1 2 6
1Institute for Simulation and Graphics, Otto von Guericke University, Magdeburg, Germany
2Department of Neurology, Otto von Guericke University, Magdeburg, Germany
3Faculty of Natural Sciences, Otto von Guericke University, Magdeburg, Germany
4German Center for Neurodegenerative Diseases (DZNE), Magdeburg, Germany
5Mediaire GmbH, Berlin, Germany
6Center for Behavioral Brain Sciences (CBBS), Magdeburg, Germany

Background: Sporadic cerebral small vessel disease (CSVD) refers to microvascular brain pathologies leading to various types of tissue lesions. Typically, two main CSVD subtypes are differentiated based on the localization of hemorrhages in either strictly lobar (cerebral amyloid angiopathy, CAA) or deep regions (hypertensive arteriopathy, HA). Assignment of patients with hemorrhages in mixed (lobar and deep) regions to one or–simultaneously–both diagnoses is currently impossible. An analysis of (additional) hemorrhagic and nonhemorrhagic brain lesions (load, co-occurrence, localization, patterns) in these mixed cases may aid in a (better) classification.

Methods: We propose a web-based tool for an interactive visual analysis of individual and cohort CSVD lesion load. The tool supports three lesion types: white matter hyperintensities (WMH), enlarged perivascular spaces (ePVS) and cerebral microbleeds (CMB). In a pre-processing step, the lesions must be segmented in different MRI sequences and the image data as well as the masks must be co-registered.

The tool integrates multiple views for cohort specification [1] and visualization of lesion load (Fig. 1). It supports the comparison of several subcohorts, e.g., CAA, HA, mixed cases. A detailed representation of individual lesions and lesion co-occurrence are shown in 2D/3D. Since the cohort representation can quickly become cluttered due to many (overlapping) lesions, we included a more abstract visualization of the lesion load distribution using the bullseye brain parcellation [2].

Results: We evaluated the tool in a pilot study with 10 cases from clinical routine. Lesions were segmented using mdbrain (Mediaire GmbH) and Mango (RII, UT Health). Three CSVD experts tested the tool. They stated that it is very useful in detecting lesion patterns that may be characteristic for CAA or HA and support a better differentiation of mixed cases. They found for instance, that some cases had an asymmetrical lesion load in the frontal lobes deserving further investigation.

Discussion: The tool provides new insights about the lesion load and pattern of CSVD patients. To improve the analysis process, more statistical evaluation should be included in the tool. A follow-up study of 240 clinical cases is in progress.

Conclusion: The general principle of an interactive visual analysis of CSVD lesion load is a very promising approach to further research in CAA-HA differentiation.

References
Cerebral venous outflow profiles are associated with early edema progression rate on noncontrast computed tomography in ischemic stroke patients

Noel van Horn1*, Reza Kabiri1, Sören Christensen1, Michael Mlynash1, Gabriel Broocks1, Lukas Meyer1, Maarten Lansberg1, Gregory Albers1, Jens Fiehler1, Max Wintermark1, Jeremy Heit2, Tobias Faizy1

1Institut für Diagnostische und Interventionelle Neuroradiologie, Universitätsklinikum Hamburg-Eppendorf, Hamburg, Germany
2Stanford University, Department of Neurology and Neurological Sciences, USA
3Stanford University, Department of Radiology, USA

Background: Robust cortical venous outflow (VO) profiles correlate with favorable tissue perfusion in patients with acute ischemic stroke due to large vessel occlusion (AIS-LVO). In these patients, development of extensive early ischemic brain edema is associated with poor functional outcome, despite (after) treatment. We hypothesized that favorable VO profiles correlate with less early edema progression rate (EPR).

Methods: In this multicenter analysis we retrospectively investigated AIS-LVO patients treated by mechanical thrombectomy between January 2015 and December 2020. Baseline CT angiography (CTA) was used to determine VO using the cortical vein opacification score (COVES); favorable VO was defined as COVES ≥3. EPR was determined as the ratio of net water uptake (NWU) on baseline non-contrast CT and time from symptom onset to admission imaging. Multivariable regression analysis was used to assess the primary outcome (EPR).

Results: A total of 728 patients were included in this study. In univariable regression analysis lower COVES (p = 0.002), lower Maas collateral score (p = 0.005), a higher infracortical volume (p = 0.001) and the location of vessel occlusion (p = 0.003). Multivariable logistic regression analysis showed that higher COVES (OR: –0.01, 95% CI –0.021 to 0.004, p < 0.003) is associated with EPR.

Conclusion: A more favorable VO profile defined by a higher COVES is associated with lower EPR in AIS-LVO patients treated by endovascular thrombectomy.

References

Cerebral venous outflow profiles are associated with first-pass effect in endovascular thrombectomy

Noel van Horn1*, Reza Kabiri1, Marius Mader2, Sören Christensen1, Michael Mlynash1, Gabriel Broocks1, Jawed Nawahi1, Maarten Lansberg1, Gregory Albers1, Jens Fiehler1, Max Wintermark1, Jeremy Heit2, Tobias D. Faizy1

1Institut für Diagnostische und Interventionelle Neuroradiologie, Universitätsklinikum Hamburg-Eppendorf, Hamburg, Germany
2Klinik und Poliklinik für Neurochirurgie, Universitätsklinikum Hamburg-Eppendorf, Hamburg, Germany
3Stanford University, Department of Neurology and Neurological Sciences, USA
4Institut für Diagnostische und Interventionelle Radiologie, Universitätsklinikum Hamburg-Eppendorf, Hamburg, Germany
5Stanford University, Department of Radiology, USA

Background: Recent studies found that favorable venous outflow (VO) profiles are associated with higher reperfusion rates after mechanical thrombectomy (MT) in patients with acute ischemic stroke due to large vessel occlusion (AIS-LVO). Fewer retrieval attempts during MT lead to better functional outcomes, also due to the first-pass effect. We hypothesized that favorable VO profiles assessed on baseline computed tomography angiography (CTA) images correlate with successful vessel reperfusion after the first retrieval attempt.

Methods: Multicenter retrospective cohort study of AIS-LVO patients treated by MT. Baseline CTA was used to determine the cortical vein opacification score (COVES). Favorable VO was defined as COVES ≥3. Primary outcome was successful vessel reperfusion defined as Thrombolysis in Cerebral Infarction (TICI) 2b–3 after first retrieval attempt.

Results: A total of 617 patients were included in this study, of which 205 (33.2%) experienced first-pass reperfusion. In univariate analysis, higher COVES (p = 0.011) and shorter interval from symptom onset to groin puncture (p = 0.003) were independently associated with first-pass reperfusion after MT. In multivariable logistic regression analysis, higher COVES (OR = 0.84, 95% CI 0.73–0.98, p = 0.027) and higher Maas score (OR 1.28, 95% CI 1.08–1.53, p = 0.005) were associated with first-pass reperfusion, while intravenous application of alteplase indicated no independent correlation.

Conclusion: A robust cerebral VO profile classified as higher COVES is associated with first-pass reperfusion in patients with AIS-LVO treated by endovascular thrombectomy.

References

T2-FLAIR and quantitative MR

References
gung der fokalen Läsion abhängt. Unsere Ergebnisse weisen darauf hin, dass der axonale Verlust innerhalb der Läsionen nicht parallel mit der inflammatorischen Demyelinisierung entsteht, was hypothetisch auf teilweise axonal schützende Remyelinisierung zurückzuführen ist. Gleichzeitig verlaufen aber Demyelinisierung und axonaler Verlust außerhalb der Läsionen im NAIT parallel, hinweisend auf einen möglicherweise langsamer progredienten, homogenen degenerativen Prozess.

**Literatur**


[80] Vergleich zweier Thrombektomie-Versorgungskonzepte beim akuten Schlaganfall: „drip and ship“ vs. „drive the doctor“

Fatih Seker1, Christian Urbanek2, Jasmin Jung1*, Martin Bendszus1, Markus Möhlenbruch1

1Neuroradiologie, Universitätsklinikum Heidelberg, Deutschland
2Neurologie, Klinikum Ludwigshafen, Deutschland


Methoden: In dieser retrospektiven Arbeit wurden alle Schlaganfallpatienten untersucht, die von 2015 bis 2019 im Rahmen einer Koope-rationsvereinbarung zwischen einem Universitätsklinikum und einem städtischen Krankenhaus (ca. 30 km Entfernung) thrombektomiert worden sind. Die Patienten wurden je nach personeller bzw. technischer Kapazität entweder vom städtischen Krankenhaus an das Universitätsklinikum zwecks Thrombektomie verlegt (DS) oder vor Ort am städtischen Krankenhaus durch Anfahrt eines Neuroradiologen aus dem Universitätsklinikum thrombektomiert (DD). Gutes Outcome wurde definiert als mRS-Score bei Entlassung 0–2 bzw. unverändert gegenüber dem prämorbid mRS.

Ergebnisse: Insgesamt wurden 114 Patienten im Rahmen von DS und 179 Patienten im Rahmen von DD thrombektomiert. Gutes Outcome wurde ähnlich häufig in DS und DD erreicht (DS 6,3 % vs. DD 31,3 %; p=0,43). Auch hinsichtlich mRS bei Entlassung (DS median 4 [IQR 3–5], DD median 4 [IQR 2–5]; p=0,686) und NIHSS bei Entlassung (DS median 9 [IQR 3–21], DD median 7 [IQR 2–19]; p=0,208) gab es keinen signifikanten Unterschied zwischen beiden Gruppen.

Diskussion: In dieser retrospektiven Studie, in welcher „drip and ship“ und „drive the doctor“ direkt miteinander verglichen worden sind, konnte gezeigt werden, dass „drive the doctor“ hinsichtlich des klinischen Outcomes dem bereits etablierten „Drip and ship“-Konzept nicht unterlegen ist.

Fazit: Das „Drive-the-doctor“-Konzept, welches von anderen Schlaganfallnetzwerken auch unter diversen Namen publiziert worden ist, liefert gute klinische Ergebnisse und kann neben „mothership“ und „drip and ship“ als weiteres Konzept zur flächendeckenden Schlaganfallversorgung berücksichtigt werden.

[82] Diagnostic value of DW-MRI and 18F-FDG PET/CT in detection of residual/recurrent tumors after (chemo)radiotherapy for head and neck squamous cell carcinoma

Christophe Schroeder1, Jung-Hyun Lee2, Johannes Roßkopf3, Soung Yung Kim1*

1Department of Diagnostic and Interventional Radiology, Neu-Ulm, Germany
2Hospital Center Luxembourg–Center, Department of Diagnostic and Interventional Radiology, Luxembourg, Luxembourg
3Institute of Molecular Virology, Neu-Ulm, Germany
4Bezirkskrankenhaus Günzburg, Department of Neuroradiology, Günzburg, Germany

Background: Detection of residual or recurrent tumors in patients treated for head and neck squamous cell carcinoma (HNSCC) can be very challenging. This retrospective study compares the diagnostic accuracy of diffusion-weighted MR imaging (DW-MRI) and fluorine 18F-fluorodeoxyglucose (18F-FDG) PET/CT in detection residual or recurrent tumors and their local extension, in patients with HNSCC after treatment with (chemo)radiotherapy (CRT).

Methods: Twenty-five patients (17 men, 8 women, median age: 64 years, range: 53–86) who underwent surgical salvage for residual or recurrent tumors after (chemo)radiotherapy for head and neck squamous cell carcinoma (HNSCC) can can be very challenging. This retrospective study compares the diagnostic accuracy of diffusion-weighted MR imaging (DW-MRI) and fluorine 18F-fluorodeoxyglucose (18F-FDG) PET/CT in detection of residual or recurrent tumors and their local extension, in patients with HNSCC after treatment with (chemo)radiotherapy (CRT).

Results: Both DW-MRI and 18F-FDG PET/CT had a sensitivity of 92% (23/25) in the detection of residual or recurrent tumors. MRI had a sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) for detecting perineural spread of 62.5% (5/8), 88%. (15/17), 71% (5/7) and 83% (15/18), respectively; in compari-

son, PET/CT did not detect any cases of perineural spread. The sensitiv-
ity, specificity, PPV and NPV of MRI in detecting muscle infiltration was 75% (9/12), 77% (10/13), 75% (9/12) and 77% (10/13) respectively, while the values for 18F-FDG PET/CT were 58% (7/12), 69% (9/13), 64% (7/11) and 64% (9/14).
Discussion: The detection rate of residual or recurrent tumor was equally high in DW-MRI- and 18F FDG PET/CT with 92% (23/25). Prior studies in patients with HNSCC have shown that 18F FDG PET/CT has a higher diagnostic accuracy compared to MRI for assessment of untreated HNSCC or treated HNSCC. However, these studies did not include MRI with DWI, which obviously influences the diagnostic performance. In addition, DW-MRI can pinpoint suspicious areas where biopsy should be taken if needed. Therefore, we have assessed to measure the ability of biopsy where PET/MRI can pinpoint suspicious areas and assess to measure the ability of biopsy where PET/MRI cannot. Therefore, we investigated the reproducibility of PET/MRI for assessing perineural spread (PNS) and muscle infiltration.

Conclusion: DW-MRI and 18F-FDG PET/CT have an identical detection rate of residual or recurrent tumors after CRT. MRI has a higher sensitivity in detecting local perineural spread, has a better accuracy in the detection of muscle infiltration and more accurately correlates the lesion size to the histopathologic specimen.

[88] Multi-parametric quantitative mapping of R1, R2*, PD, and MTsat is reproducible when accelerated with Compressed SENSE

Ronja Berg1*, Tobias Leutritz2, Nikolaus Weiskopf2, Christine Preibisch1

1Technische Universität München, Klinikum rechts der Isar, Abteilung für Neuroradiologie, Fakultät für Medizin, München, Germany
2Max Planck Institut für Kognitions- und Neurowissenschaften, Abteilung Neurophysik, Leipzig, Germany

Introduction: Conventional clinical routines use qualitative magnetic resonance imaging (MRI) to assess diseased tissue. Multiparametric mapping (MPM) of R1, R2*, PD, and MTsat is a quantitative MRI method that promises better comparability across sites and higher sensitivity to systemic tissue changes. For clinical applications of MPM, the sequences need to be accelerated and their accuracy verified. Therefore, we investigated the reproducibility of MPM using Compressed SENSE acceleration.

Methods: Five healthy subjects were scanned three times on a Philips 3T Ingenia Elition. MPM comprised B1 mapping and gradient echo sequences with T1w: TR = 18 ms, α = 6°; PDw: TR = 18 ms, α = 4°; and MTw: TR = 48 ms, α = 6°, ΔTE = 220°; fMT = 8 ms, fTE = 1000 Hz; with 6 echoes each (TE1/ATE = 2.4/2.4 ms) and (1 mm)3 resolution. In each scan session, SENSE (20 min) and Compressed SENSE (CS) with acceleration factors CS = 4 (15:40 min) and CS = 6 (10:30 min) were used. Quantitative parameter maps (qMaps) were calculated using the hMRI toolbox [1, 2]. Coefficients of variation (CoV) were calculated across both scan sessions ("repeatability") and accelerations ("reproducibility" with different acceleration parameters) and were compared in whole-brain GM and WM.

Results: R1, R2*, PD and MTsat parameter maps appeared visually similar across different accelerations (Fig. 1a) and scan sessions (Fig. 2a). Repeatability-based CoV values of qMaps acquired with the same acceleration across scan sessions were comparable for SENSE, CS = 4, and CS = 6 (Fig. 1b). Likewise, reproducibility-based CoV values of qMaps acquired with different accelerations were comparable for scans A, B, and C (Fig. 2b). In GM and WM, subject-mean reproducibility-based
CoVs (green) were comparable to repeatability-based CoVs (blue) for R1 and PD and even slightly lower for R2* and MTsat (Fig. 3).

**Discussion:** Average R1 and PD showed similar variability across either scan sessions or accelerations, and average R2* and MTsat were even more stable (lower CoV) across accelerations than scan sessions. Together with the high visual similarity between qMaps acquired with different accelerations, this suggests that the highest investigated acceleration, CS with acceleration factor of 6, provides accurate MPM results.

**Conclusion:** As Compressed SENSE allows considerably reducing scan durations while providing accurate quantitative parameter maps, it facilitates MPM in clinical routines.

**References**
1. Tabelow 2019 NeuroImage
2. Weiskopf 2015 CurrOpinNeurol

[Perfusion imaging-based tissue-level collaterals are associated with early edema progression rate in ischemic stroke]

Noel van Horn1, Soren Christensen2, Michael Mlynash2, Reza Kabiri1, Gabriel Broocks1, Maarten Lansberg2, Gregory Albers2, Jens Fiehler1, Max Wintermark1, Jeremy Heit2, Tobias Faizy1,3

1Institut für Diagnostische und Interventionelle Neuroradiologie, Universitätsklinikum Hamburg-Eppendorf, Hamburg, Germany
2Department of Neurology and Neurological Sciences, Stanford University, USA
3Stanford University, Department of Radiology, USA

**Background:** Hypoperfusion intensity ratio (HIR) is an automated perfusion imaging-based assessment tool that quantifies tissue-level collaterals (TLC) and microperfusion in patients with acute ischemic stroke due to large vessel occlusion (AIS-LVO). Poor TLC status may be correlated with infarct growth and edema progression. To investigate the relationship between TLC and edema progression, reflected by ischemic lesion Net Water Uptake (NWU) on non-contrast head CT (NCCT). We hypothesized that favorable HIR is correlated with early edema progression rate (EPR) prior to treatment in AIS-LVO.

**Methods:** Multicenter retrospective analysis of AIS-LVO patients who underwent mechanical thrombectomy (MT). HIR was assessed on baseline CTP (defined as time-to-maximum [TMax]>10 s/[TMax]>6 s). Ischemic lesion NWU and EPR (quantitative NWU/time from symptom onset to baseline imaging) were assessed on baseline NCCT. Arterial collaterals were assessed by the Maas Score. Primary Outcome was EPR. Secondary outcome was poor outcome defined as a modified Rankin scale at 90-days (mRS90) of 3–6.

**Results:** A total of 718 patients were included. Multivariable logistic regression analysis showed higher (unfavorable) HIR (OR 0.06, 95% CI 0.23–0.10; \( p < 0.002 \)) and lower Maas collateral score (OR –0.18, 95% CI –0.03 to –0.005, \( p \)) were associated with higher EPR. Higher (unfavorable) HIR (OR 20.56, 95% CI 9.65–43.79, \( p < 0.001 \)) was also associated with mRS90 of 3–6.

**Conclusion:** A favorable cerebral collateral status at a tissue level (TLC) was associated with a lower early edema progression rate and decreased total NWU on baseline non contrast head CT as well as good functional outcome in AIS-LVO patients.

**References**
Hintergrund: „Chemical exchange saturation transfer“(CEST)-MRT-Bildgebung ermöglicht in vivo die Quantifizierung körpereigener Metabolite von z. B. in Proteinen gebundenen Amidgruppen (Amid-Protonen-Transfer-CEST, APT-CEST), wie sie beispielsweise in Hirntumoren vorkommen [1, 2].

Methoden: Es wurden APT-CEST-Assymmetriedaten am 3-T-MRT (Skyra, Siemens) an einer Kohorte von Hirntumorpatienten unter Therapie erhoben (n=27; 6 Glioblastome multiforme, 6 Meningeome, 4 Lymphome, 11 intrazerebrale Metastasen). Mittels ROI-basierten Analysen wurden Sensitivitäten (Sens) und Spezifitäten (Spez) über ROC-Kurven bestimmt. Als Vergleich wurden Diffusions-(ADC-) und Perfusionsbildgebung (rCBV, relatives Blutvolumen) als weitere fortgeschrittene MRT-Sequenzen herangezogen.

Ergebnisse: Die kontrastmittelverurnehmenden Tumoranteile zeigten statistisch signifikant höhere APT-CEST-Werte als die normal erscheinende weiße Hirnsubstanz (NAWM) bei einer Sensitivität von 89 % und einer Spezifität von 78 % (0,32 vs. –0,64; p<0,05). Hirneigene Tumoren wiesen im Durchschnitt höhere CEST-Signale als Metastasen auf (–0,67 vs. –0,20; p<0,05; Sens/Spez 81 %/55 %). Die Perfusionsbildgebung bei Glioblastomen liefert zu CEST vergleichbare Ergebnisse. ADC ergab keine Signifikanz hinsichtlich Differenzierung zwischen Tumor und NAWM oder zwischen hinneigene Tumoren und Metastasen.


Literatur

[98] Automated detection and quantification of brain metastases on clinical MRI data using artificial neural networks: improving the assessment accuracy of disease burden

Irada Pflüger1, Fabian Isensee2, Tassilo Wald3, Marianne Schell1, Hagen Meredig1, Kai Schlamp1, Claus Peter Heußel1, Denise Bernhardt2, Wolfgang Wick2, Klaus H Maier-Hein1, Martin Bendszus1, Philipp Vollmuth2
1University of Heidelberg Medical Center, Department of Neuroradiology, Heidelberg, Germany
2German Cancer Research Center (DKFZ), Medical Image Computing, Heidelberg, Germany
3Clinic for Thoracic Diseases (Thoraxklinik), Department of Diagnostic and Interventional Radiology with Nuclear Medicine, Heidelberg, Germany
4Translational Lung Research Center Heidelberg (TLRC), Heidelberg, Germany
5Klinikum rechts der Isar, Technical University Munich, Department of Radiation Oncology, München, Germany
6University of Heidelberg Medical Center, Department of Neurology, Heidelberg, Germany
7German Cancer Research Center (DKFZ), Clinical Cooperation Unit Neurooncology, Heidelberg, Germany

Background: The growth dynamic of brain metastases (BM) is an essential criterion for the assessment of the efficiency of a therapy. It is mainly determined by MRI by manual measurements of the targeted lesions according to the Response Assessment in Neuro-Oncology [1]. This is potentially less accurate and reproducible than volumetric measurements. Therefore, we evaluate the potential of artificial neural networks (ANN) for automated volumetric assessment of BM burden.

Methods: The development and testing of the ANN for automated detection and segmentation of contrast-enhancing tumors (CE) and non-enhancing FLAIR signal abnormalities (NE) on MRI were performed on a single institutional cohort of 308 patients with BM from several primary cancer scanned on a 3T MRI. Independent testing was done in a dataset with 30 patients with BM from lung cancer scanned on a 1.5T MRI. The performance was assessed separately per scan for CE and NEC using case-wise DICE coefficient (C-DICE) and concordance correlation coefficient (CCC). Also, we evaluated performance for CE per lesion using lesion detection performance (LPPV), lesion-wise positive predictive value (LPPV) and lesion sensitivity (L-Sensitivity).

Results: The ANN shows good performance for accurate detection and segmentation of CE and NEC in both test datasets per scan (median C-DICE for CE 0.91 and for NEC 0.96 in institutional test set, and for CE 0.84 and for NEC 0.83 in independent test set), and the CCC was ≥0.98 in each dataset. A similar good performance (mean L-DICE) was reached in both institutional (0.72) and independent (0.79) test sets. In institutional test set mean L-Sensitivity and LPPV for CE were 0.74 and 0.89 accordingly, as compared to 0.84 for L-Sensitivity and 0.76 for LPPV in independent test set.

Discussion: We showed that automated quantitative analysis of MRI using ANN could allow radiologist and clinicians to overcome the inherent limitations of manual assessment of tumor burden. This has important implications particularly in the context of longitudinal follow-up, because of intrinsic human variability e.g. small changes in disease burden may be overlooked.

Conclusion: Our results highlight the capability of ANN for reliable, automated volumetric quantification of BM and precise differentiation between CE and NEC on MRI. Our developments can improve the quantitative assessment of disease burden and disease progression on MRI in patients with BM.

References


Alexander Rau1, Roland Rötz2, Horst Urbachi1, Volker Arnd Coenen2, Theo Demerath1, Peter Reinacher3
1Universitätsklinikum Freiburg, Klinik für Neuroradiologie, Freiburg im Breisgau, Germany
Augmented reality greatly improved accuracy of simulation-guided percutaneous rhizotomy of the Gasserian ganglion.

Methods: A head phantom with soft tissue structures of the facial area was built. A 3D dataset of the phantom was generated using a stereotactic planning workstation. An optimal trajectory to the foramen ovale was created and then transferred to an AR headset. Two neurosurgeons and two neuroradiologists independently performed eight augmented reality-guided and eight landmark-guided cannulations of the foramen ovale, respectively. For each AR-guided cannulation, the hologram was manually aligned with the phantom. Accuracy was evaluated using the Euclidean distance to the target point as well as the lateral deviation between the achieved trajectory from the planned trajectory at target point level.

Results: With the help of augmented reality, a successful cannulation of the foramen ovale was achieved in 90.6% compared to the purely landmark-based method with 18.8%. Euclidean distance and lateral deviation were significantly lower with AR guidance than landmark-guided (p < 0.01).

Discussion: We see a great potential of AR-based planning and execution for minimizing risks of cannulation of the foramen ovale. This minimally invasive procedure is challenging and is subject to several considerable risks due to the proximity of the foramen ovale to critical structures. Beside CT guidance, intra-or perioperative imaging modalities such as MRI have also been established. However, these are usually resource intensive, include radiation exposure, or invasive head fixation.

Conclusion: Augmented reality greatly improved accuracy of simulated percutaneous rhizotomy of the Gasserian ganglion.

Funding: The authors received no financial support.

Conflict of Interest: The authors have no conflicts of interest.

References:

1. Klinik für Neuroradiologie, Universitätsklinik Magdeburg, Magdeburg, Deutschland
2. Forschungscampus STIMULATE, Magdeburg, Deutschland
3. AMEOS Klinik Bernburg, Bernburg, Deutschland
4. Klinik für Neurochirurgie, Universitätsklinik Magdeburg, Deutschland
5. Department of Simulation and Graphics, Universität Magdeburg, Deutschland
6. Department of Fluid Mechanics and Technical Flows, Universität Magdeburg, Deutschland


Ergebnisse: Wir konnten ein strukturiertes Reporting für anspruchsvolle geometrische und hämodynamische Aneurysmaanalysen produzieren, welches ohne besondere Hardware semiautomatisch erzeugt werden kann.

Diskussion: Strukturierte Reports zu diversen relevanten Aneurysmamis- risikofaktoren existieren bisher nicht und ergänzen bestehende klinische Scores um wichtige Informationen.

Fazit: Strukturiertes Reporting hämodynamischer und geometrischer Aneurysmamis- risikofaktoren ist praktisch durchführbar und kann die Beratung von Patient*innen mit unrupturierten intrakraniellen Aneurysmen in der Zukunft deutlich verbessern.
Aneurysma Rupture Risk Assessment

KJ87456^*

**Clinical Scores**

<table>
<thead>
<tr>
<th>PHASES</th>
<th>Score</th>
<th>5-year risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>UIATS</td>
<td>10</td>
<td>1.2%</td>
</tr>
</tbody>
</table>

All 5 morphological parameters together result in a high risk of rupture.

All 5 hemodynamic parameters together result in a high risk of rupture.

Associated Rupture Risk^1

^1Sections that have an ^ in the title are excluded in the “Associated Rupture Risk” analysis.
Increased interstitial fluid in periventricular caps and deep white matter hyperintensities in patients with suspected iNPH

Theo Demerath1*, Alexander Rau1, Marco Reisert2, Elias Kellner1, Jonas Hosp1, Horst Urbach1

1Neuroradiologie, Universitätsklinikum Freiburg, Deutschland
2Medizinphysik, Universitätsklinikum Freiburg, Deutschland

Background: Periventricular white matter changes are common in patients with idiopathic normal pressure hydrocephalus (iNPH) and considered to represent focally elevated interstitial fluid. We compared diffusion measures in periventricular caps in patients with imaging features of iNPH to patients without. The hypothesis is that periventricular caps in patients with possible iNPH show higher water content than in patients without imaging features of iNPH.

Methods: A total of 21 patients with iNPH Radscale 7–12 (“high probability of iNPH”) and 10 patients with iNPH Radscale 2–4 (“low probability of iNPH”) were examined with a neurodegeneration imaging protocol including a diffusion microstructure imaging sequence. Periventricular caps and deep white matter hyperintensities were segmented and diffusion measures were compared.

Results: In patients with iNPH, the free water content in periventricular caps was significantly higher compared to the control group (p<0.001). This effect was also detectable in deep white matter hyperintensities (p=0.002). Total brain volumes and total gray or white matter volumes did not differ between the groups. Periventricular free cap water fraction was highly discriminative regarding iNPH patients and controls with an ROC AUC of 0.933.

Discussion: Quantitative diffusion microstructure imaging shows elevated water content in periventricular caps and deep white matter lesions in patients with iNPH, which could be the imaging correlate for pathologic fluid accumulation.

Conclusion: Advanced diffusion imaging may be suitable for measuring increased white matter free water in patients with iNPH.

Within a minute* detection of focal cortical dysplasia (FCD)

Theo Demerath1*, Marcel Heers2, Dirk-Matthias Altenmüller2, Andreas Schulze-Bonhage2, Anke Maren Staack3, Thomas Bast4, Marco Reisert4, Ralf Schwarzwald4, Hans-Jürgen Hupperz4, Horst Urbach1

1Neuroradiologie, Universitätsklinikum Freiburg, Deutschland
2Neurochirurgie, Universitätsklinikum Freiburg, Deutschland
3Neurologie und Neurophysiologie, Universitätssklinikum Freiburg, Deutschland
4Medizinphysik, Universitätssklinikum Freiburg, Deutschland

Background: Focal cortical dysplasia (FCD) can be subtle and easily overlooked on MRI. Voxel-based morphometric analysis and automated FCD detection using a shallow artificial neural network (ANN) integrated in the Morphometric Analysis Program (MAP18) has been shown to facilitate FCD detection. The aim of our study was to evaluate ANN MAP using the MP2RAGE sequence for the enhanced and rapid FCD detection on MRI.

Methods: Prospective study including 40 consecutive, so far MRI-negative patients and 36 healthy controls. Post-processing of 3-Tesla MP2RAGE sequences to highlight typical FCD features. The resulting morphometric maps served as inputs for an artificial neural network facilitating FCD probability maps. The FCD probability maps were inversely normalized, co-registered to the MP2RAGE sequences and re-transferred into the PACS system. Co-registered images were scrolled through “within a minute” to determine whether a FCD was present or not.

Results: Fifteen FCD and three subcortical band heterotopias (SBH) were identified. Of those, four FCD and one SBH were only detected by MRI post-processing. False positive results occurred in 21 patients and 22 healthy controls. True positive cluster volumes were significantly larger than volumes of false positive clusters (p<0.001). The area under the curve of the receiver operating curve was 0.851 with a cut-off volume of 0.05 ml best indicating a FCD.

Discussion: Automated MRI post-processing and presentation of co-registered output maps in the PACS allowed for rapid (i.e. “within a minute”) identification of FCDs. The presence of false-positive findings currently requires a careful comparison with conventional MR images but may be reduced in the future using a ANN better adapted to MP2RAGE images.

Conclusion: Morphometric Analysis Program (MAP18) post-processing of 3-Tesla MP2RAGE sequences using artificial neural networks facilitates the FCD detection and is a promising tool for radiologists less experienced with epilepsy imaging.

Long-term epilepsy-associated tumors (LEATs): a voxel-based neuroimaging analysis

Urs Würtemberger1, Theo Demerath1, Christoph Kaller1, Niklas Lützen1, Elias Kellner1, Rösch Julie2, Arnd Dörfler2, Rössler Karl1, Blümcke Ingmar4, Horst Urbach1

1Klinik für Neuroradiologie, Uniklinik Freiburg, Freiburg, Germany
2Neuroradiologische Abteilung, Universitätsklinik Erlangen, Erlangen, Germany
3Universitätsklinik für Neurochirurgie des Allgemeinen Krankenhauses Wien, Universitätsklinikum AKH Wien, Wien, Austria
4Neuropathologisches Institut, Universitätssklinik Erlangen, Erlangen, Germany

Background: Long-term epilepsy-associated tumors (LEATs) are cortical-subcortical tumors in which preferential localization in the temporal lobe has been described (1). The aim of our work was to sta-
Statistically compare the spatial distribution of gangliogliomas (CD34+ and –), DNET, PXA, and ANET.

**Methods:** Preoperative MR images of 157 patients with histologically confirmed LEATs were retrospectively evaluated. All tumors were segmented semiautomatically and registered to MNI space. Based on the respective lesion center, standardized atlases were used to visualize and compare lesion localization.

**Results:** Four larger subgroups were identified: gangliogliomas ($n = 100$) with ($GG+$) and without ($GG–$) CD34 immunoreactivity, DNETs ($n = 32$), ANETs ($n = 8$), and PXA ($n = 17$). Gangliogliomas are significantly more likely temporally located than DNETs ($p = 0.005$). Similarly, $GG+$ are significantly more often temporally localized than $GG–$ gangliogliomas ($p = 0.024$).

**Discussion:** Gangliogliomas, in contrast to DNET, differ significantly in their localization preference regarding the temporal lobe. The much more frequent extratemporal location of CD34 negative gangliogliomas supports the hypothesis that they may represent a separate tumor entity (“GNET”; [2]).

**Conclusion:** Voxel-based lesion analysis provides new aspects of preferential tumor localization in LEATs.

---

Fig. 1 111 Axial MP2RAGE image with a FCD IIB of the right superior frontal gyrus (a). Post-processing with a data base of 154 healthy controls results in the calculation of junction (b), thickness (c), and extension maps (d). These serve among others as input maps for an ANN that creates binary output maps (e). FLAIR images should be considered to separate the FCD and false positives (f). Finally, co-registered output and MP2RAGE maps are sent back to the PACS system (g, h).

Fig. 1 113 Color map of LEAT tumor distribution in coronal view on MNI Space (yellow CD34+ GGL, red CD34– GGL, blue DNET, cyan PXA, green ANET)

**References**


[117] Artificial intelligence substantially improves differential diagnosis of dementia—added diagnostic value of rapid brain volumetry

Jan Rudolph1, Johannes Rückel1, Jörg Döpfner2, Wen Xin Ling1, Jens Opalka2, Christian Brem1, Nina Hesse1, Boris Rauchmann1, Maria Ingenieur1, Vanessa Koliogiannis1, Olga Solyanik1, Hanna Zimmermann1, Wilhelm Platz1, Robert Forbrig1, Maximilian Patzig1, Oliver Peters1, 3, Josef Priller1, 3, 4, Anja Schneider1, 4, Klaus Fließbach1, 5, Andreas Hermann1, 6, Jens Wiltfang1, 7, Frank Jessen7, 14, 15, Emrah Düzel16, 17, Katharina Bürger18, 19, Stefan Teipel20, 21, Christoph Laske22, 23, Matthias Synofzik22, 24, A. Spottke25, 26, Michael Ewers18, 27, Klaus Scheffler27, Jens Ricke1, Michael Ingrisch1, Sophia Stöcklein1

1Klinik und Poliklinik für Radiologie, München, Germany
2Mediaire GmbH, Berlin, Germany
3Institut für Diagnostische und Interventionelle Neuroradiologie, München, Germany
4Deutsches Zentrum für Neurodegenerative Erkrankungen (DZNE), Berlin, Germany
5Klinik für Psychiatrie und Psychotherapie, Charité–Universitätsmedizin Berlin, Berlin, Germany
6Klinik für Psychiatrie und Psychotherapie, Klinikum rechts der Isar der Technischen Universität München, München, Germany
7Deutsches Zentrum für Neurodegenerative Erkrankungen (DZNE), Bonn, Germany
8Klinik für Neurodegenerative Erkrankungen und Gerontopsychiatrie, Universitätsklinikum Bonn, Bonn, Germany
9Deutsches Zentrum für Neurodegenerative Erkrankungen e. V. (DZNE), Dresden, Germany
Tab. 1 Spatial distribution of GG+ and GG- regarding the temporal lobe

<table>
<thead>
<tr>
<th></th>
<th>Other</th>
<th>TL</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>GG-</td>
<td>8</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>GG+</td>
<td>21</td>
<td>64</td>
<td>85</td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>71</td>
<td>100</td>
</tr>
</tbody>
</table>

Tab. 2 Spatial distribution of GGL and DNET regarding the temporal lobe

<table>
<thead>
<tr>
<th></th>
<th>Other</th>
<th>TL</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>GGL</td>
<td>29</td>
<td>71</td>
<td>100</td>
</tr>
<tr>
<td>DNET</td>
<td>18</td>
<td>14</td>
<td>32</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>85</td>
<td>132</td>
</tr>
</tbody>
</table>

Background: Brain volumetry is a key aspect in dementia diagnostics. We applied an artificial intelligence (AI) system based on a Convolutional Neural Network (CNN) which aims to perform lobe-separated rapid brain volumetry (<1/2 h) of three-dimensional T1-weighted magnetic resonance imaging (MRI) with automated segmentation as well as comparison to age- and gender-adapted percentiles. Our aim was to quantify the added value in the differential diagnostics of dementia.

Methods: A total of 55 patients—17 with confirmed diagnosis of Alzheimer’s disease (AD), 18 with confirmed diagnosis of frontotemporal dementia (FTD) and 20 healthy controls—received T1-weighted three-dimensional magnetization prepared–rapid gradient echo (MP-RAGE) MRI. Images were retrospectively assessed by one board-certified neuroradiologist (BCNR) and two radiology residents (RR)—one of whom had received 6 months of neuroradiology training (RR1). All cases were evaluated in a two-step reading process—beginning without AI-support and followed by an AI-supported reading (AI tool: mdr-brain version 3.3.0). For each subject, the suspected diagnostic category (AD, FTD and healthy controls) was determined using a likelihood score (0–5), adding up to a sum of 5 for all three diagnostic categories. Individual reader performance with and without AI support was statistically evaluated using receiver operating characteristics (ROC).

Results: AI support substantially improved AD diagnosis in all three readers. The effect was most pronounced for RR2 who had not undergone neuroradiology training (area under the curve [AUC] without AI support [–AI]: 0.629, AI supported [+AI]: 0.885). But, even for the BCNR, a substantial benefit was measurable (AUCs: BCNR—AI: 0.827, + AI: 0.882; RR1—AI: 0.713, + AI: 0.834). In diagnosing FTD RR2 improved with AI support (AUCs:—AI: 0.610, + AI: 0.754), while BCNR and RR1 had comparable reading performances with and without AI support (AUCs: BCNR—AI: 0.843, + AI: 0.828; RR1—AI: 0.865, + AI: 0.868).

Discussion: Even experienced BCNR can improve their diagnostic accuracy for AD by using AI based rapid brain volumetry and comparison with the age- and gender-matched reference cohorts. In diagnosing FTD, especially radiologists who are less experienced in dementia differential diagnosis can strongly benefit from AI support.

Conclusion: AI support in the radiological work-up of dementia patients is feasible and can substantially improve diagnostic accuracy, which might lead to earlier diagnosis and therefore optimized patient management.


Christian Nelles1, Kai Roman Lautkamp1, Charlotte Zaeske1, Nils Große Hokamp1, Simon Lennartz1, Christoph Kabbasch1, Marc Schlammann1, David Zopfs1

1Institut für Diagnostische und Interventionelle Radiologie, Universitätsklinik Köln, Köln, Deutschland

Hintergrund: Vor stereotaktischer Biopsie von Hirnläsionen erfolgt häufig eine kontrastmittelgestützte CT des Kopfes zur Interventionsplanung, in der die Unterscheidung zwischen Enhancement und verkalkten Strukturen schwierig ist. Ziel der Studie war es, virtuell native Bilder (VNC) der Dual-Layer-Dual-Energy-CT (dlDECT) im Vergleich zu konventionellen Bildern (CI) zur Differenzierung wandaussatzer Verkalkung von Kontrastmittelaufnahme und Verkalkungen zystischer intrakranieller Tumoren zu untersuchen.


Ergebnisse: Die diagnostische Genauigkeit stieg unter zusätzlicher Verwendung von VNC im Vergleich zu CI von 64 % auf 83 % (p<0,01). Die diagnostische Sicherheit stieg von 3 (2–3) auf 4 (4–8).
123, während das Bildrauschen in VNC niedriger bewertet wurde: CI 5 (4–5) vs. VNC 4 (3–5), \( p < 0.01 \). Während in CI die Unterschiede der Kontrast-zu-Rausch-Verhältnisse zwischen weißer Hirnsubstanz und randständiger Verkalkung bzw. Kontrastmittelaußauerhne nicht signifikant waren (2.9 vs. 3.5; \( p = 0.07 \)), unterschieden sich diese in VNC signifikant (2.6 vs. 1.3; \( p < 0.01 \)).

**Diskussion:** Die zusätzliche Verwendung von VNC ergab gegenüber CI eine signifikant höhere diagnostische Genauigkeit und Sicherheit bei der Beurteilung von wandassoziierter Kontrastmittelaußauerhne und Verkalkungen zystischer Hirnläsionen.

**Fazit:** VNC der dDECT erleichtern eine Differenzierung randständiger Verkalkungen und randständigen Enhancements in stereotaktischen Planungs-CT-Untersuchungen bei Patienten mit zystischen Hirntumoren.

[126] Vermindertes Hypothalamusvolumen ist assoziiert mit vermindertem Körperwachstum bei sehr frühgeborenen Erwachsenen

Tobias Ruzok¹, Benita Schmitz-Koep¹, Aurore Menegaux¹, Robert Eves², Dieter Wolke³, Peter Bartmann⁴, Claus Zimmer¹, Christian Sorg¹, Dennis Hedderich¹,²

¹Abteilung für Diagnostische und Interventionelle Neuroradiologie, Klinikum rechts der Isar—Neuro-Kopf-Zentrum, Technische Universität München, München, Deutschland
²TUM-NIC Neuroimaging Center, Klinikum rechts der Isar, Technische Universität München, München, Deutschland
³Department of Psychology, Lifespan Health and Wellbeing Group, University of Warwick, Coventry, Vereinigtes Königreich
⁴Warwick Medical School, University of Warwick, Coventry, Vereinigtes Königreich
⁵Abteilung für Neonatologie, Universitätsklinikum Bonn, Bonn, Deutschland
⁶Abteilung für Psychiatrie und Psychotherapie, Klinikum rechts der Isar, Technische Universität München, München, Deutschland

**Hintergrund:** Nach Frühgeburt zeigen sich häufig eine verringerte Körpergröße und -gewicht bis ins Erwachsenenalter, allerdings ist noch nicht vollständig verstanden, welche Faktoren oder Mechanismen dies bedingen. Der Hypothalamus (HYP) und ausgewählte Kerngebiete (z. B. Ncl. paraventricularis und Ncl. infundibularis) regulieren u. a. Körperwachstumsprozesse. Neuartige Segmentierungsalgorithmen erlauben die Identifikation von HYP-Subsegmenten in strukturellen MRT-Untersuchungen des Gehirns. Wir vermuten strukturelle HYP-
tum assoziiert sind. 

**Methoden:** HYP-Subsegmentsegmentierung mittels Deep Convolutional Neural Network Algorithmus [1] anhand T1-gewichteter MRT (MPRAGE, 1 mm isotrop) von 101 sehr frühgeborenen Erwachsenen (Geburt vor der 32. Schwangerschaftswoche und/oder Geburtsgewicht <1500 g) und 110 Kontrollpersonen, als Teil der „Bayerischen Entwicklungsstudie“.

**Ergebnisse:** Die Volumina des gesamten HYP und aller Subsegmente sind bei den frühgeborenen Erwachsenen vermindert ($p<0,05$, kontrolliert u. a. für intrakranielles Volumen und multiples Testen). Es zeigt sich eine signifikante Korrelation des HYP mit Variablen der Frühgeburtslichkeit (Schwangerschaftswoche bei Geburt, „Intensity of Neonatal Treatment Index“), insbesondere für mit Wachstumsverzögerungen assoziierten Subsegmenten. Letztere sind nicht nur mit dem Körpergewicht im Erwachsenenalter assoziiert, sondern vermitteln auch die Beziehung von Frühgeburtsvariablen mit diesem. Hierbei tritt vorrangig das Subsegment „antubsup“ als Mediator auf, welches sich durch Zusammenfügen zweier der fünf aus dem HYP segmentierten Untereinheiten ergibt und dadurch u. a. den Ncl. paraventricularis enthält (Abb. 1).

**Diskussion:** Die Volumina des HYP und seiner Kerngebiete hängen bei Frühgeburt mit Körperwachstum zusammen, wobei ursächlich auch andere ZNS-Ursachen und Komorbiditäten, maternale und genetische, umwelteinflusste sowie endokrinologisch/metabolische Ursachen miteinbezogen werden müssen. Die Berücksichtigung individueller Wachstumstrajektorien und longitudinal erhobener MRT-Bilddaten könnte derartige Einflüsse weiter spezifizieren.

**Fazit:** Im Erwachsenenalter besteht eine Volumenverringerung des HYP nach Frühgeburtt, die mutmaßlichen Einfluss von Frühgeburtt auf das erwachsene Körpergewicht vermittelt.

**Literatur**

[127] Improving automated glioma segmentation in routine clinical use through AI-based replacement of missing sequences with synthetic MR images

Marie Thomas1*, Florian Kofler1, Lioba Grundl1, Tom Finck1, Hongwei LI2, Claus Zimmer3, Björn Menze3, Benedikt Wiestler1

Klinikum rechts der Isar der Technischen Universität München, Abteilung für diagnostische und interventionelle Neuroradiologie, München, Germany
Technische Universität München, Chair for Computer Aided Medical Procedures & Augmented Reality, Garching, Germany
Technische Universität München, Zentralinstitut für translationale Krebsforschung, München, Germany

**Background:** While automated glioma segmentation holds promise for objective assessment of tumor biology and response [1], its routine clinical use is impaired by missing sequences, e. g. due to motion artifacts. The aim of our study was to develop and validate a Generative Adversarial Network for synthesizing missing sequences to allow for a robust automated segmentation.

**Methods:** Our model was trained on data from The Cancer Imaging Archive [2] ($n=238$ WHO °II–°IV gliomas) to synthesize either missing FLAIR, T2w, T1w or contrast-enhanced T1w images from available sequences, using a novel tumor-targeting loss to improve synthesis of tumor areas. We validated performance in a test set from both the REMBRANDT repository and our local institution ($n=68$ WHO °II–°IV gliomas), using qualitative image appearance metrics, but also segmentation performance with state-of-the-art segmentation models. Segmentation of synthetic images was compared with two commonly used strategies for handling missing input data, entering a blank mask or copying an existing sequence.

**Results:** Across tumor areas and missing sequences, synthetic images generally outperformed both conventional approaches, in particular when FLAIR was missing. Here, for edema and whole tumor segmentation we improved the Dice score by 12% and 11%, respectively, over the best conventional method. No method was able to reliably replace missing contrast-enhanced T1w images.

**Conclusion:** Our approach significantly outperforms conventional strategies of handling missing input data. Importantly, this outperformance is stable across two very different, challenging glioma data sets, highlighting the robustness and clinical applicability of our model.

8 Springer

Methoden: 3-D-AVM-Oberflächenmodelle wurden von multimodalen Bildbäumen (3-D-DSA und -MRT) extrahiert. Für die virtuelle Embolisation wurden alle Feeder identifiziert und separat verschlossen. Für die Anzahl Feeder (n) würde eine Gesamtzahl von $n^2$ Blutflussimulationen mittels CFD durchgeführt. Ein Tool zur 3-D-Visualization des Flusses und seiner Veränderungen wurde die Game Engine Unity genutzt und der Fluss als Millionen kleiner Partikel dargestellt.

Ergebnisse: Das Softwaredoll zur virtuellen AVM-Embolisation erlaubt es den behandelnden Neurointerventionalist*innen, spezifische AVM im 3-D-Modell zu simulieren; hierbei können einzelne Feeder selektiv verschlossen werden und Fluss- bzw. Druckveränderungen so im Vorhinein abgeschätzt werden.

Diskussion: Die Planung einer AVM-Embolisation beruht aktuell fast ausschließlich auf der Erfahrung von Behandler*innen, das Tool zur virtuellen AVM Embolisation gibt nun eine Möglichkeit, dedizierte Fragen an Fluss- und Druckveränderungen einer AVM während einer Intervention zu planen.

Fazit: Da der Behandlungserfolg und das Risikomanagement einer AVM-Embolisation mit der hämodynamischen Balance während der AVM-Embolisation zusammenhängen, kann das Tool zur virtuellen Embolisation wertvolle Unterstützung bieten, um die richtige Embolisationsstrategie anzuwenden.

[132] Einfluss von Feedback über das Outcome von endovaskulär behandelten Schlaganfallpatienten auf die Arbeitszufriedenheit neuroradiologischer Personals

Charlotte Hager1, Homan Taufik1, Friederike Blum1, Andrea Stockero1, Rebecca May1, Arno Reich1, Martin Wiesmann1, Omid Nikoubashmann*1

1Uniklinik RWTH Aachen, Aachen, Deutschland

Hintergrund: In der endovaskulären Schlaganfalltherapie sind Therapie und der weitere Verlauf von Patienten häufig entkoppelt. Daher gaben wir auf Wunsch unseres Personals dem gesamten neuroradiologischen Personal, einschließlich Ärzten, MTRAs und Forschern, über einen Zeitraum von 6 Monaten per E-Mail systematisches Feedback über den weiteren klinischen Verlauf (Entlassung und 90-Tage-Follow-up) von endovaskulär behandelten Schlaganfallpatienten. Wir analysierten die Auswirkungen dieses Feedbacks auf die Arbeitszufriedenheit, die Bewertung der Sinnhaftigkeit der Arbeit und die Bewertung der endovaskulären Therapie.


Ergebnisse: Mitarbeiter mit höherer Bewertung der Sinnhaftigkeit ihrer Arbeit und höherer Arbeitszufriedenheit bewerteten die endovaskuläre Schlaganfalltherapie als nützlicher (p < 0,01). Ein gutes klinisches Ergebnis wurde als motivierend angesehen als ein gutes interventionelles Ergebnis (p < 0,001). Das Erhalten von systematischem Feedback erhöhte wesentlich die Arbeitszufriedenheit (p = 0,318) noch die Sinnhaftigkeit der Arbeit (p = 0,178). MTRAs bewerteten die Sinnhaftigkeit der Interventionstherapie am schlechtesten von allen Mitarbeitern (p ≤ 0,017). Nach der Feedback-Phase schätzten 75% der MTRAs den Schlaganfall als eine schwere Erkrankung ein als zuvor. Auch ihr Wunsch nach Feedback nahm signifikant ab (p = 0,007). Vor allem Falle mit ungünstigem Ausgang blieben den Mitarbeitern im Gedächtnis.


Fazit: Systematisches E-Mail-Feedback über den klinischen Verlauf von endovaskulär behandelten Schlaganfallpatienten erhöht nicht per se die Arbeitszufriedenheit, kann aber dazu dienen, das Bild über die Erkrankung und die Möglichkeiten der Therapie besser zu erfassen.

[134] Start, stop, continue? Overlapping intravenous thrombolysis and mechanical thrombectomy: a matched case-control analysis from the German Stroke Registry

Egon Burian1, Dominik Sepp1, Manuel Lehm1, Kathleen Bernkopf1, Silke Wunderlich1, Christian Maegerlein1, Claus Zimmer1, Tobias Boeck-Behrens1

1Abteilung für Neuroradiologie, Klinikum rechts der Isar, München, Germany
2Klinikum rechts der Isar der Technischen Universität München, München, Germany

Hintergrund: Intravenous thrombolysis is frequently started before mechanical thrombectomy in patients with large vessel occlusion. Reliable data on different clinical approaches regarding the temporal overlap of alteplase administration and the beginning of mechanical thrombectomy are scarce. Here we report the procedural and clinical outcome of patients undergoing thrombectomy with running thrombolysis to matched controls with completed intravenous therapy and no overlapping activity.

Methoden: Patients’ baseline characteristics (including ASPECTS, NIHSS and mRS), grade of reperfusion, and functional outcome 24 h at day 90 after intervention were extracted from the German Stroke Registry (n = 2566). In a case-control design we stepwise matched the groups due to age, sex and time to groin puncture and time to flow restoration. Surrogate parameters for early neurological improvement (ΔNIHSS baseline/NIHSS after 24 h and NIHSS 24 after hours of 0/1), procedural and functional outcome were compared between the two groups.

Results: In the initial cohort (overlap group n = 864, control group n = 1702) reperfusion status (median TICI in overlap group vs. control...
group: 3 vs 2b), NIHSS after 24 h, early neurological improvement parameters, mRs at 24 h and at day 90 were significantly better in the overlap group (p<0.001) with a similar risk of bleeding (2.9% vs. 2.4%) and death (18% vs. 22%).

After adjustment for age, sex, baseline NIHSS, ASPECTs and time to groin puncture and time to flow restoration, mRs at day 90 still showed a statistical tendency for lower disability scores in the overlap group (3 IQR 4 vs 3 IQR 5, p=0.09). While comparable bleeding risk could be maintained (4% in both groups), there were more deaths in the control group (18% vs. 30%).

**Discussion:** The presented results support the approach of continuing and completing a simultaneous administration of intravenous thrombolysis during mechanical thrombectomy procedures in patients with acute ischemic stroke.

**Conclusion:** Simultaneous administration of intravenous thrombolysis and initiation of mechanical thrombectomy is safe with comparable functional and procedural outcome as mechanical thrombectomy performed after completed alteplase treatment.

[138] Altered grey matter myelination in premature-born adults

Benita Schmitz-Koep1,2, Aurore Menegaux3,4, Claus Zimmer1,2, Christian Gaser5,6, Dieter Wolke5,6, Peter Bartmann7, Christian Sorg1,2,4, Dennis Hedderich1,2

1Abteilung für Diagnostische und Interventionelle Neuroradiologie, Klinikum rechts der Isar, Technische Universität München, München, Germany
2TUM-NIC Neuroimaging Center, Klinikum rechts der Isar, Technische Universität München, München, Germany
3Klinik für Neurologie, Universitätsklinikum Jena, Jena, Germany
4Klinik für Psychiatrie und Psychotherapie, Universitätsklinikum Jena, Jena, Germany
5Department of Psychology, University of Warwick, Coventry, United Kingdom
6Warwick Medical School, University of Warwick, Coventry, United Kingdom
7Abteilung für Neonatologie, Universitätsklinikum Bonn, Bonn, Germany
8Klinik und Poliklinik für Psychiatrie und Psychotherapie, Klinikum rechts der Isar, Technische Universität München, München, Germany

**Background:** Microscopic studies in newborns and animal models indicate impaired myelination after premature birth, particularly for cortical myelination; however, it is not clear whether myelination impairments of prematurity last into adulthood and – if so – are relevant for impaired cognitive performance. The ratio of T1w and T2w MRI signal intensity is a proxy for myelin content. We hypothesized altered grey matter (GM) T1w/T2w ratio in premature-born adults, which is associated with lower cognitive performance after premature birth.

**Methods:** We analyzed the T1w/T2w ratio in GM in 101 very premature-born adults (<32 weeks of gestation and/or birth-weight <1500 g, VP/VLBW) and 109 full-term (FT) controls at 26 years of age. Cognitive performance was assessed by verbal, performance, and full-scale intelligence quotient (IQ) using the Wechsler Adult Intelligence Scale.

**Results:** We found significantly (p<0.05, FDR-corrected, cluster size >10 voxels) higher T1w/T2w ratio in VP/VLBW subjects compared to FT controls in widespread cortical areas, particularly in frontal, parietal and temporal cortices, and in bilateral thalamus, putamen, pallidum, hippocampus and amygdala. Furthermore, we found significantly lower T1w/T2w ratio in bilateral superior temporal gyrus which was positively associated with gestational age and birth weight, and approximated a significant positive relationship with verbal IQ in the VP/VLBW group.

**Discussion:** In VP children, lower T1w/T2w ratio has been reported in the temporal lobes, occipital lobes, thalamus, putamen and amygdala. However, GM myelination is an ongoing process with an inverted U-shaped trajectory and a steep increase until the end of the 30s. Hence, findings of increased T1w/T2w ratio could reflect reorganization of cortical myelin architecture, while lower T1w/T2w ratio might indicate particular vulnerability with lastingly reduced myelination after premature birth, possibly as a consequence of dysmaturational processes such as pre-oligodendrocyte death.

**Conclusion:** T1w/T2w ratio in GM is lastingly altered after premature birth, indicating aberrant GM myelination.

**References**


Samer Elsheikh1*, Markus Möhlenbruch1, Fatih Seker2, Ansgar Berlis3, Christoph Maurer1, Naci Kocer4, Ala Jamous1, Daniel Behme5,*, Horst Urbach1, Stephan Meckel1,6

1Neurozentrum der Uniklinik Freiburg, Freiburg im Breisgau, Germany
2Universitätsklinikum Heidelberg, Heidelberg, Germany
3Universitätsklinikum Augsburg, Augsburg, Germany
4Istanbul Universitesi-Cerrahpaşa, Radiology Department, Division of Neuroradiology, Turkey
5Institut für Diagnostische und Interventionelle Neuroradiologie–Universitätsmedizin Göttingen, Göttingen, Germany
6Otto-von-Guericke-Universität Magdeburg, Institut für Neuroradiologie, Magdeburg, Germany
7Johannes Kepler Universität Linz–JKU, Linz, Austria

Background: Ruptured basilar artery perforator aneurysms (BAPAs) represent a very rare cause of subarachnoid hemorrhage and under-reported subtype of cerebral aneurysm. There is no consensus for the optimal treatment strategy (conservative vs. surgical vs. various endovascular approaches). We aim to present a multicenter experience of BAPA treatment using flow-diverter (FD) stents.

Methods: At five large tertiary neurovascular centers, all cases of ruptured BAPAs treated by FD were retrospectively collected. Baseline imaging and clinical characteristics, complications, as well as early and long-term angiographic and clinical outcome (mRS) were analyzed.

Results: A total of 18 patients (mean age: 57; SD ±10.7 years) with acute SAH related to a BAPA were treated using 18 FD stents. Aneurysms were detected on initial imaging study in 28%; delayed diagnosis was triggered by clinical deterioration due to rebleeding in 15%. No rebleeding after FD was seen, 28% developed FD-related ischemic complications. At long-term (n = 16), overall mortality was 13% (2/16), and favorable outcome (mRS 0–2) was 81% (13/16). All BAPAs were completely occluded at long-term angiographic follow-up.

Discussion: In this pooled multi-center cohort is, to our knowledge, the largest published case-series of FD treatment of BAPAs. BAPAs are usually small and commonly not diagnosed in the acute neurovascular imaging. Early rebleeding is not uncommon. Treatment using FD mandates long-term antiplatelet therapy. The need for antiplatelet therapy may collide with acute operative procedures (e.g. drainage of acute hydrocephalus). Careful coordination is important to avoid bleeding complications. Ischemia is an important complication both in conservative and endovascular treatment of BAPAs. As spontaneous resolution is well documented in the literature, conservative treatment is a valid alternative strategy. Although the occlusion rate is lower compared to endovascular therapy, the outcome of both strategies is comparable. Due to the rarity of BAPAs, there is no clear evidence favoring conservative vs. endovascular treatment.

Conclusion: In our retrospective multicenter experience, FD was a safe and effective treatment for ruptured BAPAs exhibiting complete angiographic occlusion, protection from rebleeding, and a high rate of favorable outcome. Future studies comparing FD to conservative management are required to define the optimal treatment strategy.

[142] Ätiologie und klinische Relevanz von extravasalen Kontrastmittelakkumulationen in der kranialen Computertomographie nach endovaskulärer Behandlung inzidenteller zerebraler Aneurysmen

Jenna Schellin1*, Hannes Schacht1, Peter Schramm2, Alexander Neumann1

1Lübeck, UKSH, Campus Lübeck, Lübeck, Deutschland

Hintergrund: Nach endovaskulärer Therapie (ET) von zerebralen Aneurysmen (CA) sind abweichende Befunde mit Kontrastmittelakkumulationen (KMA) in der kranialen Computertomographie (CCT) beschrieben. Diese können eine Blutung vortäuschen und mit klinischen Symptomen einhergehen.


Ergebnisse: Nach 17/62 ET von CA (27,4%) zeigten sich extravasale KMA in der CCT; in 2 Fällen (3,2%) zunächst unauffällige CCT, in der Verlaufs bildgebung Nachweis einer peripheren SAB. In der logistischen Regressionsanalyse signifikante Assoziation von KMA sowohl mit der Interventionsdauer (p = 0,038) als auch mit der verwendeten TAH (p = 0,04; häufiger KMA bei Mono- als bei dualer TAH). Signifikanter Zusammenhang von Symptomen und KMA (p = 0,01), jeweils vollständig reversibel.

Diskussion: Bislang spärliche Literatur zu Befunden in der CCT unmittelbar nach ET von CA und Einflussfaktoren [1, 2]. Hier bislang größte Fallserie zu speziell auftretenden symmetrischen CA und Berück- sichtigung erstmals auch moderener Devices (IFD, TFD).

Fazit: EDS im CCT sind nach der ET von CA ein häufiger Befund, in der Mehrzahl KMA entsprechend. Möglicher Zusammenhang mit Symptomen, die bei uns auftreten und reversibel waren. KMA sind als wichtige DD zu Blutung oder Infarkt zu bedenken.

Literatur

[144] Effects of videogaming on dexterity while learning neurointerventional techniques

Sebastian Reder1, Annaïg Rohou2, Naureen Keric3, Carolin Brockmann1, Mario Alberto Abello Mercado1, Sebastian Altmann4, Ahmed Ohman5, Marc A. Brockmann1

1Department of Neuroradiology, University Medical Center Mainz, Mainz, Germany
2Faculty of Psychology, University of Graz, Graz, Austria
3Department of Neurosurgery, University Medical Center Mainz, Mainz, Germany
4Department of Radiology, University Medical Center Mainz, Mainz, Germany

Background: Playing video games has been discussed to influence dexterity of individuals while learning and practicing medical techniques. There is no data available on the effects of video gaming experience on learning neurointerventional techniques.

Methods: Performance of 64 subjects (35 Gamer, 29 Non-gamer) naïve to neurointerventional techniques were analysed solving four neurointerventional tasks using a simulator. After a standardized short training sequence required time, number and pathway of catheter movements and tries to pass vascular branches were analysed. Afterwards, subjects had to answer a questionnaire regarding videogaming activities and other skills possibly influencing manual dexterity including NASA Task Load Index to rate individual workload.

Results: Gamer (G) required fewer tries to pass vascular branches with vertebral-(V) and sidewinder-shaped (SW) catheters (5.03±3.4 vs. 6.6±3±6; p=0.035 respectively 24.7±16.6 vs. 34.4±23.9; p=0.08), V-pathway (25.1±10.6 cm vs. 30.8±15.5 cm; p=0.085) and time (V+SW): 308.3±227.4 s vs. 372.7±215.2 s; p=0.059 respectively SW: 255.8±222.2 s vs. 315.3±206.9 s; p=0.079) than Non-gamer (NG). For G, perceived stress-level correlated positive to pathway (r=0.43; p=0.01), tries (r=0.4; p=0.017) and catheter movements (r=0.37; p=0.03), but not for NG. Less G (1.7±0.76) asked for help than NG (4.7±2.7; p=0.029). G playing ego-shooter/fighting-games (EF) needed less time in four tasks (in average 45%; p=0.02 to 0.06) than those playing strategic games (S). For EF, pathway correlated positive to stress-level (r=0.53; p=0.076). For S, tries correlated positive to stress-level (r=0.793; p=0.034).

Conclusion: Gamer, and here especially EF, needed less time, pathway, help and tries in simulated neurointerventional tasks than Non-gamer. Stress-level of G correlated positive to pathway, tries and movements, but not for NG. Stress-level of EF correlated positive to pathway. Stress-level of NG correlated positive to tries. Whether these findings should be transferred to selection and training of neuroradiologists remains to be elucidated.

Discussion: These results are in line with [1]. A too short time gap between CTA and CTP is the major cause for bolus interference. Other confounding factors might be low cardiac output [2] and carotid stenosis.

Conclusion: CTP can be reliably performed after CTA without a significant net effect on perfusion metrics. However, when measuring CTP after CTA either a short pause in the order of 30 s should be respected or an appropriate correction method be applied.

References
Subcortical volume changes in glioma patients after radio(chemo)therapy

Felix Raschke1, Annekatrin Seidlitz1, Tim Wesemann1, Christina Jentsch1, Ivan Platzer2, Jörg Kotzerke3, Jörg van den Hoff3, Bettina Beuthien-Baumann1, Michael Baumann4, Jennifer Linn4, Mechthild Krause1, Esther Troost1,2

1OncoRay–National Center for Radiation Research in Oncology, Faculty of Medicine and University Hospital Carl Gustav Carus, Technische Universität Dresden, Helmholtz-Zentrum Dresden–Rossendorf, Dresden, Germany, Germany
2Department of Radiotherapy and Radiation Oncology, Faculty of Medicine and University Hospital Carl Gustav Carus, Technische Universität Dresden, Dresden, Germany
3Institute of Neuroradiology, Faculty of Medicine and University Hospital Carl Gustav Carus, Technische Universität Dresden, Dresden, Germany, Germany
4Department of Diagnostic and Interventional Radiology, Faculty of Medicine and University Hospital Carl Gustav Carus, Technische Universität Dresden, Dresden, Germany
5Department of Nuclear Medicine, Faculty of Medicine and University Hospital Carl Gustav Carus, Technische Universität Dresden, Dresden, Germany
6Helmholtz-Zentrum Dresden–Rossendorf, Institute of Radiopharmaceutical Cancer Research, Center for Positron Emission Tomography, Dresden-Rossendorf, Germany
7Radiology, German Cancer Research Center (DKFZ), Heidelberg, Germany
8German Cancer Research Center (DKFZ), Heidelberg, Germany

Background: Radiotherapy of brain tumor patients causes brain atrophy [1] and neurocognitive dysfunction [2]. The hippocampus is a suspected focal point of neurocognitive impairment, due to its known connection to dementia [3] and suspected increased radiosensitivity [4]. The goal of this study was to investigate volume changes of six subcortical structures in glioma patients after radio(chemo)therapy (RT) and compare the estimated atrophy rates.

Methods: The hippocampus, amygdala, putamen, thalamus, pallidum and caudate were automatically segmented from T1-weighted MR images (voxel size 1 mm³) of 91 glioma patients before RT (n=91) and from longitudinal follow-ups acquired in three monthly intervals (n=349). Right and left structures were evaluated separately. Structures overlapping with or touching the clinical target volume or T2-hyperintensities were excluded from the analysis. Relative volumes were calculated as ratios to the pre-RT values. A multivariate linear mixed effects model was used to determine volume changes as function of time after RT, mean dose delivered to the corresponding structure and time dependent atrophy occurs in the hippocampus, followed by the amygdala and thalamus. The caudate was the only structure that showed no significant volume changes with time and dose. Exemplarily, assuming a mean dose of 20 Gy and a follow-up time of 2 years, volume changes resulting from the mixed effects model were: hippocampus –6.1%, amygdala –4.4%, thalamus –3.5%, pallidum –2.6%, putamen –2.5%, caudate –1.9%.

Discussion: The six subcortical regions show very different levels of atrophy following RT. Further work is now needed to determine clinically relevant levels of hippocampal atrophy and subsequently calculate effective normal tissue complication probability models. This would be the basis to establish dose thresholds and dose sparing strategies.

Conclusion: The hippocampus showed the largest volume changes after RT, thus further strengthening the hypothesis that it is particularly radiosensitive.

References

Mechanische Thrombektomie bei Patienten mit distalem Gefäßverschluss im vorderen Stromgebiet: eine Propensity-Score-Matching-Analyse

Dominik Sepp1, Moritz Hernandez Petzsche1, Teresa Zarth1, Claus Zimmer1, Christian Maegerlein1, Tobias Boeckh-Behrens1, Jan Kirschke1

1Technische Universität München, Klinikum rechts der Isar, Abteilung für Diagnostische und Interventionelle Neuroradiologie, München, Deutschland


Ergebnisse: Insgesamt konnten 148 Patienten eingeschlossen werden. Davon konnten 48 Patienten mit MT und 48 Patienten mit BMT mit tels 1:1 Propensity-Score-Matching gemacht werden. Die Gefäßverschlüsse befanden sich bei 70 Patienten (72,9%) in der MCA (distale M2 und M3), bei 21 Patienten (21,9%) in der ACA und bei 5 Patienten (5,2%) in beiden Gefäßen. Die MT war bei 33 von 48 Patienten erfolgreich (≥ TICI 2b). Die mediane Verbesserung des NIHSS bis Entlassung betrug 3.0 Punkte (Q1 = 0.0; Q3 = 6.0) bei den Patienten mit MT und nur 1.0 Punkte (Q1 = 0.0; Q3 = 5.0) bei den Patienten mit BMT (p = 0.16). Bei ausschließlicher Berücksichtigung der Patienten mit ei ner erfolgreichen mechanischen Rekanalisation (≥ TICI 2b) war die Verbesserung des NIHSS im Vergleich zu der BMT-Gruppe noch relevanter (Median: 5.0 Punkte; Q1 = 1.0, Q3 = 8.5, p = 0.01).

Diskussion/Fazit: Diese Studie zeigt, dass die mechanische Thrombektomie auch bei distalen Gefäßverschlüssen der MCA und der ACA angewendet werden kann und insbesondere bei erfolgreicher Rekanalisation den klinischen Verlauf signifikant verbessert.

Kl-basierte Volumetrialgorithmen zur Unterstützung bei der bildgebenen Epilepsiediagnostik

Anna-Lena Mayer1, Angelika Mennecke1, Stefan W. Hock1, Dominique Marterstock1, Julie Rösch1, Hajo Hamer2, Burkhard Kasper1, Arnd Dörfeler1, Manuel Schmidt1

1Universitätsklinikum Erlangen, Neuroradiologische Abteilung, Erlangen, Deutschland
2Universitätsklinikum Erlangen, Neurologische Klinik, Erlangen, Deutschland

Hintergrund: Die automatisierte Berechnung des Hirnvolumens aus MRT-3-D-Datensätzen erlaubt eine zeitsparende quantitative Beurteilung des Hirnvolumens in der klinischen Befundungsroutine. Ziel dieser Arbeit war es, zwei unabhängige Softwarelösungen hinsichtlich
Abbildungslegende:

Abb. 1|153 a: Segmentierungskartierung der Software mdbrain. Hippocampusformation (lila), Temporallappen-Kortex (rot), Parietallappen-Kortex (blau), Frontallappen-Kortex (grün). b: mdbrain-Hippocampus-Segmentierung (lila)

Abb. 2|153 a: Boxplots der absoluten Volumenangaben des pathologischen Hippocampus (HC) in Milliliter (ml). mdbrain vs. BrainMorphometry (3,2 ml vs. 2,7ml; p<0,005). b: Absolute Volumenangaben aller Hippocampi (HC) in ml (gesunde und pathologische Seite) für mdbrain- und BrainMorphometry (blau). Darstellung der Volumenbewertung: Goldstandard klassifizierte Hippocampusvolumenminderung (rot), falsch negativ bewertetes HC-Volumen durch mdbrain (grün), falsch negativ bewertetes HC-Volumen durch BrainMorphometry (gelb)


Fazit: Abhängig von der gewählten Softwarelösung ist eine Hippocampusstörung (Volumenminderung) mit einer Sensitivität von bis zu 92,3 % bei einer Spezifität von 100 % detektierbar. So können KI-basierte Algorithmen den Radiologen unterstützen und die bildgebende Epilepsiediagnostik verbessern bzw. beschleunigen.

Literatur

[154] Standardisierte Klassifikation des zerebralen Vasospasmus nach subarachnoidaler Blutung in der digitalen Subtraktionsangiographie

Cindy Richter1*, Helena Merkel1, Jennifer Jentzsch1, Ulf Quäschling1, Dirk Lindner2, Svitala Ziganshyna2, Stefan Schob2, Karl-Titus Hoffmann3, Khaled Gaber1

1Institut für Neuroradiologie Universitätsklinikum Leipzig, Leipzig, Deutschland
2Klinik und Poliklinik für Neurochirurgie Universitätsklinikum Leipzig, Leipzig, Deutschland
3Klinik und Poliklinik für Anästhesiologie und Intensivtherapie, Universitätsklinikum Leipzig, Leipzig, Deutschland
4Universitätsklinikum Halle Universitätsklinikum und Poliklinik für Radiologie, Halle (Saale), Deutschland
5Klinik und Poliklinik für Neurochirurgie, Universitätsklinikum Leipzig, Leipzig, Deutschland

Hintergrund: Der zerebrale Vasospasmus (ZVS) nach einer aneurysmatischen, subarachnoidalblutung (SAB) ist eine Erkrankung, die mit einer hohen Letalität von mehr als 30 % einhergeht. Pharmakologische und mechanische Spasmolyse sind aktuelle Forschungsschwerpunkte, jedoch gibt es keine standardisierte ZVS-Klassifikation, die einen Vergleich der Wirksamkeit ermöglicht. In dieser Studie wurden Referenzwerte für eine Gefäßdurchmesser-basierte ZVS-Klassifikation erhoben. Weitererfuhrend wurde die zeitliche und anatomische Manifestation des ZVS untersucht, um eine neue standardisierte, visuelle Klassifikation zu etablieren.


Ergebnisse: Die 6-Monats-Kontrollen der ZVS-Gruppe und die Referenzwerte unterschieden sich nicht signifikant, was die Genauigkeit unserer Ergebnisse bestätigt. Hingegen wichen die Gefäßdurchmesser bei Hospitalisierung am Tag der SAB signifikant von den Referenzwerten ab, wohingegen die Tage 1–2 physiologische Werte ergaben. Die initialen Messungen ab Tag 3 zeigten eine progrediente Gefäßverengung. Die frühe Manifestation von ZVS betrifft die distalen Segmente (besonders das A2-Segment), gefolgt von einer proximalen Ausbreitung bis zum C5-Segment.

Diskussion: Als Konsequenz dieses zeitlichen Verlaufs entwickelten wir eine neue visuelle Klassifikation, die auf der Ausbreitung des ZVS von den distalen zu den proximalen Gefäßsegmenten basiert. Referenzwertsbasierte Klassifikationen sind umständlich und zeitaufwändig.

Fazit: Die vorgeschlagene Klassifikation ist als Standardbewertungsverfahren für einen geräteunabhängigen, interindividuellen und gruppenübergreifenden Vergleich geeignet.
[162] Absence of differences between male and female collegiate athletes after sports-related concussion: preliminary findings

Vivian Schultz1,2,3, Holly Carrington4, Nico Sollmann1,2,3,4,5, Paul Raffelhüschen2,3, Leonard Jung2,3, Lara Pankatz2,3, Katherine Breedlove5, Scott Passaluco5, Martha E. Shenton2,6,9, Claus Zimmer1, David Howell10,11, Alexander P. Lin2,6,8, Inga K. Koerte2,3,12

1Department of Diagnostic and Interventional Neuroradiology, Klinikum rechts der Isar, Technische Universität München, Munich, Germany
2Psychiatry Neuroimaging Laboratory, Department of Psychiatry, Brigham and Women’s Hospital, Harvard Medical School, Boston, MA, USA
3cBRAIN, Department of Child and Adolescent Psychiatry, Psychosomatic and Psychotherapy, Ludwig-Maximilian-University, Munich, Germany
4TUM-Neuroimaging Center, Klinikum rechts der Isar, Technische Universität München, Munich, Germany
5Department of Diagnostic and Interventional Radiology, University Hospital Ulm, Albert-Einstein-Allee 23, 89081 Ulm, Germany
6Center for Clinical Spectroscopy, Department of Radiology, Brigham and Women’s Hospital, Harvard Medical School, Boston, MA, USA
7Division of Sports Medicine, Department of Orthopedics, Boston Children’s Hospital, Harvard Medical School, Boston, MA, USA
8Department of Radiology, Brigham and Women’s Hospital, Harvard Medical School, Boston, MA, USA
9VA Boston Healthcare System, Boston, MA, USA
10Sports Medicine Center, Children’s Hospital Colorado, Aurora, CO, USA
11University of Colorado School of Medicine, Department of Orthopedics, Aurora, CO, USA
12Department of Psychiatry, Massachusetts General Hospital, Harvard Medical School, Boston, MA, USA

Background: There is evidence that female athletes are at increased risk for sustaining a sports-related concussion (SRC) compared to their male counterparts [1]. However, only a small number of studies have focused on sex differences following SRC and the results remain mixed [2]. This preliminary study investigates sex differences in white matter microstructure following acute SRC.

Methods: We included 18 (10 female and 8 male) collegiate contact-sport athletes (mean age: males 20.1 ± 0.9 years, females 20.1 ± 1.1 years) following SRC (24–72 h postinjury). We analyzed diffusion weighted MR images (dMRI) acquired at 3T. FA maps were calculated for each subject and tract-based spatial statistics (TBSS) were performed. Symptons were assessed using the Post-Concussion Symptom Scale (PCSS). Time (in days) to symptom resolution (TSR) and return-to-play (TRP) was noted. Means were compared using an unpaired, two-sample t-test. A p-value of <0.05 was considered statistically significant for all analyses with a correction for multiple comparisons being applied throughout.

Results: TBSS did not show statistically significant group differences in white matter FA between males and females. There were no statistically significant differences between sexes in PCSS total scores (p = 0.20), TSR (p = 0.24), or TRP (p = 0.24). However, a tendency for higher PCSS total scores and longer TSR and TRP were observed in female athletes compared with males (mean (SD) PCSS scores: males: 11 (±7.9), females: 21 (±18.4); mean (SD) TSR: males: 9.7 (±2.5), females: 16.8 (±11.4); mean (SD) TRP: males: 12.2 (±3.5), females: 28.6 (±26.4).

Discussion: This is a preliminary analysis of collegiate athletes in an acute phase following SRC. Recruitment was paused due to the COVID-19 related pandemic. Sex showed no significant effect on white matter microstructure, symptom severity, TSR, or TRP. However, a trend for higher post-injury symptom loads, longer return to play, and symptom resolution times were observed in female athletes.

Conclusion: Our results correspond to previous findings in this field [2]. Finally, the small sample size may have precluded statistically significant results for some of the analyses.

References

[163] Tissue at risk is underestimated by admission NIHSS as a clinical marker for penumbral right-sided large vessel occlusion (LVO) stroke

Adrian Mak1,2, Charles C. Matouk3, Emily W. Avery1, Jonas Behland1, Dietmar Frey2, Vincent I. Madai2, Peter Vajkoczy4, Ajay Malhotra5, Pina C. Sanelli6, Guido J. Falcone6, Nils Petersen6, Lauren H. Sansing6, Kevin N. Sheth7, Seyyedeh Payabvash1

1Yale School of Medicine, Department of Radiology, New Haven, USA
2Charité–Universitätsmedizin Berlin, Charité Lab for Artificial Intelligence in Medicine, Berlin, Germany
3Yale School of Medicine, Department of Neurosurgery, New Haven, USA
4Charité–Universitätsmedizin Berlin, Department of Neurosurgery, Berlin, Germany
5Feinstein Institutes for Medical Research, Department of Radiology, Manhasset, USA
6Yale School of Medicine, Department of Neurology, New Haven, USA

Purpose: The concept of clinical-core mismatch is applied to determine eligibility for endovascular therapy (ET) in the extended time window after large vessel occlusion (LVO), using the admission NIHSS as clinical surrogate for the total tissue-at-risk. It is however known that the NIHSS for an infarct of a given volume is higher in left compared to right-hemispheric stroke. We aimed to determine the effects of LVO side on final infarct volume and clinical outcome after ET with regards to admission NIHSS score.

Methods: We retrospectively identified anterior circulation LVO stroke patients that received ET and had follow-up MRI. Using a multivariate voxel-wise general linear model, we assessed the post-thrombectomy infarct distribution in relation to admission NIHSS, post-thrombectomy reperfusion success (mTICI) and discharge modified Rankin Scale (mRS) score. We identified independent predictors for final infarct volume and clinical outcome using multivariate regression models.

Results: We included a total of 469 patients (254 left, 215 right). Admission NIHSS was significantly lower among patients with right (median 11: IQR 8–16) versus left-sided LVO (16: 10–22, p > 0.001). In voxel-wise analysis, lower mTICI, lower admission NIHSS, and poor discharge outcome (mRS >2) were associated with right-hemispheric infarct lesions. Right-sided LVO was an independent predictor of larger final infarct volume (β = 18.3, p = 0.003). There was a significant three-way interaction between admission stroke severity (based on NIHSS), LVO side, and mTICI regarding final infarct volume (F(7,440) = 2.11,
Final infarcts associated with higher admission NIHSS, after correction for reperfusion success. b Final infarcts associated with worse reperfusion, after correction for admission NIHSS. c Final infarcts associated with poor outcome and worse reperfusion, after correction for admission NIHSS.

Specifically, in patients with moderate stroke (NIHSS 6–15), incomplete reperfusion (mTICI 0–2b) was associated with larger infarct volume (55.5 ± 76.6 ml vs. 30.0 ± 47.2 ml, p < 0.001) and worse discharge mRS (4: 2–4 vs. 3: 1–4, p = 0.022) in right compared to left-sided LVO. We found no differences in outcomes of patients with moderate stroke and complete reperfusion (mTICI 3).

Discussion: Incomplete reperfusion in the context of right-sided LVO was associated with larger loss of eloquent brain tissue, which led to worse clinical outcome for patients. These results likely represent larger tissue-at-risk in patients with right-sided LVO for a given admission NIHSS score.

Conclusion: Using admission NIHSS as clinical surrogate of tissue-at-risk may lead to underestimation and consequently undertreatment among patients with right-sided LVO. This highlights the need for more nuanced eligibility criteria for ET in the extended time window.

Prediction of incident vertebral fractures in routine MDCT: Comparison of global texture features, 3D finite element parameters and volumetric BMD

Michael Dieckmeyer1*, Nithin Manohar Rayudu2, Long Yu Yeung2, Maximilian Löffler1, Anjany Sekuboyina1, Egon Burian1, Nico Sollmann1, Jan Kirschke1, Thomas Baum1, Karupppasamy Subburaj2

1Abteilung für Diagnostische und Interventionelle Neuroradiologie, Klinikum rechts der Isar der Technischen Universität München, München, Germany
2Pillar of Engineering Product Development, Singapore University of Technology and Design, Singapur, Singapore
3Klinik für Diagnostische und Interventionelle Radiologie, Universitätsklinikum der Albert-Ludwigs-Universität Freiburg, Freiburg, Germany
4Klinik für diagnostische und interventionelle Radiologie, Universitätsklinikum Ulm, Ulm, Germany

Background: Osteoporosis is a systemic disorder of bone metabolism and has become a global healthcare problem [1]. The increased risk of vertebral fractures (VF) results in high morbidity, mortality and enormous socioeconomic costs [2]. To guide prevention and early treatment of osteoporotic fractures, an accurate diagnostic tool is more important than ever. In this case-control study, we evaluated different quantitative parameters derived from routine multi-detector computed tomography.

Fig. 1 163 a Final infarcts associated with higher admission NIHSS, after correction for reperfusion success. b Final infarcts associated with worse reperfusion, after correction for admission NIHSS. c Final infarcts associated with poor outcome and worse reperfusion, after correction for admission NIHSS.
Clin Neuroradiol

(MDCT) scans with respect to their ability to predict incident osteoporotic vertebral fractures of the thoracolumbar spine.

Methods: A total of 16 patients who received baseline and follow-up (FU) contrast-enhanced MDCT and were diagnosed with an incident osteoporotic VF at FU (Fig. 1), and 16 age-, sex-, and FU-time-matched controls were included. Vertebrae were labelled and segmented using a fully automated pipeline. Volumetric bone mineral density (vBMD), finite element analysis (FEA)-based failure load (FL) and failure displacement (FD), as well as 24 texture features (TF) were extracted from L1–L3 and averaged. Odds ratios (OR) with 95% confidence intervals (CI), expressed per standard deviation decrease, receiver operating characteristic (ROC) area under the curve (AUC), and logistic regression, including all parameters as independent variables, were used to assess the prediction of incident VF (Fig. 2).

Results: The TF Correlation (AUC=0.754, p=0.014; OR=2.76, CI=1.16–6.58) and vBMD (AUC=0.750, p=0.016; OR=2.67, CI=1.12–6.37) classified incident VFs best, while the best FEA parameter FL showed AUC=0.719 (p=0.035; Fig. 3). Correlation was the only significant predictor of incident VF in the logistic regression (p=0.022).

Discussion and conclusion: FEA parameters and vBMD have been investigated before, and the combination of different local parameters outperformed global parameters for the prediction of incident vertebral fractures. In the present study, MDCT-derived FEA parameters and TFs, averaged from L1–L3, showed only a moderate, but no statistically significant improvement of incident VF prediction beyond vBMD, supporting that vertebra-specific parameters are superior for fracture risk assessment.

References
2. Borgstrom et al. (2020).

[177] Der neuartige P64 HPC Flow Diverter – initiale klinische Erfahrungen und Kurzzeit-Follow-up-Daten

Victoria Hellstern1*, Marta Aguilar Perez1, Elina Henkes1, Oliver Ganslandt2, Hans-Jörg Bätzner3, Hans Henkes1

1Klinikum Stuttgart, Neurozentrum, Klinik für Neuroradiologie, Stuttgart, Deutschland
2Klinikum Stuttgart, Neurozentrum, Klinik für Neurochirurgie, Stuttgart, Deutschland
3Klinikum Stuttgart, Neurozentrum, Klinik für Neurologie, Stuttgart, Deutschland

Hintergrund: Der p64 HPC-FD (Phenox GmbH, Bochum, Germany) ist ein neuartiger FD, der sich durch eine hydrophile Oberflächenbeschichtung auszeichnet und die Implantation unter Mono-Thrombozytenaggregation (SAPT) erlaubt. Wir berichten über die initiale klinische Erfahrung mit dem p64 HPC mit besonderem Augenmerk auf ischämischen Ereignissen und Kurzzeit-follow-up-Daten bezüglich Verschlussraten.


Ergebnisse: Es wurden 56 Patienten mit 63 Aneurysmen mit mindestens einem p64 HPC behandelt. Die Implantation des p64 HPC war in allen Fällen technisch erfolgreich. In 55 Aneurysmen (87,3 %) wurde ein FD verwendet. In 7 Aneurysmen (11,1 %) musste aufgrund erheb-
lcher Stentverkürzung nach Freisetzung ein weitere FD implantiert werden. Bei 2 Patienten (3,8 %) traten symptomatische ischämische Ereignisse nach der FD-Implantation auf, darunter in einem Fall eine In-Stent-Thrombose aufgrund insuffizienter AH bei Non-Compliance. In dem ersten FU-DSA-Kontrollen (verfügbar für 43/63 Aneurysmen) zeigte sich ein adäquater Verschluss OKM C+D in 70 %.

**Diskussion:** Die Behandlung intrakranieller Aneurysmen mit FD hat sich als Standartmethode etabliert. Jedoch gilt die Notwendigkeit einer dualen Thrombozytenaggregationshemmung als großer Nachteil des Verfahrens. Mit der Einführung von Oberflächenmodulierten FD wie dem p48 HPC (PhenoX GmbH, Bochum, Germany) und dem Pipeline Shield (Medtronic, CA USA) ist erstmal die Verwendung von FD unter Mono-Antiaggregation möglich [1, 2]. Mit dem p64 HPC steht nun ein weiterer hydrophil beschichteter Stent zur Verfügung unter SAPT zu Verfügung.

**Fazit:** Implantation des p64 HPC unter SAPT ist sicher und effizient mit geringer Morbi-Mortalität und hohen Okklusionsraten.

**Literatur**

[181] Local cerebral matrix metalloproteinase-9 concentrations correspond to the degree of bleeding complications and functional outcome following mechanical thrombectomy

Alexander Kollikowski1, Michael Schuhmann2, Jörn Feick1, Fabian Essig2, Bernhard Nieswandi1, 4, Marc Strinitz1, Alexander G. Mähr1, Guido Stoll1, Mirko Pham1

1Institut für Diagnostische und Interventionelle Neuroradiologie, Universitätsklinikum Würzburg, Würzburg, Germany
2Neurologische Klinik und Poliklinik, Universitätsklinikum Würzburg, Würzburg, Germany
3Institut für Experimentelle Biomedizin, Universitätsklinikum Würzburg, Würzburg, Germany
4Rudolf-Virchow-Zentrum, Universität Würzburg, Würzburg, Germany

**Background:** Numerous clinical and experimental studies have addressed the role of matrix metalloproteinases (MMPs) in blood-brain barrier degradation, the generation of vasogenic edema or hemorrhagic transformation following ischemic stroke, but local concentrations during occlusion condition have never been assessed in acute ischemic stroke patients [1].

**Methods:** We conducted a prospective observational study on 258 consecutive patients undergoing mechanical thrombectomy (MT) due to large-vessel-occlusion stroke of the anterior circulation (08/2018–05/2020). Intraprocedural microcatheter aspiration of 1 ml of cerebral-ischmic (occlusion condition) and systemic arterial blood samples was attempted according to a prespecified protocol. Plasma levels of MMP-9 and -2 were quantified by enzyme linked immune sorbent assay, Pappenheim-stained smears were used for white blood cell differential counting [2]. Biological relevance was assessed by analyses of hemorrhagic events on postinterventional brain CT scans at 24–48 h (Heidelberg Bleeding Classification, HBC), clinical outcome (modified Rankin Scale at discharge) and multivariable testing (molecular-cellular, clinical and interventional parameters).

**Results:** A total of 70 consecutive patients entered analyses. Mean cerebral MMP-9 (736 vs 543 ng/ml, p = 0.0008) but not MMP-2 levels (139 vs 115 ng/ml, p = 0.56) were increased compared with control samples. Among leukocytes, neutrophils had the strongest association with cerebral MMP-9 levels (r = 0.51, p < 0.0001). Mean cerebral MMP-9 levels corresponded to the degree of bleeding following intervention (no hemorrhage: 490 ng/ml vs hemorrhagic infarction [HBC 1a/b]: 603 ng/ml vs parenchymatous hematoma [HBC 1c/2]: 1801 ng/ml, p = 0.0002). Cerebral MMP-9 levels were lower in patients with favourable outcome (mRS≤2: 385 vs mRS>2: 987, p = 0.0011). Multiple logistic regression revealed cerebral MMP-9 concentrations as independent predictor of functional outcome (mRS≤2: aOR = 0.9981, p = 0.0416).

**Conclusion:** Our data for the first time show that MMP-9 is locally released into the ischemic cerebral vasculature in acute stroke and supports the notion that MMP-9 contributes to hemorrhagic transformation and affects outcome.

**References**
Background: Brain clearance imaging revealed penetration of gadolinium-based contrast agents (GBCAs) into the anterior eye chamber (AC) in healthy humans [1, 2]. We investigated whether the degree of GBCA enhancement of the AC predicts histopathologic tumor features in children suffering from retinoblastoma (RB).

Methods: This study encompassed 539 orbital MRIs performed between 2010 and 2019. MRI was performed with an orbital coil and with the children in a state of general anesthesia. Differences of signal intensity ratios of the AC to the lens ($\Delta$SIRs) were determined between native and GBCA-enhanced T1-weightings (Fig. 1). Subsequently, $\Delta$SIRs of RB eyes were correlated with histopathologic tumor features such as infiltration of the optic nerve (ON), choroid, ciliary body, sclera and AC.

Results: $\Delta$SIRs were significantly higher in RB eyes compared to healthy eyes ($p<0.001$). $\Delta$SIR of the RB eye was an independent, significant predictor for ON invasion in multivariate analysis with adjustment for tumor size ($p<0.05$) and increased with infiltration level (Fig. 2). $\Delta$SIR was not predictive for any other assessed histopathologic tumor feature.

Discussion: Increased GBCA enhancement of the anterior eye chamber in retinoblastoma with optic infiltration might be explained by disturbed retinal homeostasis with consecutive neovascularisation of the iris due to dysfunction of the orbital glymphatic system (Fig. 3; [3]).

Conclusion: GBCA enhancement of the anterior eye chamber predicts optic nerve infiltration by retinoblastoma.

References

[186] Synthetic DIR is superior to FLAIR for multiple sclerosis lesion detection: multi-center validation of a task-specific generative adversarial network

Tom Finck1*, Sarah Schlaeger1, Hongwei Li2, Lioba Grundl1, Nico Sollmann1, Benjamin Bender1, Eva Buerkle4, Jan Kirschke1, Björn Aaberg1
1Klinikum rechts der Isar der Technischen Universität München, Abteilung für diagnostische und interventionelle Neuroradiologie, München, Germany
2Klinikum rechts der Isar der Technischen Universität München, Abteilung für diagnostische und interventionelle Neuroradiologie, München, Germany
3Klinikum rechts der Isar der Technischen Universität München, Abteilung für diagnostische und interventionelle Neuroradiologie, München, Germany
4Radiologische Universitätsklinik Tübingen–Abteilung für Diagnostische und Interventionelle Radiologie, Tübingen, Germany
5Klinikum rechts der Isar der Technischen Universität München, Abteilung für Neurologie, München, Germany

Background: Generative adversarial networks (GANs) create high-contrast magnetic resonance imaging (MRI) data from lower-contrast input. Targeted translation of lesions in multiple sclerosis (MS) augments their clinical value, provided that a GAN’s performance remains robust for external data. Here, we investigate the external validity of a novel GAN framework aimed at improving MRI in patients with MS.

Methods: Our GAN synthesized double-inversion-recovery (DIR) from fluid-attenuated-inversion-recovery (FLAIR) and T1w of 50 prospectively acquired MS patients (training data). In another 50 patients (test data), two blinded readers (R1&R2) quantified lesions in synthetic DIR (synthDIR), acquired DIR (trueDIR), and FLAIR. Of these patients, 20 were investigated on the same scanner than training data (internal data), while 30 were scanned on different scanners (external data). Lesions were grouped according to the McDonald criteria. Contrast-to-noise ratios (CNRs) were compared.

Results: Higher counts of MS-specific lesions were found in synthDIR vs. FLAIR (R1: 26.7 ± 2.6 vs. 22.5 ± 2.2, p < 0.0001; R2: 22.8 ± 2.2 vs. 19.9 ± 2.0, p = 0.0005). Importantly, improvements in lesion counts were noted to similar degrees in internal and external data and synthDIR replicated the intrinsic strength of DIR to improve the depiction of juxtacortical lesions. SynthDIR had higher CNRs than FLAIR with respective medians of 46.2 (IQR: 26.5; 50.8) vs. 31.8 (IQR: 22.1; 44.9; [p < 0.0001]) in internal and 33.1 (IQR 18.4; 37.0) vs. 23.4 (IQR 17.7; 27.5; [p < 0.0001]) in external data.

Discussion: This multicentric study confirms the efficacy and external validity of a DL tool aimed at improving MRI in patients with MS.

[189] Qualitative and quantitative comparison of hippocampal volumetric software applications

Stephanie Mangesius1 2, Lukas Haider3 4, Lukas Lenhart1 2, Ruth Steiger1 2, Ferran Prados3 5 6, Christoph Scherfler2, Elke Ruth Gizewski1 2
1Medical University of Innsbruck, Department of Neuroradiology, Innsbruck, Austria
2Medical University of Innsbruck, Neuroimaging Core Facility, Innsbruck, Austria
3University College London Institute of Neurology, NMR Research Unit, Queen Square Multiple Sclerosis Centre, United Kingdom
4Medical University of Vienna, Department of Biomedical Imaging and Image Guided Therapy, Austria
5University College London, Centre for Medical Image Computing (CMIC), Department of Medical Physics and Biomedical Engineering, United Kingdom
6Universitat Oberta de Catalunya, e-Health Center, Spain
7Medical University of Innsbruck, Department of Neurology, Austria

Background: Brain volumetric software is increasingly suggested for clinical routine [1]. The present study quantifies agreement across different software applications.

Methods: Ten individuals were chosen based on hippocampal volume z-scores < –1.96 as measured by FreeSurfer (FS) based on an in-house gender and age-adjusted healthy control (HC) group, and 10 age-matched HCs, median age; 74 years (25–75 %, range: 66–77). Hippocampal volumes were computed based on 3 T T1-MPRAGE-sequences with FS, statistical parametric mapping (SPM; neuroradiometrics and Hammers atlases), Geodesic-Information-Flows (GIF),
Discussion:

Comparing against the mean of all methods, moderate to low agreement was present considering categorization of hippocampal volumes into quartiles. Interclass correlation coefficients (ICC) ranged noticeably between software applications (left hippocampus, LH): from 0.42 (STEPS) to 0.88 (FS); right hippocampus (RH): from 0.36 (commercially available software application) to 0.86 (FS). The mean differences between individual methods and the mean of all methods (mm³) was considerable (LH: FS – 209; SPM-Neuromorphometrics – 820; SPM-Hammers – 1474; commercially available software application – 680; GIF 891; STEPS 2218; RH: FS – 232; SPM-Neuromorphometrics – 745; SPM-Hammers – 1547; commercially available software application – 723; GIF 982; STEPS 2188).

Discussion: Consistency across centers is viable for any diagnostic test [2]. Our results reveal considerable variability in volumetric measurements between different established applications, even in a cohort with large spread in the data (normal aging vs. severe atrophy) and absence of structural lesions.

Conclusion: Interchangeable use of different volumetric software applications is not recommended.

References


Clinical utility of automatically derived acute ischemic volumes on native computed tomography in patients with anterior acute ischemic stroke and endovascular therapy

Peter Mihalicz1*, Christian Herweh1, Simon Nagel2, Peter Arthur Ringleb3, Martin Bendzusz1, Markus Möhlenbruch4, Ulf Neuberger4

1Universitätsklinikum Heidelberg Neurologische Klinik: Neuroradiologie, Heidelberg, Germany
2Neurologische Klinik, Heidelberg, Germany

Background and purpose: The clinical utility and non-inferiority of electronically derived ASPECTS (eASPECTS) to quantify signs of acute ischemic infarction could be demonstrated. Here, we aimed to evaluate the clinical and predictive capabilities of a new parameter, automatically derived acute ischemic infarct volumes (AIV) from native computed tomography (NCT) images in patients undergoing endovascular therapy due to anterior acute ischemic stroke (AAIS).

Methods: We performed a retrospective analysis of n = 1132 consecutive patients with AAIS and subsequent endovascular therapy between 01/2013 and 01/2020. eASPECTS and AIV were generated from baseline NCT with the Brainomix software (www.brainomix.com, Version 9.0). Obtained data were correlated with clinical outcome (stroke severity measured by National Institute of Health Stroke Scale, NIHSS, at baseline and after 24 h, modified Rankin Scale, mRS, after 90 days). Furthermore, the predictive capabilities of AIV were tested using adjusted multivariate logistic regression and machine learning methods.

Results: Patients with a good clinical outcome (mRS 0–2 after 90 days) had a significant lower AIV (16.91 ± 16.68 ml vs. 24.56 ± 20.21 ml, p < 0.001). AIV correlated significantly with NIHSS at baseline (p = 0.22) and 24 h after therapy (p = 0.27) as well as with mRS after 90 days (p = 0.20; Fig. 1). In a multivariate logistic regression model, adjusted for important clinical parameters AIV was revealed as an independent predictor for good clinical outcome (aOR 0.98, 95% CI 0.97–0.99). Prediction of clinical outcome with machine-learning using AIV showed a moderate accuracy (ROC-AUC = 0.64, 95% CI 0.61–0.67), in comparison to ordinary eASPECTS (ROC-AUC = 0.62, 95% CI = 0.59–0.65). However, a significant difference between the

Predictive accuracy between the two models could not be shown with DeLong’s test (p = 0.730; Fig. 2).

Discussion and conclusion: AIV independently predicted clinical outcome in patients with AAI with a higher predictive accuracy than eASPECTS. In an era where acute stroke diagnosis and treatment eligibility is mainly performed with NCT, AIV might be a useful and easily applicable addition in stroke diagnostics to identify patients eligible for endovascular therapy, with a higher statistical power due to the continuous nature of the parameter, in comparison to the ordinal ASPECTS.

Spatial correlation of resting state activity alterations in premature-born adults with nuclear imaging derived neurotransmitter maps

David Schinz1,2, Benita Schmitz-Koepsel1,2, Aurore Menegaux1,2, Claus Zimmer1,2, Dieter Wolke1, Peter Bartmann1, Christian Sorg1,2, Dennis Hedderich1,2

1Klinikum rechts der Isar der Technischen Universität München, Neuroradiologie, München, Germany
2TUM-NIC Neuroimaging Center, Technical University of Munich, München, Germany
**Background:** The brains of premature-born subjects show a wide range of structural and functional differences compared to full-term (FT) born controls [1, 2]. However, the effect of prematurity on neurotransmitter systems in humans remains largely unknown. Recently, a new tool for linking MRI data to neurotransmitter information based on nuclear imaging derived estimates was introduced [3].

**Methods:** We included 99 very-preterm/very-low-birthweight (VP/VLBW; <32 weeks of gestation/birth weight below 1500 g) and 107 FT born adults at 26 years of age in a prospectively acquired cohort. We investigated whether fractional amplitude of low-frequency fluctuations (fALFF) alteration patterns in the functional activity of premature-born adults with previously shown alterations through perinatal brain damage as well as to changes in the structure and architecture of premature-born brains [4].

**Conclusion:** Prematurity is associated with functional resting state activity alterations that may reflect underlying neurotransmitter-level changes in dopaminergic and serotonergic pathways.

**References**


---

**High serum glucose in patients with acute ischemic stroke: quantification of the mediation effect of edema formation on poor functional outcome**

Helge Kniep1*, Lukas Meyer1, Matthias Bechstein1, Jens Fiehler1, Uta Hanning1, Gabriel Broocks1

1Klinik und Poliklinik für Neuroradiologische Diagnostik und Intervention, Universitätsklinikum Hamburg-Eppendorf, Hamburg, Germany

**Introduction:** Different risk factors for poor clinical outcome after endovascular thrombectomy with successful recanalization have been identified. Higher blood glucose levels were shown to be associated with worse clinical outcome and increased edema formation [1]. A better understanding of the pathophysiological pathways and a quantification of their effects might support targeted therapeutic approaches. We therefore conduct a mediation analysis to quantify the effect of edema formation on clinical outcome in patients with high blood glucose.

**Methods:** A total of 124 patients with acute ischemic stroke who underwent mechanical thrombectomy were included. Mediation analysis was performed to evaluate whether serum glucose associated edema formation has a significant effect on the probability of good outcome (mRS ≤2).

**Results:** The likelihood for poor outcome increased with increasing blood glucose levels (odds ratio [OR] 1.23 per 10 mg/dl increase; \( p=0.005 \)), edema formation (OR 1.13 per % net water uptake; \( p=0.02 \)) and poor collaterals (OR 1.64; \( p=0.04 \); Fig. 1). Edema formation was also associated with higher blood glucose (linear regression coefficient 0.033; \( p=0.01 \); Fig. 2). The mediation effect of edema formation on functional outcome was 15% (\( p=0.034 \)). The mediation model showed an increase of the probability for good outcome of 47% (\( p<0.005 \)) in...
patients with good collaterals and of 26 % (p<0.005) in patients with poor collaterals at blood glucose levels of 100 mg/dl vs. 200 mg/dl.

**Discussion:** In patients with poor functional outcome accompanied by high blood glucose, excessive edema formation accounts for 15 % of the total adverse effects. Hence, major pathways are also linked to other direct effects of high blood glucose, such as altered vessel wall and thrombus characteristics and higher thrombogenicity of the cerebral blood flow. Additional intermediation effects are introduced by the collateral status.

**Conclusion:** Targeted treatment approaches for patients with high blood glucose require a personalized multidimensional approach not only aiming at reducing edema formation but also considering other adverse effects of high serum glucose.

**References**


**[204] CSF venous fistulas: diagnostic work-up**

Niklas Lützen1, Philippe Dovi-Akué1, Christian Fung2, Jürgen Beck2, Horst Urbach1

1Uniklinik Freiburg–Klinik für Neuroradiologie, Freiburg im Breisgau, Germany
2Uniklinik Freiburg–Klinik für Neurochirurgie, Freiburg im Breisgau, Germany

**Background:** CSF venous fistulas–initially described in 2014 [1]–are a significant cause of spontaneous intracranial hypotension (SIH) in so-called head-positive, SLEC-negative (spinal longitudinal extradural contrast) patients. Recently, transvenous embolization has been suggested as a less invasive therapeutic option than surgery [1].

**Methods:** Eight patients with CSF venous fistulas, four were surgically ligated by clipping and four were occluded with Onyx. For embolization, a Scepter balloon occlusion microcatheter was navigated via the azygos or hemiazygos veins into the paravertebral veins at the levels Th 5/6 left, Th2/3 right, Th 10/11 right (n=2). Post-embolization CT slices confirmed the Onyx cast in the venous channels surrounding the leaking nerve root sleeve.

**Results:** Three patients showed a significant improvement (Fig. 1), while one woman with co-existing cerebral amyloid angiopathy died from a macrohemorrhage which was detected after the transvenous embolization.

**Discussion:** The definitive clinical outcome of both methods (surgical vs. endovascular) in comparison remains to be seen and more studies need to be done.

**References**

Conclusion: Transvenous Onyx embolization is an elegant therapeutic option to occlude CSF venous fistulas.

References

[208] Challenging cases for WMH segmentation comparatively processed by seven automated methods

Merita Aruci1*, Max Dünnwald2, 3, Frank Schreiber3, 4, Alessandro Sciarra3, Anne Maass4, Stefanie Schreiber3, 4, Steffen Oeltze-Jafra2, 3, 5
1Otto-von-Guericke University Magdeburg, Faculty of Natural Sciences, Magdeburg, Germany
2Otto-von-Guericke University Magdeburg, Faculty of Computer Sciences, Magdeburg, Germany
3University Hospital Magdeburg, Department of Neurology, Magdeburg, Germany
4German Center for Neurodegenerative Diseases, Magdeburg, Germany
5Center for Behavioral Brain Sciences (CBBS), Magdeburg, Germany

Background: White matter hyperintensities of presumed vascular origin (WMH), a hallmark feature of cerebral small vessel disease (CSVD), are FLAIR/T2-hyperintense lesions that predict various clinical readouts, e.g., stroke or dementia [6, 8]. WMH are commonly determined according to their volume load [1], while capturing or classifying more subtle features such as different WMH patterns or “WMH mimics” is demanding. We aimed to compare automatic methods to segment challenging WMH patterns (e.g. multifocal spots, peri-basal ganglia WMH or WMH “mimics” surrounding lacunes/large hemorrhages) in clinical CSVD cases.

Methods: We applied seven different automatic WMH segmenting methods (LGA and LPA [7], SLS [5], MDbrain (Medaire GmbH), BIANCA [2], FreeSurfer[4] and PGS—a Deep Learning approach [3]) in T1/FLAIR MRI sequences and compared their performance against gold standard manual segmentations in 10 CSVD patients with challenging WMH patterns aiming to identify the most suitable method to segment them. Segmentation accuracy was determined though Dice similarity coefficient and other metrics measuring sensitivity or precision.

Results: In our dataset, the PGS (DSC:0.6), LPA (DSC:0.59) and MDbrain (DSC:0.57) score the highest DSC followed by SLS, LGA, BIANCA and SAMSEG FreeSurfer. (boxplots depict the 25 %, 75 % percentile and the median for DSC distribution, orange circles represent each subject)
Fig. 3 | 208 WMH segmentation performance of different tools falsely detecting FLAIR hyperintense „WMH mimics“ surrounding large hemorrhages (a) or post-hemorrhagic hyperintense changes (b). Pathological hyperintense FLAIR structures are depicted in white arrow in the GT panel.

Fig. 4 | 208 Mean similarity metrics for each segmenting method

- **References**
  5. Roura E, et al. Neuroradiology. 2015;57(10)

[210] The Tigertriever 13 for mechanical thrombectomy in distal and medium intracranial vessel occlusions: initial experience from two high-volume stroke centers

Sebastian Fischer1*, Volker Maus1, Hannes Nordmeyer2, Werner Weber1

1Institut für Diagnostische und Interventionelle Radiologie, Neuroradiologie und Nuklearmedizin, Knappschaftskrankenhaus Bochum, Bochum, Germany
2Neurozentrum Solingen, Radpax St. Lukas Hospital, Solingen, Germany

**Background:** To report our two-center initial experience using the Tigertriever 13 (a manually expandable low-profile stentretriever) in the treatment of acute stroke due to distal medium vessel occlusions (DMVO).

**Methods:** We performed a retrospective analysis of patients treated by mechanical thrombectomy using the Tigertriever 13 device due to an acute DMVO. Locations included the anterior, middle and posterior cerebral artery in the A2 and A3, the M3 and M4 and the P2 or P3 segment and the superior cerebellar artery.

**Results:** Forty-three patients with 45 DMVOs underwent MTE using the Tigertriever 13 on an intention to treat approach between May 2019 and December 2020. A median of two thrombectomy maneuvers resulted in a successful reperfusion rate (mTICI 2b-3) of 84.4% (38/45) with a first pass effect of 26.7 % (12/45). The rate of symptomatic intracranial hemorrhages (sICH) and subarachnoid hemorrhages (SAH) was 7.0 % (3/43) and 14.0 % (6/43), respectively. At discharge, 53.5 % (23/43) of the patients had a favorable clinical outcome (mRS 0–2).

**Discussion:** To date only one study focuses on DMVOs exclusively treated with the Tigertriever 13. Rikhtegar et al. presented a series of 115 patients suffering from DMVOs treated with the Tigertriever 13 [1]. The concept of the Tigertriever offers the possibility to manipulate the expansion and by this, the radial force of the device. This might help to obtain a higher likelihood of capturing the clot compared to traditional stent retrievers [2].

**Conclusion:** MTE in DMVOs using the Tigertriever 13 is safe and effective with high recanalization rates. The incidence of clinically asymptomatic hemorrhagic events appears to be higher in comparison MTE procedures in LVOs.

**References**


[211] Latest artificial intelligence provides fast, accurate and consistent detection of multiple sclerosis lesions

Stefan Hock1*, Dominique C. Marterstock2, Anna-Lena Meyer1, Clemens Bettry3, Konstantin Huhn1, Veit Rothhammer1, Arnd Dörfler3, Manuel Schmidt2

1Universitätsklinikum Erlangen, Neurologische Klinik, Erlangen, Germany
2Universitätsklinikum Erlangen, Neuroradiologische Abteilung, Erlangen, Germany

**Background:** Artificial intelligence (AI) algorithms have already had a major impact on medical imaging and opened a wide field of detec-
Our aim was to evaluate the potential of latest AI regarding diagnosis and follow-up of Multiple Sclerosis (MS) in clinical radiology.

Methods: We included 101 patients who had undergone MRI at a single academic hospital to evaluate MS lesions according to McDonald criteria. T2w 3D FLAIR and T1w MPRAGE sequences were processed by two AI (Fig. 1)–deep learning (“latest”) and traditional computer vision techniques (“previous”)–and analyzed by three expert neuroradiologists (gold standard) independently. Statistical metrics were calculated and compared as follows: Sensitivity (TPR), specificity (TNR), overall accuracy (ACC), false positive rate (FPR) and Dice similarity score (DSC).

Results: A comparison of two artificial neuronal networks (ANN) corroborates the superiority of the latest generation AI in detection of MS lesions (Fig. 2). Overall sensitivity (77% vs. 29%) and DSC (0.81 vs 0.39) of the latest version AI were significantly higher as compared to previous version. In the periventricular compartment TPR (77% vs. 53%), ACC (92% vs. 87%) and DSC (0.8 vs 0.64) were higher, while TNR (96% vs. 96%) and FPR (0.043 vs. 0.041) did not change significantly. In the juxtacortical compartment TPR (62% vs. 0.5%), ACC (95% vs. 90%), FPR (0.018 vs. 0.001) and DSC (0.7 vs 0.01) were higher, while TNR (98% vs. 99%) was unaltered. In the deep white matter TPR (82% vs. 46%), ACC (82% vs. 62%) and DSC (0.85 vs 0.6) were higher, while TNR (80% vs. 86%) was lower. FPR (0.14 vs. 0.20) did not change significantly. Infratentorial TPR (53% vs. 16%) and DSC (0.69 vs 0.27) were higher, while TNR (99% vs. 99%), ACC (97% vs. 95%) and FPR (0.015 vs. 0.015) did not change significantly.

Conclusion: Preliminary data show that the latest generation AI provides consistent, automated and fully reproducible assessment of MS lesions without being influenced by intra- and/or interobserver intrinsic human variability—especially in the context of longitudinal patient follow-up. Thus, this novel tool may provide improved reliability and standardization in diagnosis and follow-up imaging of MS.

Background: Studies in both animal models and in premature born adults suggest impaired development of the cholinergic basal forebrain (cBF) after premature birth [1–3]; however, these studies focused on local cBF changes only, ignoring effects on cBF connectivity. We hypothesized aberrant functional connectivity (FC) of ongoing cBF blood oxygenation fluctuations in premature-born adults.

Methods: Resting-state functional magnetic resonance imaging was used to determine whole brain seed connectivity from bilateral anteri-
or and posterior cBF [4] in a large and prospectively collected cohort of 79 very premature-born adults (<32 weeks of gestation and/or birth weight <1500 g, VP/VLBW) and 96 full-term born (FT) controls at 26 years of age. Group comparisons were performed with sex, scanner and cBF volume as covariates.

**Results:** While anterior cBF was significantly (p<0.001 uncorrected, cluster size >10) decreased in the anterior cingulate cortex (Fig. 1), posterior cBF was significantly increased in the left superior frontal gyrus, left superior temporal gyrus and middle temporal gyrus (Fig. B).

**Discussion:** Prematurity impacts cBF connectivity distinctively for anterior and posterior parts. It is unclear whether cBF volume loss interferes with these findings.

**Conclusions:** Results demonstrate impaired connectivity of the cBF into the forebrain in premature-born adults. Data suggest impaired cBF connectivity development in prematurity.

**References**

[218] Semiautomatic reperfusion grading after endovascular therapy for acute ischemic stroke

Maximilian Thormann1, Muhannad Sabieleish1, Axel Boese2, Jonathan Metzler2, Harald Paukisch1, Mostafa Ergawy1, Elie Diamandis1, Anastasios Mpotsaris1, Daniel Behme1

1Clinic for Neuroradiology, Magdeburg University Hospital, Magdeburg, Germany
2INKA HealthTec Innovation Laboratory, Otto-von-Guericke University Magdeburg, Magdeburg, Germany

**Background:** The degree of reperfusion after mechanical thrombectomy graded with mTICI score is an independent outcome predictor in acute ischemic stroke after endovascular treatment. However, the interrater reliability is low and operators tend to overestimate their own results. We therefore designed a fast, image-based grading for unbiased mTICI scoring.

**Methods:** A semiautomatic reperfusion grading on digital subtraction angiography (DSA) series was developed based on image processing techniques. After field of view adjustments, the internal carotid artery (ICA) curve was detected in the first “fill” image (Fig. 1) and used as a reference point. The region of interest (ROI) representing the target downstream territory (TDT) of the middle cerebral artery (MCA) was defined in the “capillary fill”-phase and divided into grid based check-zones classified as perfused or unperfused (Fig. 2). The percentage of reperfusion was calculated for each patient. Our approach was tested on 55 patients after thrombectomy in acute M1 occlusion. The mTICI grading as performed by our software was compared to the consensus scoring by two experienced neuroradiologists.

**Results:** Consensus reading mTICI scores in our cohort ranged from 2a to 3, with mTICI ≥2c in 63.6 % (35/55). Overall accuracy of the grading system was 47/55 (85.5 %), with 27/30 (90.0 %) mTICI 3 scored in agreement. Accuracy in mTICI >2c was 85.7 % (30/35). Differentiation into mTICI 2a/2b/2c was consistent in 20/25 patients (80.0 %). Five out of 8 disagreements occurred in mTICI 2c/3 gradings.

**Discussion:** Visual TICI scoring after mechanical thrombectomy is operator dependent and prone to interrater inconsistency. AI based approaches have been reported, but usually suffer from long computing
time and high GPU demand. A simpler method utilizing only post processing of angiographic images might be an adequate approach to develop an impartial grading standard. Our model presents an accurate and reliable semiautomated method for mTICI grading.

Conclusion: Semiautomated scoring of mTICI results for M1 occlusions is feasible, robust, and easy to integrate into routine reporting.


Ergebnisse: Bei 15 Patienten mit unilateralen akzidentellen Läsionen der sensiblen Mandibularisäste (NL n=10; NAI n=5) gelang eine direkte Visualisierung der betroffenen Nerven in ihrem anatomischen Verlauf und nach der typischen Läisionstopographie. Es gelang keine Differenzierung axonaler, endo- und perineurialer Läsionen, d. h. von Läsionen mit erhaltener Kontinuität (Sunderland Grad I–IV). Davon ausgehen ließ sich eine vollständige Kontinuitätsunterbrechungen und Neurombildungen (Sunderland Grad V und VI/Mackinnon-Dellon) zuverlässig erkennen, wie die anschließende intraoperative Korrelation in einigen Fällen (NL n=5; NAI n=1) zeigte.

Diskussion/Fazit: Das beschriebene MRT-Protokoll ermöglicht eine neuroradiographische Darstellung bei NL- und NAI-Läsionen und kann schon in der Frühphase nach Verletzung eine Basis zur Differenzierung des Schädigungsausmaßes liefern. In der Konsequenz wird die MRT-Bildgebung damit zum Wegweiser in der Entscheidungsfindung für ein konservativ-abwartendes Verhalten versus operative Revision. Die Kontroll-Intervalle und Wartezeiten bis zu einer chirurgischen Intervention verkürzen sich, was Abänderungen im Managementkonzept nach sich zieht.

Background: The assessment of the collateral vessel supply in stroke patients is a major criterion of the triage for endovascular thrombectomy (EVT). Collaterals are classified in single- or multi-phase/dynamic CT angiography (CTA) using scoring systems. However, visual scoring systems harbour the risk of not being precise and robust. We aimed to assess the performance of an automated quantification of the vessel density in comparison to established stroke triage parameters.

Methods: We prospectively included consecutive stroke patients who received CTA and CT perfusion (CTP) for EVT triage between April and May 2021. We used an artificial intelligence stroke software (Brainomix Ltd., Oxford, UK) to automatically assess ASPECT Score and infarct volume in non-contrast CT, location of target occlusion, collateral score and vessel density on single phase and dynamic CTA (Fig. 1) as well as infarct core (rCBF<30%) and tissue-at-risk (Tmax>6 s) volumes on CTP images. Dynamic CTA was derived from a 1.5 mm CTP source images. We recorded baseline data including baseline NIHSS, time-metrics, treatment strategy and NIHSS score at discharge. We compared vessel density on single and dynamic CTA with the Wilcoxon signed-rank test and determined Spearman’s rank correlation coefficient for correlation with other parameters.

Results: A total of 18 patients (median age 83 [78–86] years, six male, baseline NIHSS 12 [5–19] and time from symptom onset to imaging 168 [84–448] min) met the inclusion criteria. Five patients did not qualify for EVT due to no large vessel occlusion (n=4) and low ASPECTS without CTP-mismatch (n=1). We achieved successful reperfusion in 11/13 patients. Median NIHSS score at discharge was 9 [3, 14]. The median vessel density on the single-phase CTA was significantly lower compared to the dynamic CTA (77 % vs 96.5 %; p=0.001) which resulted in a higher rate of collateral score 0–1 (n=4 vs n=1). Tab. 1 summarizes results of the correlation analysis.

Discussion: In stroke patients who are screened for EVT, collateral vessel supply can be automatically assessed by measurement of vessel density as a quantifiable parameter. Importantly, single-phase CTA may significantly underestimate the vessel density due to delayed filling of collaterals.
Conclusion: The automated assessment of the vessel density could be a quantifiable and robust alternative to visual scoring systems in the triage of stroke patients for EVT.

[222] Machine learning on top of deep learning-based brain volumetry segmentation to support neuroradiologists in diagnosing neurodegenerative disorders

Chang Gyu Cho1, Holger Wenz’, Alex Förster, Markus Sebald, Thomas Ganslandt, Christoph Groden, Máté Maros*
1Universitätsklinikum Mannheim, Abteilung für Neuroradiologie, Mannheim, Germany
2Siemens Healthineers, Erlangen, Germany
3Medizinische Fakultät Mannheim, Abteilung für Biomedizinische Informatik, Mannheim, Germany

Background: We investigated whether supervised machine learning (ML) algorithms can be effectively applied to segmentation results of an FDA-approved deep learning-based brain morphometry algorithm in order to aid objective empirical neuroradiological scoring and comprehensive dementia diagnosis.

Methods: A single-center retrospective cohort of 275 patients (157F, 57.1%; median age: 68 years, range: 17–95 years) with suspected neurocognitive disorders was retrieved from local RIS/PACS between 01/2012 and 08/2020. Brain volumetric segmentation (BVS) of 47 anatomical regions and structures was performed using the AI-Rad Companion MR Brain (Siemens Healthineers) software based on 3 T (Siemens, Trio) isotropic (1 mm) sagittal T1-weighted MPRAGE images. Three neuroradiologists generated consensus values of well-established empirical scoring systems including global cortical atrophy (GCA), medi-al temporal lobe atrophy (MTA), Koedam for parietal atrophy and Fazekas volumetric morphometry results can objectively aid radiological and diagnostic accuracy of neurodegenerative disorders. Due to its an-

Discussion: Supervised ML algorithms on top of deep learning-based volumetric morphology results can objectively aid radiological and clinical diagnosis of neurocognitive disorders while providing robust and reproducible measures for follow-up evaluation.

Conclusion: Multilayer ML setup is feasible to improve report quality and diagnostic accuracy of neurodegenerative disorders. Due to its anonymized nature, our study cohort could serve as benchmark data set for comparing algorithms of various vendors.

References

[224] Identifikation hämodynamischer Parameter zur Vorhersage asymptomatischer Carotis-interna-Stenosen mittels Random Forest Machine Learning

Carina Gleißner*, Stephan Kaczmarz, Jan Kufer, Lena Schmitzer, Michael Kallmayer, Claus Zimmer, Benedikt Wiestler, Christine Preibisch, Jens Göttler
1Technische Universität München, Klinikum rechts der Isar, Abteilung für Diagnostische und Interventionelle Neuroradiologie, München, Deutschland
2Technische Universität München, Klinikum rechts der Isar, Abteilung für Gefäßchirurgie und Endovaskuläre Chirurgie, München, Deutschland

Hintergrund: Eine Vielzahl von zerebralen hämodynamischen Parametern sind bei Patienten mit asymptomatischer Arteria-carotis-interna-Stenose (ACIS) verändert. Um die relevantesten Parameter und Regionen zu identifizieren, wurde ein Random-Forest-Klassifikator (RFK) [1] auf multimodale MRT-Daten angewandt. Individuelle Grenzzonen (iGZ) zwischen Gefäßterritorien sind hämodynamisch besonders anfällig [2], weshalb wir für die Parameterwerte in iGZ eine erhöhte Vorhersagegenauigkeit (VG) erwarten.


Ergebnisse: Abb. 1 zeigt 1000-mal gemittelte Feature-Relevanz-Scores des mit 96 Features trainierten RFKs.

Nach Ausschluss von Redundanzen sind die wichtigsten Features in abgestiegender Reihenfolge: interhemisphärische Differenz von CBF und die Seitendifferenz von GM und CVR, gefolgt von ipsilateraler CBF und ipsilateraler CVR (Abb. 2). Trainiert man den RFK mit einer größeren Zahl von Features, erreicht die VG 87,7±2,3 % und wird durch weitere Features nicht wesentlich erhöht (Abb. 3). VOIs ohne TTP in iGZ erzielen signifikant geringere VG (Abb. 3). Unter Verwendung eines 10-fach Kreuzvalidierten AdaBoost-Klassifikators steigt die VG auf 92,3±2,7 %.

Diskussion: Bereits wenige sensitive hämodynamische Features, wie die Seitendifferenz von TTP, CBF und die CVR ipsilateral zur Stenose, können ACIS-Patienten identifizieren. iGZ erhöhen dabei die VG.

Fazit: RFK ermöglichen es, die Relevanz von Parametern für die Vorhersage von ACIS zu ranken und könnten helfen, die Früherkennung von schweren hämodynamischen Einschränkungen bei ACIS-Patienten zu verbessern.

Literatur
2. Kaczmarz, Neuroradiology, 2018
3. Kaczmarz, JCBFM, 2020

Fig. 2 [221] Spearman’s rank correlations

<table>
<thead>
<tr>
<th></th>
<th>onset to imaging</th>
<th>baseline ASPECTS</th>
<th>baseline infarct volume</th>
<th>collateral score</th>
<th>iCBF &lt;30%</th>
<th>Tmax &gt;6s</th>
<th>follow up ASPECTS</th>
<th>discharge NIHSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>single-phase CTA vessel density</td>
<td>coefficient</td>
<td>-0.639</td>
<td>0.633</td>
<td>-0.600</td>
<td>0.980</td>
<td>-0.646</td>
<td>-0.722</td>
<td>-0.608</td>
</tr>
<tr>
<td></td>
<td>sig. (2-tailed)</td>
<td>0.034</td>
<td>0.005</td>
<td>0.005</td>
<td>0.000</td>
<td>0.004</td>
<td>0.001</td>
<td>0.010</td>
</tr>
<tr>
<td>dynamic CTA vessel density</td>
<td>coefficient</td>
<td>-0.660</td>
<td>0.666</td>
<td>-0.662</td>
<td>0.866</td>
<td>-0.719</td>
<td>-0.768</td>
<td>-0.630</td>
</tr>
<tr>
<td></td>
<td>sig. (2-tailed)</td>
<td>0.027</td>
<td>0.003</td>
<td>0.003</td>
<td>0.000</td>
<td>0.001</td>
<td>0.000</td>
<td>0.003</td>
</tr>
</tbody>
</table>
MR neurography in chemotherapy-induced peripheral polyneuropathy

Anastasia Priester1*, Laura Michel2, Philipp Romar2, Michael Breckwoldt1, Andreas Schneeweiss2, Sabine Heiland1, Martin Bendszus1, Daniel Schwarz1

1Universitätsklinikum Heidelberg, Neuroradiologie, Heidelberg, Germany
2Universitätsklinikum Heidelberg, Gynäkologie, Heidelberg, Germany

Background: Chemotherapy-induced polyneuropathy (CIPN) is a common side effect of taxane-containing chemotherapies resulting in a pure sensory and painful, peripherally accentuated neuropathy. In up to 30% of patients CIPN is irreversible [1] and can therefore require dose reduction or even discontinuation of the required chemotherapy. To date, hardly any preventive or therapeutic measures are available, with moderate effects reported for cooling or compression [2, 3]. The aim of this study was to investigate in vivo morphological and functional correlates of taxane-induced CIPN by means of magnetic resonance neurography (MRN) for early diagnosis and follow-up.

Methods: In this prospective study in progress, we performed a standardized high-resolution 3 Tesla (T) MRN on patients diagnosed with breast cancer undergoing taxane-containing chemotherapy. The protocol included imaging at baseline with two follow-ups. All patients underwent a clinical examination and detailed neurophysiological examination prior to neuroimaging. We examined the median, ulnar and radial nerves at the upper arm and wrist region using T2-weighted fat-saturated sequences and diffusion tensor imaging. Quantitative assessment included nerve T2-weighted (T2) signal (caliber), fractional anisotropy (FA) and apparent diffusion coefficient (ADC).

Results: Compared to baseline and age-matched controls, preliminary data indicate an increased T2 nerve-to-muscle signal ratio with corresponding elevated ADC. Surprisingly, these findings occur predominantly at upper arm level, although clinical symptoms are typically to be found at hand level.

Conclusion: We hypothesize that taxane-induced neurotoxicity leads to specific edematous nerve changes which underlie a distal neuropathic phenotype of CINP. These changes are readily picked up by high-resolution MRN and may show potential for early diagnosis and follow-up.

MRI imaging of the glymphatic system after intrathecal gadolinium administration

Ikram Eda Duman Kavus1*, Elias Kellner2, Niklas Lützen1, Philippe Dovi-Akué3, Horst Urbach1

1Uniklinik Freiburg–Klinik für Neuroradiologie, Freiburg im Breisgau, Germany
2Uniklinik Freiburg–Klinik für Radiologie, Medizin Physik, Freiburg im Breisgau, Germany
Background and purpose: The glymphatic (glia-lymphatic) system is a paravascular pathway for the clearance of waste metabolites including amyloid-β from the brain (Iliff et al. 2012). It can be visualized with serial Gadolinium cisternography (Ringstad et al. 2017). Here, we applied serial T1 relaxation time measurements in order to analyze the temporal dynamics of the glymphatic system.

Material and methods: 3D T1-weighted MP2RAGE sequences were acquired before and after intrathecal gadobutrol injections at 2–4, 6–8, and 24–48 h. MR scans were warped to the MNI space and serial scans were co-registered. T1 relaxation time measurements were performed in predefined ROIs including the perivascular spaces at the base of the basal ganglia. Five patients with spontaneous intracranial hypotension (SIH) and suspected spinal CSF leaks and four patients with frontobasal CSF leaks were studied so far.

Results: The time–T1-relaxation time curves indicate a flow e.g. through the perivascular spaces surrounding the lenticulostriate arteries. Compared to CSF in the ventricles, the decline is less extended and the return to baseline values obviously slower (Fig. 1).

Discussion: The decline and delayed return of T1-relaxation times when compared to CSF is compatible with a convective flow via perivascular spaces.

Conclusion: The glymphatic system can be visualized with serial Gadolinium cisternography.

References
Identification of arterial microaneurysm and micro venous abnormalities using susceptibility-weighted images (SWI) in perimesencephalic subarachnoid haemorrhage (PMSAH)

Silke Hopf-Jensen1, Ann-Kathrin Lohse2, Michael Preiß2, Rüdiger Buchalla1, Jan Regelsberger1, Stefan Müller-Hülsbeck1

1Department of Diagnostic and Interventional Radiology and Neuroradiology, DIAKO Hospital Flensburg, Flensburg, Germany 2Department of Radiology, University Hospital, LMU Munich, München, Germany 3Department of Neurosurgery, DIAKO Hospital Flensburg, Flensburg, Germany

Purpose: Perimesencephalic subarachnoid hemorrhage (PMSAH) is centered anteriorly to the pons and midbrain. The cause of the bleeding is still unknown, although a venous source is still discussed [1]. Susceptibility-weighted images (SWI) represent a powerful tool to visualize venous structures [2]. The purpose of the study was to assess the value of SWI MRI for visualization and characterization of vessel micro-angioarchitecture in PMSAH.

Methods: Analyses of clinical data and SWI sequences of 22 patients with PMSAH compared with 13 patients with aneurysmal SAH in perimesencephalic location (control group).

Results: PMSAH patients (mean age 53.6 years, ±11.3, fem. 10) showed a more favourable clinical course compared to the control group (56.8 years, ±8, fem. 9) with median of 15 on the Glasgow coma scale [IQR 15–15] at admission vs. 11 (IQR 3–15, p=0.006), with median HH 1 (1–2) vs. 4 (IQR 3–4), median Fisher-grade 3 (IQR 3–3.75) vs. 4 (IQR 3–4), 6 patients with vasospasm (27.3 %) without delayed ischaemic (DIC) vs. 7 patients with vasospasm (53.8 %) with 4 patients with DIC (30.8 %), 1 patient with ventriculoperitoneal shunt indication (4.5 %) vs. 5 patients (38.5 %, p=0.035) and a median of 1 on the Glasgow outcome scale (IQR 1–1) at discharge vs. 3 (IQR 3–3, p<0.00001). In SWI analysis of PMSAH one case of thrombosed basilar artery microaneurysm was identified. In three cases, petechial microbleedings beneath the uncus vein were detected. Microhemorrhages ventral to the interpeduncular vein (four cases) and eight enlarged Rosendahl veins have been described. These susceptibility artefacts were not seen in aneurysmal SAH.

Discussion: SWI sequences can visualize increased levels of deoxygenated hemoglobin in cortical vein thrombosis and are useful in visualization of arterial clots [2]. We show enlarged veins as a result of local venous high pressure suitable with micro-venous thrombosis. Petechial microhemorrhages beneath the uncus vein speak for local breakdown of the blood brain barrier and could indicative for venous inflammation. Thrombosed arterial or venous microaneurysm can change susceptibility by decreasing flow with increased level of deoxygenated blood.

Conclusion: Susceptibility-weighted images are feasible in PMSAH and might have significant impact on detection of thrombosed microaneurysms and identification of venous pathology.

References

Acute central retinal artery occlusion: correlating DWI-MRI with OCT

Eberhard Siebert1, Mirjam Rossel-Zemkouo2, Kersten Villringer3, Eberhard Schmahl2, Kersten Villringer1, Konrad Neumann1, Georg Bohner1, Leon Danyel1

1Institut für Neuroradiologie, Charité–Universitätsmedizin Berlin, Berlin, Germany 2Klinik für Augenheilkunde, Charité–Universitätsmedizin Berlin, Berlin, Germany 3Department of Neurology, Charité–Universitätsmedizin Berlin, Berlin, Germany

Background: Retinal diffusion restrictions (RDR) have recently been identified as a regular finding on diffusion-weighted (DWI) MRI in patients with central retinal artery occlusion (CRAO). However, sensitivity for standard 1.5 T and 3 T brain stroke DWI sequences is limited. Optical coherence tomography (OCT) allows for noninvasive examination of retinal layers with a micrometer spatial resolution and has been shown to detect microstructural retinal changes in CRAO. In this study we investigated differences in retinal microstructure between CRAO patients with and without discernable RDR on DWI.

Methods: Consecutive CRAO patients with both MRI and OCT within 7 days after symptom onset between 2010 and 2019 were included in this retrospective cohort study. Standard stroke MRI including DWI, acquired at 1.5 or 3 T, was evaluated for RDR. OCT scans were evaluated for retinal ischemia related microstructural changes such as central, superior, inferior macular thickness (CMT, SMT, IMT) and inner retinal layer thickness (IRLT). OCT results were compared to the presence of RDR using Mann–Whitney U or Chi-squared testing.

Results: A total of 58 patients were included in the study. RDR were seen in 39 patients (67.2 %, 75 % at 3 T and 57.7 % at 1.5 T). Retinal layer thickness measurements of RDR negative patients were significantly lower compared to RDR positive patients (CMT: 305±45.9 vs. 345.4±76.9 µm, p=0.034; SMT: 366.7±45.6 µm vs. 418.5±75.06 µm, p=0.007; IMT: 370.3±45.2 µm vs. 428.9±62.4 µm, p=0.002; IRLT: 233.9±48.6 µm vs. 186.7±34.7 µm, p=0.001). CMT of the fellow eye did not differ between RDR positive and negative cases (297.8±96.58 µm vs. 291±52.9 µm, p=0.949). DWI tended to be negative at higher IRLT values at 1.5 T compared to 3 T (199.8±29.7 µm vs. 168.6±32.8 µm; p=0.057) reflecting improved detectability of RDR at 3 T.
Discussion: The sensitivity of DWI in CRAO is dependent on retinal thickness that increases due to ischemic retinal edema formation and associated microstructural changes as determined by OCT. Differences in the extent of retinal cell edema appear to influence the ability to produce a perceivable DWI signal in affected voxels.

Conclusion: The sensitivity of DWI–MRI in CRAO is dependent on the extent of retinal ischemic edema that leads to an increase of the inner retinal thickness. This interrelation may explain false-negative DWI investigations.

[234] Transformation of stroke lesions after ischemic stroke: do inflammatory processes matter?

Simone Henze1*, Kathleen Bernkopf2, Christian Maegerlein1, Claus Zimmer1, Moritz Hernandez Petzsche1, Benno Ikenberg2, Tobias Boeckh-Behrens1, Maria Berndt1

1School of Medicine, Technical University of Munich, Klinikum rechts der Isar, Department of Diagnostic and Interventional Neuroradiology, Munich, Germany
2School of Medicine, Technical University of Munich, Klinikum rechts der Isar, Department of Neurology, Munich, Germany

Background: The immune system plays an important role in the pathophysiological processes after ischemic stroke, both causing additional damage and stimulating remedial action. The direct impact of inflammation on brain tissue in the further course after ischemic stroke is not finally clarified. Aim of the study was to analyze the stroke lesions and their transformation in the follow-up imaging in relation to inflammatory occurrence in the acute stroke phase and to assess the impact on clinical outcome.

Methods: Stroke lesions were segmented in FLAIR-images in the acute post-stroke phase (3 days after reperfusion) and in the follow-up (3 months later) for 69 patients after mechanical recanalization. After coregistration and subtraction of lesion maps, volume change was quantified and patients were classified into two main groups: patients with a volume decrease of more than 50% without increase (group A; n=40) and patients with a volume decrease of less than 50% (n=11) or growth of stroke lesions (n=18, group B; n=29; Fig. 1). Inflammation values (C-reactive protein [CRP] and leukocytes) were gathered on admission (T0), 24 hours later (24 h), three days after stroke (T1), and the maximum value (max). These values were compared between the two patient groups and correlated to clinical outcome (NIHSS after 90 days).

Results: Patients of group A have lower values of CRP and leukocytes in the acute phase than patients of group B (Fig. 2). CRP at T1 and maximum values are lower in group A (median/IQR of CRP-T1:1.3/1.3 and CRP-max:1.8/2.35) than in group B (2.1/3.8 and 3.9/8.6; p=0.047/0.01). Also, the maximum value of the leukocytes is
lower in group A (median/IQR: 9.9/4.25) than in group B (11.7/4.64; p=0.03; Fig. 3).

NIHSS score after three months is lower for patients in group A (median/IQR:1.0/1) than in group B (1.5/4; p=0.03) and is correlated to the maximum value of CRP (r=0.21/p=0.04) and leukocytes (r=0.27/p<0.01).

Discussion: Inflammatory processes assessed by CRP and leukocytes in the acute post-stroke phase seem to influence the transformation of stroke lesions in the follow-up imaging. Both inflammation and consecutive changes of the stroke lesions impact the clinical outcome. Additionally, the pathophysiological background of lesion increase must be studied.

Conclusion: Patients with signs of inflammation in the acute post-stroke phase seem to influence the transformation of stroke lesions in the follow-up imaging. Both inflammation and consecutive changes of the stroke lesions impact the clinical outcome. Additionally, the pathophysiological background of lesion increase must be studied.

[235] Beyond mean value analysis—a voxel-based analysis of the quantitative MR biomarkers water T2 and PDFF for assessment of skeletal muscle tissue of patients with neuromuscular diseases

Sarah Schlaeger1, Dominik Weidlich1, Agnes Zoffl1, Edoardo Aitala Becherucci1, Elisabeth Klupp1, Federica Montagnese1, Marcus Deschauer1, Benedikt G. H. Schoser1, Claus Zimmer1, Thomas Baumn1, Dimitrios Karampinos2, Jan Kirschke1

1Klinikum rechts der Isar der Technischen Universität München, Neuroradiologie, München, Germany
2Klinikum rechts der Isar der Technischen Universität München, Radiologie, München, Germany
3Friedrich-Baur-Institut, München, Germany
4Klinikum rechts der Isar der Technischen Universität München, Neurologie, München, Germany

Background: The main pathologies in muscles of patients with neuromuscular diseases (NMD) are fatty and edematous changes [1–3]. Recently, quantitative magnetic resonance (MR) imaging for determination of the corresponding MR biomarkers proton density fat fraction (PDFF) and water T2 (T2w) has been advanced [4]. Biophysical effects or pathology can have counteracting effects on MR biomarkers, e.g. MR spectroscopy showed a dependency of T2w on the fat fraction (FF) [5]. Thus, in heterogeneously affected muscles the routinely performed mean value analysis [6] is questionable. Our work proposes a voxel-based histogram analysis of PDFF and T2w based on co-registered quantitative images to mitigate partial volume effects.

Methods: In 12 patients with NMD (LGMD2A n=5; DM2 n=5; Pompe n=2) chemical shift encoding-based water-fat imaging for PDFF and T2w mapping with SPAIR [7] for T2w determination were performed. Nine thigh muscles were segmented bilaterally (n=216). PDFF and T2w maps were co-registered.

Results: A voxel-based comparison of PDFF and T2w revealed a dependency of T2w on the FF showing that T2w is decreased with increasing FF (Fig. 1). A comparison of the T2w value distribution in the semimembranosus muscle of a patient with [1] Pompe disease and [2] DM2 revealed different histograms. Both muscles have the mean T2w of healthy muscles (~32 ms). However, the Pompe patient’s T2w histogram has a broad distribution, and two peaks are present (at 22/35 ms) corresponding to T2w of edematous and fatty voxels, whereas in the DM2 patient’s T2w histogram a single peak is present (at 31 ms) corresponding to T2w of healthy voxels (Fig. 2).

Discussion: Partial volume effects can lead to misinterpretation of muscle health when only the mean T2w of a heterogeneously affected muscle is assessed. A muscle with healthy muscle tissue that is simultaneously affected by fatty and edematous changes might have a mean T2w like healthy muscles.

Conclusion: The assessment of muscle pathologies based on PDFF and T2w requires an interpretation beyond mean value analysis to account for regional pathological differences. Histograms could be an alternative way of interpretation.

References
Occupation-related effects on motor cortex thickness among older, cognitive healthy individuals

Lucas Lenhart¹, Melanie Nagele¹, Ruth Steiger¹, Vincent Beliveau¹, Elisabeth Skalla¹, Laura Zamaran¹, Elke Ruth Gizezki¹, Thomas Benk¹, Margarete Delazer¹, Christoph Scherfler¹

¹Medizinische Universität Innsbruck, Innsbruck, Austria

Background: Both, decline of sensorimotor functions and decrease of cortical thickness are known processes in healthy aging [1]. Physical activity has been suggested to have a positive effect on the execution of daily routine activities and to extend the time of functional independence in advanced age [2]. We hypothesized that cortical thickness of motor areas in retired individuals would be related to physical demands of the profession carried out during the working life period.

Methods: The study population consisted of 69 healthy participants (range from 70–85 years) without signs of cognitive impairment as assessed by neuropsychological testing (MMSE value>25, GDS score<5 and z-values>–2 CERAD). Participants’ former occupations were divided into higher physically complex occupations and lower physically complex occupations (HPCO, n=27 and LPCO, n=42) according to the international standard classification of occupations (ISCO-08).

Results: Surface-based morphometry analyses revealed higher cortical thickness in the left precentral (p=0.001) and postcentral gyrus (p<0.001) and right postcentral gyrus (p=0.001) for the HPCO relative to the LPCO group (corrected for multiple comparisons, sex, age, and leisure activities in the past 20 years). Physical leisure activities associated with exertion were positively correlated with cortical thickness in the left postcentral gyrus (p=0.004) of the HPCO group.

Discussion: Executing a physical complex occupation before retirement was related to increased cortical thickness in motor regions supporting the hypothesis that exercise contributes to neural reserve in these regions. However, neural reserve and assumed protective effects appear to vanish when physical activity is reduced because of retirement.

Conclusion: Increased understanding of reserve capacity and age-related motor decline in older adults may help to design appropriate rehabilitation strategies to improve everyday needed motor abilities, which in turn lead to better health and quality of additional lifetime.

References

Altered dynamics connectivity patterns in multiple sclerosis at rest: a case-control and a longitudinal study

Xiaojing Fang¹,², Michael Marxen², Bruce Morton³, Paul Kuntke¹, Hagen H. Kitzler¹

¹Technische Universität Dresden, University Hospital Carl Gustav Carus, Institute for Diagnostic and Interventional Neuroradiology, Dresden, Germany
²Technische Universität Dresden, University Hospital Carl Gustav Carus, Department of Psychiatry and Neuroimaging Center, Dresden, Germany
³University of Western Ontario, Department of Psychology, Cognitive Development and Neuroimaging Laboratory, Canada

Background: Neural functional connectivity (FC) dynamics at rest may be linked to cognitive and behavioural deficits in multiple sclerosis (MS) [1]. However, it is still unclear how FC network dynamics can be differentially characterized for MS versus healthy controls (HC) and during the cause of the disease. Here, we investigate properties of two mutually exclusive dynamic FC brain states: functional segregation (I) and integration (II).

Methods:

Results: Dynamic functional connectivity (DFC) analyses.

Statistical analyses: There was no significant linear time effect on the parameters. We observed an increasing trend of the effect on DMT of state I (F-value: 0.352, p-value: 0.071; Fig. 5). In the group comparisons, we observed significant group differences in the MDT of state I (p-value: 0.002) and prevalence of state I (p-value: 0.0002).
Discussion: 1) The two patterns in the HC confirm that functional segregation versus integration is a useful organizational principle of brain function [2].
2) We found no linear effect of time on our dynamic FC parameters over a time scale of 3 years in MS.
3) Altered MDT and prevalence of the states may help to explain cognitive impairments in MS [1].

Conclusion: Our analyses show that dynamic FC parameters may show differences in MS as compared to HC but are not sensitive enough to track longitudinal decline. Additional analysis to investigate correlations with clinical severity and other imaging measures are in progress.

---

Fig. 1 | 237 Flow chart of methods

Fig. 2 | 237 Results of clustering analyses for HC. a) Silhouette indices for k-means clustering results based on the 1-IC data.

b) Averaged DFC for each state in HC when k = 2

Fig. 3 | 237 Averaged DFC for each state of patients based on back projection
References


[238] Gender aspects in interventional neuroradiology (INR) training

Sebastian Reder1, Annaïg Rohou2, Naureen Keric3, Marc A. Brockmann1, Sebastian Altmann4, Ahmed Othman1, Mario Alberto Abello Mercado1, Carolin Brockmann1

1Department of Neuroradiology, University Medical Center Mainz, Mainz, Germany
2Faculty of Psychology, University of Graz, Graz, Austria
3Department of Neurosurgery, University Medical Center Mainz, Mainz, Germany
4Department of Radiology, University Medical Center Mainz, Mainz, Germany

Background: Gender-differences have been discussed for various surgical techniques. We aimed at investigating gender differences in training of INR techniques using a silicone model.

Methods: After a standardized training sequence, performance of 64 subjects (26 women, 38 men) naïve to neurointerventional techniques was analysed. Analysing four different, simulated, neurointerventional tasks to required time, number of catheter movements, covered pathway and tries to pass vascular branches. Afterwards, subjects had to answer a questionnaire regarding video gaming activities and a NASA Task Load Index to rate individual perceived workload.

Results: Women required more time to solve the tasks (688 ± 363 vs. 501 ± 230 s; p = 0.019) and more female participants (n = 19) asked earlier for help than men (n = 8; 203 ± 94 vs. 305 ± 142 s; p = 0.049). Women perceived higher stress-levels (8.9 ± 4.9 vs. 6.3 ± 4.4; p = 0.037) and tasks more difficult (11.5 ± 4.2 vs. 9.6 ± 3.3; p = 0.016). They subjectively rated their own performance lower than men (9.12 ± 3.3 vs. 11.3 ± 3.3; p = 0.009). There were no significant gender-based differences for catheter movements, covered pathway, number of tries or objective performance (except time). In females, subjective performance correlated to movements (r = −0.555; p = 0.004), pathway (r = −0.469; p = 0.018), time (r = −0.513; p = 0.009), tries (r = −0.394; p = 0.051) and objective performance (r = −0.383; p = 0.059). Perceived difficulty correlated to time (r = 0.459; p = 0.021), objective performance (r = −0.469; p = 0.018) and number of tries (r = 0.379; p = 0.061). Stress-level correlated to objective performance (r = −0.429; p = 0.033). In males, stress level correlated to number of movements (r = 0.587; p = 0.001), number of tries (r = 0.399; p = 0.013), catheters pathway (r = 0.459; p = 0.004) and time (r = 0.469; p = 0.003).

Conclusion: Women were slower, asked earlier and more frequently for help than men. There were no gender-based differences in objective performance otherwise. Since perceived stress level and objective parameters in men and women differ, these aspects should be considered in training of future neurointerventionalists.

[240] Subtraction of 3D-FLAIR for monitoring disease progression in multiple sclerosis using a clinically approved medical product

Mario Alberto Abello Mercado1, Andrea Kronfeld1, Sebastian Altmann2, Ahmed Othman1, Felix Lüssi1, Marc A. Brockmann1, Sebastian R. Reder1

1Department of Neuroradiology, University Medical Center Mainz, Mainz, Germany
2Department of Radiology, University Medical Center Mainz, Mainz, Germany
Background: MR-imaging results significantly influence therapy of multiple sclerosis (MS). Image interpretation in MS can be time-consuming. We aimed at simplifying and accelerating image analysis using an approved medical product, such as image fusion with subtraction.

Methods: MRI studies of 73 patients with MS were retrospectively analyzed. Every case included a baseline and a follow-up scan (incl. T2 SPACE dark fluid). Images were analyzed by unexperienced (R1) and experienced (R2) neuroradiology resident. Using an automatic matching software (Syngo via; Siemens Healthineers), the follow-up images were co-registered and subtracted from the baseline images, hereby more clearly showing differences between both scans. Both readers analyzed the unsubtracted and the subtracted images separately for new lesions in independent readings blinded to each other’s findings. Primary outcomes were reading time, diagnostic confidence (visual analog scale, VAS), sensitivity and specificity to detect new MS plaques for each reader and both methods (standard and with post-processed images). Reading sessions were timed two weeks apart.

Results: In analyzing standard images R1 was slower than R2 (186.6±72.6s vs. 159.1±49.3s, \( p = 0.026 \)), same was observed analyzing post-processed image reading (90.3±22.7s vs. 80.2±14.7s, \( p = 0.008 \)). The experienced reader analyzed all images significantly faster (both \( p < 0.001 \)). Sensitivity increased for both readers analyzing post-processed images, while specificity decreased (standard images: R1/R2: sensitivity=0.72/0.81, specificity=0.32/0.91 vs. post-processed images: R1/R2: sensitivity=1.0/1.0, specificity=0.16/0.71). Confidence increased while analyzing post-processed images, which affected the unexperienced reader stronger (VAS=5.6±1.9 vs. 6.4±1.7, \( p = 0.011 \)) than the experienced reader (VAS=7.4±0.72 vs. 8.06±0.72, \( p = 0.001 \)).

Conclusion: Using an approved medical product, image fusion with subtraction significantly reduces reading time in MS-imaging. Due to the increased sensitivity it appears to be a helpful tool in daily routine, despite its reduced specificity.

Discussion: The syn T2-w fs delivers valuable additional information on spine pathologies, showing excellent intra-method agreement and an overall better image quality compared to true T2-w fs. Additional

Fig. 1 | 241 Diagram of architecture and training process of the Synthesis task. The Generator G uses T1- and T2-w images to generate syn T2-w fs images. Feedback on the similarity between syn T2-w fs and true T2-w fs is offered by the Discriminator D and causes modifications in network weightings until the loss of function to discriminate between both images is minimal.

[241] Synthetic T2-weighted fat sat delivers valuable information for pathology assessment in the spine: validation of a task-specific generative adversarial network

Sarah Schroeter1, Katharina Drummer1, Malek Hussen1, Nico Sollmann1, Claus Zimmer1, Benedikt Wiestler1, Jan Kirschke1

1Klinikum rechts der Isar der Technischen Universität München, Neuroradiologie, München, Germany

Background: Generative adversarial networks (GAN) based on deep learning (DL) can create novel contrasts in magnetic resonance imaging data [1]. The purpose of this study was to compare a GAN-based synthetic (syn) T2-weighted (w) fat saturated (fs) sequence with its true counterpart regarding (1) ability to detect spinal pathologies not seen on non-fs T2-w and T1-w images, (2) diagnostic agreement, and (3) image quality.

Methods: We retrospectively identified 173 patients with sagittal T1-w TSE, T2-w TSE and fs T2-w TSE images of the spine. A GAN was trained to synthesize T2-w fs images from T1- and T2-w images in 129 scans of 72 patients (Fig. 1). This GAN was used to create syn T2-w fs images from the remaining, previously unseen 101 sagittal spine scans (Fig. 2). Diagnostic performance of syn images was assessed in 6 pathologies (Fig. 3). Pathologies were first assessed on T1-w and T-w images only, then (randomized syn or true) T2-w fs was blindly added. This approach was repeated with the remaining syn or true T2-w fs. We evaluated (1) the additional diagnostic information of syn vs. true T2-w fs, (2) the agreement of syn vs. true T2-w fs using Cohen’s Kappa, and (3) the grading of image and fs quality.

Results: (1) Assessment of syn T2-w fs allowed detection of abnormalities not seen on non-fs images, comparable to true T2-w fs (Fig. 3). (2) Agreement of syn vs. true T2-w fs ranked between moderate to almost perfect (Fig. 4). Of note, it was equal or higher than intrarater agreement of T1- and T2-w based ratings. (3) Image quality was higher for syn than for true T2-w fs (99.9 % vs. 88.1 % graded at least acceptable). Fat sat quality was comparable.

Discussion: The syn T2-w fs delivers valuable additional information on spine pathologies, showing excellent intra-method agreement and an overall better image quality compared to true T2-w fs. Additional
advantages are shorter scan protocols and the possibility for a retrospective generation of T2-w fs images from T1- and T2-w images.

**Conclusion:** Our work underlines the potential of a GAN based syn T2-w fs for MR spine examinations.

**References**


---

**Fig. 2** Exemplary images of true and syn T2-w fs for different scanner hardware

<table>
<thead>
<tr>
<th>Pathology</th>
<th>Syn T2-w fs</th>
<th>True T2-w fs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bone marrow abnormalities</td>
<td>0.76</td>
<td>0.76</td>
</tr>
<tr>
<td>Spondylolysisis expansion</td>
<td>0.85</td>
<td>0.89</td>
</tr>
<tr>
<td>Ischemic/Inflamed changes</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>Vertebral Fracture</td>
<td>0.78</td>
<td>0.78</td>
</tr>
<tr>
<td>Cord lesions</td>
<td>0.56</td>
<td>0.60</td>
</tr>
<tr>
<td>Paravertebral tissue abnormalities</td>
<td>0.79</td>
<td>0.79</td>
</tr>
</tbody>
</table>

**Fig. 3** Absolute (and relative) number of abnormalities, in which the syn or true T2-w fs offered additional diagnostic information compared to the rating based on T1- and T2-w images only

**Fig. 4**

- First column: Cohen’s Kappa values for inter-method agreement of true T2-w fs vs. syn T2-w fs for grading of six different pathologies. The pathology grading was based on the combined information of T1-/T2 w and T2 fs images, respectively. Second column: Cohen’s Kappa values for intra-rater agreement of first and second pathology rating round based on T1-w and T2-w images only.


**Ergebnisse:** Hochauflösende Blutflosssimulation bestätigt die Existenz komplexer Flussmuster, welche zusammen mit Hochfrequenz-Fluktuationen auftreten. Diese treten vorwiegend direkt nach dem Peak des systolischen Einstroms auf und bestehen bis zur Diastole. Die Wall-shear-stress-Verteilung zeigt zudem eine starke Oszillation und
die spektrale Flussentropie zeigt einen Wert von 0,76. Diese Beobach-
tungen konnten im unrupturierten Aneurysma nicht gemacht werden
(Entropie von 0,12 – wobei 0 konstanten Fluss repräsentiert).

**Diskussion:** Multiple Biomarker bestehen für das Rupturrisiko von in-
trakraniellen Aneurysmen, Hochfrequenz-Fluktuationen könnten ein
weiterer, wichtiger Baustein im Risikoassessment von Aneurysmen
werden, wie die Analyse unserer Beispiele nahelegt. Eine Validierung
ist allerdings an größeren Kohorten notwendig, zudem sollte eine Ana-
lyse der Beziehung zu den angrenzenden Gefäßen und deren Blutfluss
durchgeführt werden.

**Fazit:** Hochfrequenz-Fluktuationen des Blutflusses in Aneurysmen
existieren und könnten sich als guter Biomarker für Aneurysma-
stabilität etablieren.

**[247] Multiparametrische MRT-Signaturen von Response
und Resistenz unter Immuntherapie mit dem Nanopartikel
Konjugat CDNP-R848 im experimentellen Gliommodell**

Verena Turco1, Kira Pfleiderer2, Jessica Hunger2, Kianush Karimian-
Jazi2, Katharina Schregel3, Gianluca Brugnara3, Kristine Jähne3,
Manuel Fischer3, Theresa Bunse1, Wolfgang Wick3, Sabine Heiland2,
Christopher Rodell3, Philipp Vollmuth3, Martin Bendszus3, Michael
Breckwoldt3*, Michael Platten1

1Klinische Kooperationseinheit Neuroimmunologie und
Hirntumorimmunologie, Deutsches Krebsforschungszentrum DKFZ,
Deutschland

2Abteilung Neuroradiologie, Uniklinik Heidelberg, Deutschland
3Abteilung Neurologie, Uniklinik Heidelberg, Heidelberg,
Deutschland
4School of Biomedical Engineering, Drexel University, Philadelphia,
Vereinigte Staaten

**Hintergrund:** Die Therapieresistenz von Gliomen liegt u. a. am im-
munosuppressiven Tumormikromilieu (TME). Neue immuntherapeuti-
sche Ansätze induzieren proinflammatorische Veränderungen in der
TME. CDNP-R848 ist ein β-Cyclodextran-Nanopartikel, welcher den
toll-like-Rezeptor (TLR) 7/8 Agonisten, R848 komplextiert. Neue
MRT-Ansätze versuchen, eine frühzeitige Vorhersage zwischen Thera-
pieansprech und -resistenz zu erreichen. Zur Etablierung einer ent-
sprechenden Signatur nutzen wir die multiparametrische MRT (T2, T1
CE, Diffusion, Perfusion), die Phagozyten-spezifische USPIO-Bildge-
bung und Radiomics-basiertes prädiktives Modeling im experimentel-
len Gliommodell.

**Methoden:** Gli261Gliome wurden in C57Bl/6J Mäuse implantiert.
Hochfeld-MRTs (9.4T) erfolgten zu Woche 2 (Randomisierung), 3 und
4. Die Response wurde im Verlauf mittels zuvor etablierter Kriterien
verfolgt. Die „ultrasmall iron oxide“(USPIO)-Bildgebung erfolgte mit
Ferumoxytol i. v. (30 mg/kg, quantifiziert über Multigradienten-Echo
[MGE]”). Die radiomische Analyse erfolgte analog zu (Aslan et al.,
2020).

**Ergebnisse:** Unter CDNP-R848 Gabe zeigte sich eine Response-
rate von 80 % (2,5 % CR, 52,5 % PR und 25 % SD, n = 52 Mäuse),
während unter CDNP Vehikel-Gabe der Tumor exponentiell wuchs
(n = 12). 25 % (n = 8/32) der Responder-Tiere zeigten eine Pseudoprogression (PsPD). Eine gesteigerte Aufnahme von USPIOs ging mit einer Tumorprogression einher (Δ T2*: –11,7 ms ± 4,2 vs. –4,0 ms ± 2,8, p = 0,01, n = 9). Der USPIO-Uptake war auf den vermehrten Influx von Tumormakrophagen in die TME zurückzuführen (R2: 0,78, p = 0,004). Mittels Radiomics konnte das Ansprechen mit einer Genauigkeit von 84,7 % vorhergesagt werden (Sensitivität: 80,8 %; Spezifität: 86,9 %). Das Top-Radiomic-Merkmal für die Vorhersage des Therapieverlaufs war der Unterschied in der volumetrischen Kompaktheit zwischen Woche 2 und Woche 3.

Diskussion: Neben der präklinischen Effizienz dieses immuntherapeutischen Ansatzes zeigen wir, dass die USPIO-MRT im Gegensatz zu konventionellen Sequenzen (Perfusion, Diffusion) die CDNP-R848-Wirksamkeit monitorieren kann und dadurch eine Responseprädiktion vor Beginn der Tumorregression möglich ist. Unsere Radiomics-Analyse ist kohärent mit unseren früheren Analysen unter...
Checkpoint-Blockade. Somit scheint die Entwicklung einer therapeutisch-unabhängigen radiomischen Signatur für das Therapieansprechen möglich.

Fazit: Dieser Ansatz ermöglicht die zelluläre Visualisierung und Analyse von Veränderungen der TME durch multiparametrische MRT.

[250] Noninvasive perfusion territory mapping and time-resolved angiography by ASL is clinically applicable in cerebrovascular diseases

Jens Göttler1, Hans Liebl1, Miriam Reichert1, Moritz Hernandez-Petzsche1, Maria Berndt1, Kim van de Ven2, Christine Preibisch1, Jan Kirschke1, Makoto Obara3, Claus Zimmer1, Nico Sollmann1, 3, and Stephan Kaczmarz1

1Department of Neuroradiology, Technical University of Munich (TUM), München, Germany
2Philips Healthcare, Best, The Netherlands
3Phülsie Japan, Tokyo, Japan
4University Hospital Schleswig-Holstein Campus Kiel, Kiel, Germany
5Department of Radiology, University Ulm Medical Center, Ulm, Germany

Background: Collateralization status in cerebrovascular diseases (CVD) is crucial to assess stroke risk. Recently, two noninvasive imaging tools based on arterial spin labeling (ASL) have been proposed to depict collateral flow: 4D-sPack [1] enables time-resolved angiography and super-selective ASL (ss-ASL) [2] maps individual perfusion territories. Here we assessed their clinical feasibility in combination with a novel automated vessel planning tool [3] in patients with different CVDs and healthy controls (HC) in comparison with digital subtraction angiography (DSA) and perfusion weighted imaging.

Methods: A total of 14 CVD patients, including 10 with arteriovenous malformations, 3 with moyamoya and 1 with internal carotid artery (ICA) dissection, and 10 HCs (Table 1) underwent MRI on 3T Philips scanners. Sequence parameters are summarized in Fig. 1. Labeling positions of ss-ASL and 4D-sPack were set automatically [3]. In selected patients, intracranial DSA was obtained.

Results: The automated planning tool successfully identified labeling positions in 20/20 HC and 26/29 CVD patients (Fig. 5). Two of three failed attempts were caused by motion, the third was the dissected ICA (Fig. 2). Collateral flow patterns in patients were reliably depicted by ss-ASL and 4D-sPack (Fig. 2 and 3). Comparisons of 4D-sPack with DSA showed excellent spatial correspondence even for distal contralateral collaterals (Fig. 4).

Discussion: 4D-sPack and ss-ASL were successfully applied in CVD patients and HC, highly facilitated by the automated labeling tool. Rare labeling failures were associated with motion and vessel disease. 4D-sPack angiography was comparable to DSA and may be a diagnostic substitute in some cases. Ss-ASL could spatially localize shifted vascular territories and border zones explaining regional perfusion delays.

Conclusion: Noninvasive vascular territory mapping and time-resolved angiography based on super-selective ASL combined with automated planning is clinically applicable and can assess collateralization status in a number of CVDs. Thus, it may guide revascularization therapy in the future.

References
1. Obara; ISMRM2018,#185
3. Helle et al.; ISMRM2018,#302

[252] Safety profile and complication rates in emergency off-label use of tirofiban in interventional neuroradiology: an observational study

Sebastian Altmann1, 3, Daniel Dillinger1, Anastasios Mpotsaris1, Annette Speer1, Christoph Waldack1, Ahmed Othman1, Florian Ringel1, Thomas Kerz3, Marc A. Brockmann1, Carolin Brockmann1

1Universitätsmedizin Mainz, Klinik und Poliklinik für Neuroradiologie, Mainz, Germany
2Universitätsklinikum Magdeburg A.-o.R., Universitätsklinikum für Neuroradiologie, Magdeburg, Germany
3Städtisches Klinikum Braunschweig gGmbH, Neurologische Klinik, Braunschweig, Germany
4Bundeswehrzentralkrankenhaus Koblenz, Klinik VIII – Radiologie und Neuroradiologie, Koblenz, Germany
5Universitätsmedizin Mainz, Neurochirurgische Klinik und Poliklinik, Mainz, Germany

Background: Tirofiban is approved for treatment of acute coronary syndrome. Meanwhile, however, tirofiban is frequently applied in various emergency situations in INR despite contraindications (CI). This study aimed at evaluating the safety profile of tirofiban when used off-label in patients with CI.

Methods: Data of 86 patients undergoing neurointerventional therapy and being treated with tirofiban in two neuroendovascular centres between January 2016 and 2017 were retrospectively analysed: n = 18 without CI and 67 with off-label use due to one or more CI, such as recent stroke (<30 days; n = 45), recent haemorrhage, thrombocytopenia (<150,000/microl; n = 6), aPTT>1.3-fold, INR<1.5 (n = 15), severe liver or renal insufficiency (Child-Pugh C; n = 2), and preceding intravascular thrombolysis (n = 28). Haemorrhage between the beginning and up to 10 h after infusion of tirofiban was considered tirofiban-related (incl. gastrointestinal bleedings and macrohematuria). CI and treatment were evaluated using subgroup and multivariate analysis.

Fig. 1 250 Imaging protocol and derived parameters. Dynamic susceptibility contrast (DSC) MRI was applied to derive time-to-peak (TTP) maps, pseudo-continuous arterial spin labeling (pCASL) for cerebral blood flow (CBF), super-selective ASL (ss-ASL) for perfusion territories and 4D-sPack for time-resolved intracranial angiography. Vessel-selective labeling was repeated for each brain feeding artery (green) and automatically planned (orange) using time-of-flight (TOF). For comparisons, MR neckangiography and digital subtraction angiography (DSA) were applied.
Fig. 2  | 250  Perfusion and angiography in a patient with left-sided ICA (L-ICA) dissection and ipsilateral M1 occlusion. Conventional MR neck angiography (A and B) shows occlusion of the L-ICA. Brain perfusion is mainly preserved by the right-sided ICA (R-ICA, red circle in B) and left-sided vertebral artery (L-VA, yellow circle in B); the R-VA is hypoplastic. There is slightly decreased CBF (circle, C) and substantially prolonged TTP (circle, D) in the left parietal border zone. Ss-ASL reveals that the left middle cerebral artery territory is collateralized via the L-VA and R-ICA and that the region with prolonged TTP is mainly supplied by the L-VA (circle, E). Accordingly, 4D-sPack demonstrates that the L-VA supplies the posterior parts of the left brain regions (circle, F), while RICA supplies the left anterior and proximal middle cerebral arteries.

Fig. 3  | 250  Perfusion in a patient with moyamoya disease. Cerebral blood flow (CBF), time-to-peak (TTP) and both ICA territories visualized by ss-ASL (red & cyan) are compared in three axial slices (A,B,C). White no severe hypoperfusion is apparent, the R-ICA territory is shifted contralaterally and supplies the left anterior cerebral artery. The perfusion delay is severely prolonged in the left hemisphere where territories of L-ICA and R-ICA meet (circles). Note the excellent spatial correspondence of non-invasive perfusion territory mapping and angiography by 4D-sPack (arrows; see Fig. 4 for time-resolved results).
Fig. 4 | 250  Angiography of a patient with moyamoya disease. (A) Non-invasive time resolved angiography by 4D-sPack of R-ICA (red) and L-ICA (cyan) are shown in axial view with maximum intensity projections (top row). Note that delayed filling of the left middle cerebral artery is in agreement with delayed perfusion depicted by elevated time-to-peak (TTP) (circles). (B) The noninvasive angiogram at t=2000 ms is compared to conventional DSA in the same patient in coronal and sagittal view for R-ICA and L-ICA, respectively. Note, 4D-sPack can even depict small pial collaterals originating from R-ICA in agreement with DSA (arrows).

Results: Tirofiban effectively prevented thrombotic events in 81/86 patients (94.2%). Relevant tirofiban-associated complications occurred in 14 patients (16.3%), of which nine received IV thrombolysis. Twelve of 86 patients died, while the overall tirofiban-related mortality was 2.3% (two patients with ICH). Overall, we could show no significant differences for tirofiban-related complication between the control group and Patients with CI. Multivariate analysis revealed age as the only parameter significantly associated with development of tirofiban-associated complications (p = 0.026).

Discussion: Off-label use of tirofiban in INR is feasible at a low rate of adverse events. Highest risk for relevant tirofiban-associated complications is observed in older patients treated by emergency stent-PTA for acute stroke and thus requires even more precise benefit-risk assessment.

[256] Ausprägung von Zeichen einer idiopathischen intrakraniellen Hypertension in der MRT bei Adipositas

Schkebek Aludin1, Sönke Peters1, Julia Juhasz1, Olav Jansen1, Matthias Laudes2, Lars-Patrick Schmill2*

1Klinik für Radiologie und Neuroradiologie, Universitätsklinikum Schleswig-Holstein, Campus Kiel, Kiel, Deutschland
2Klinik für Innere Medizin I, Universitätsklinikum Schleswig-Holstein, Campus Kiel, Abteilung für Endokrinologie, Diabetologie und klinische Ernährungsmedizin, Kiel, Deutschland

Hintergrund: Die idiopathische intrakranielle Hypertension (IIH) tritt insbesondere bei jungen, adipösen Frauen im gebärfähigen Alter auf. Entsprechend der häufigen Coinzidenz besteht der Verdacht darauf, dass Adipositas einen Risikofaktor für IIH darstellt. Da die Adipositas in der Bevölkerung zunehmende epidemiologische Relevanz erfährt, kann angenommen werden, dass ebenfalls die Inzidenz der IIH künftig zunehmen wird. In dieser Studie soll das Auftreten typischer MR-Zeichen der IIH bei Personen mit einem BMI>30 kg/m² gegenüber normalgewichtigen Personen verglichen werden.


Ergebnisse: Adipöse Personen weisen im Vergleich zu den normalgewichtigen einen signifikant höheren Score der Hauptzeichen auf (p=0,0006). Ebenso der quantitativer Vergleich der einzelnen Hauptzeichen ergab bei adipösen Personen ein signifikant häufigeres und ausgeprägteres Auftreten von Stenosen des Sinus transversus (p<0,0005), einer Erweiterung der Sehnervenscheide (p<0,05) und einer Höhe milderung der Hypophyse (p<0,05). Weiterhin bestehen signifikante Korrelationen zwischen der Ausprägung der Hauptzeichen und dem BMI der Patienten (p<0,05).

Diskussion: Adipöse Personen weisen gegenüber normalgewichtigen signifikant häufigere zerebrale MR-Zeichen der IIH auf, was die Rolle der Adipositas als Risikofaktor für die IIH unterstützt. Es ist zu evaluieren, ob lediglich ein erhöhter intraabdomineller Druck zu einem verminderten zerebralen Abfluss und hierüber zu einem erhöhten intrakraniellen Druck führt oder ob auch andere Faktoren wie Veränderungen der hormonellen Achsen eine Verstärkung von Adipositas und IIH bedingen.

Fazit: Adipositas ist mit der Ausprägung von Zeichen einer IIH im MRT assoziiert, was verstärkt auf ihre Rolle in der Pathophysiologie der IIH hinweist. Den genauen Pathomechanismus gilt es in zukünftigen Studien weiterhin zu klären.
[265] Fluid-structure interaction for the simulation of intracranial aneurysm after endovascular flow diverter stent implantation

Elie Hachemi1, Aurelien Larcher1, Nemer Ramy1, Augusto Fava Sanches2, Yigit Özpeynirci2, Thomas Liebig2, Meliga Philippe1

1PSL Mines ParisTech, CFL Research Group at CEMEF, Sophia Antipolis, France
2Institute of Neuroradiology, University Hospital LMU, Munich, Germany

Conclusion: The results assess the relevance of the action of the hemodynamic forces. Magnetic resonance imaging show that the sac significantly deforms under aneurysm (including inflow conditions measured by phase contrast magnetic resonance imaging) and that the flow in intracranial aneurysms after flow diverter stent implantation is of particular interest to understand the relationship between treatment outcomes and the induced flow and hemodynamics modifications. In practice, however, the high-fidelity simulation of such complex systems remains challenging due to the need to realistically deploy the stent in patient-specific vascular models, adequately mesh and resolve the thin wires and gaps between the stent and the vascular wall, and account for vessel wall deformations via relevant fluid-structure interaction (FSI) modeling.

Methods: A novel FSI computational framework based on the Adaptive Immersed Mesh (AIM) method is proposed for the simulation of stented intracranial aneurysms. It combines a finite element solid dynamics solver and a fully Eulerian fluid-solid framework. The Navier-Stokes equations with non-Newtonian blood rheology and hyperelastic solid dynamics equations (valid for compressible/incompressible material) are solved with the Variational Multi Scale (VMS) method, to stabilize the advection-dominated regime for the flow problem and damp out spurious pressure oscillations for the solid problem. The approach accurately describes the mechanical exchanges between the blood flow, the vessel wall and the stent, without requiring body-conforming meshes around the stent wires and their contacts with the wall.

Results: Results obtained from a patient-specific model of unruptured aneurysm (including inflow conditions measured by phase-contrast magnetic resonance imaging) show that the sac significantly deforms under the action of the hemodynamic forces. The aspect ratio increases by up to 10% at peak systole, and the wall shear stress (commonly used to assess the risk of rupture) decreases by 20% with respect to rigid wall modeling.

Conclusion: The results assess the relevance of FSI modeling for intracranial aneurysm hemodynamics prediction, but must be confirmed with large sample sizes. We also plan to push forward the method using patient-specific wall thickness and locally tunable stress-strain relations (to account for the abrupt change in tissue structure between the parent vessel and the sac).

References

[266] Long-term outcomes of wide-necked intracranial bifurcation aneurysms treated with stent-assisted coiling using low-profile Acandis Acclino stents

Katharina Melber1, Dominik Grieb1, Frederik Boxberg1, Martin Schlunz-Hendann1, Friedhelm Brassel1

1Sana Kliniken Duisburg, Duisburg, Germany

Background: Little data exists on endovascular treatment of intracranial aneurysms with the Acandis Acclino low-profile self-expanding closed-cell stent systems and is mainly limited to short- or midterm results. We report our long-term experience with the Acandis Acclino stent systems in the treatment of complex intracranial aneurysms.

Methods: A total of 64 aneurysms were treated electively using 91 Acclino stents. Single stent-assisted coiling was the preferred treatment in 40 and the kissing-Y stenting technique in 24 cases. We analyzed demographic data and long-term results.

Results: All stents were successfully deployed with immediate complete (RROC I) or near complete (RROC II) occlusion achieved in 92.2%. Follow-up was available in 57 cases (89.1%) with a mean follow-up of 37 months (range: 6–80 months). Long-term RROC I or II was achieved in 49 cases (86%). Eight residual aneurysms (14% RROC III) were noted (4 cases of stable residual aneurysmal filling and 4 of aneurysmal recanalization). Two of those recurrent aneurysms were retreated by coiling. The directly procedural-related complication rate was 4.7%, including one death. Seven cases of in-stent-stenosis (12.3%; morbidity n = 0) were detected on follow-up with 6 of them when using the kissing-Y stenting technique.

Discussion: Our high long-term follow-up occlusion rates and overall in-stent stenosis rate are comparable to short- and midterm results of other low-profile stents. However, we detected a noteworthy number of clinically silent in-stent stenosis when using the kissing-Y stenting technique, possibly attributable to the stent configuration. Our data included long term follow-up of the latest Acclino stent generation also associated with low-complication and aneurysmal recurrence rates.

Conclusion: Endovascular treatment of various complex intracranial aneurysms using the Acandis Acclino stent systems is safe and efficient with high aneurysm occlusion rates combined with low complication rates at long-term follow-up. Overall, rates of in-stent-stenosis are low but seem to depend on the treatment technique (single stent-assisted vs. kissing-Y stenting with coiling).

References

[267] Mechanical thrombectomy for basilar artery occlusion stroke: analysis of the German Stroke Registry-Endovascular Treatment (GSR-ET)

Katharina Feil1, Maria Berndt2*, Silke Wunderlich1, Christian Maegerlein2, Kathleen Bernkopf2, Moritz Herzberg1, Manuel Lehnh2, Steffen Tiedt3, Clemens Küpper3, Johannes Wismann4, Sonja Schönecker4, Konstantin Dimitriadis1, Thomas Liebig1, Marianne Dieterich1, Claus Zimmer1, Lars Kellert1, Tobias Boeckh-Behrens1

1Department of Neurology and Stroke, Eberhard-Karls University Tübingen, Germany
2Department of Diagnostic and Interventional Neuroradiology, Klinikum rechts der Isar, School of Medicine, Technical University of Munich, Germany
3Department of Neurology, Klinikum rechts der Isar, School of Medicine, Technical University of Munich, Germany
4Institute of Neuroradiology, Ludwig-Maximilians-University Munich, Germany
5Institute for Stroke and Dementia Research (ISD), Ludwig-Maximilians-University Munich, Germany
6Department of Neurology, Ludwig-Maximilians-University Munich, Germany

Background: Stroke due to basilar artery occlusion (BAO) causes the most severe strokes with poor prognosis. Data regarding efficacy of mechanical thrombectomy (MT) in BAO are sparse.

Methods: Patients enrolled between 06/2015 and 12/2019 in the German Stroke Registry-Endovascular Treatment (GSR-ET) were analyzed. The GSR-ET is an independent, prospective, multicenter, observational registry with 25 participating stroke centers in Germany enrolling patients treated with MT. Primary outcomes were successful reperfusion (mTICI score of 2b-3) and good functional outcome at 3 months (mRS of 0–2).

Results: A total of 640 (9.6%) of the 6635 patients in the GSR were strokes due to BAO. Successful reperfusion was observed in 86.6%. At 3 months' follow-up, 31% of patients showed a good function-
al outcome, mortality was 39 %. Analysis of mTICI3 vs. mTICI2b showed considerable better outcomes (good outcome in 38.9 % vs. 24.4 % \( p = 0.005 \); Fig. 1). Strongest predictor for good functional outcome were IVT treatment (OR 3.04, 95 % CI 1.76–5.23) and successful reperfusion (OR 4.92, 95 % CI 1.15–21.11), while the effect of the time between symptom onset and start of reperfusion seems to be low (Fig. 2).

**Discussion:** Acute reperfusion strategies of BAO are common in daily practice and can be performed safely with high rates of successful reperfusion. Our data suggest that successful, and especially complete reperfusion predicts good outcome, while the time since symptom onset has a low impact.

**Conclusion:** The study reinforces the importance of reperfusion success in acute BAO. Future clinical trials should address acute reperfusion strategies of BAO patients.

**Ergebnisse:** Eine erfolgreiche Reperfusion des Verschlusses (mTICI≥2b) wurde beim Flying-doctor-Konzept in 95,0 %, im CSC bei 94,5 % (p = 0,728) erreicht. Komplikationen traten in der FIT-Gruppe in 3,0 %, im CSC in 1,6 % auf (p = 0,473). Die Onset-to-groin-Zeiten lagen beim Flying-doctor-Konzept im Median bei 234 min, bei den im CSC behandelten Patienten bei 231 min (p = 0,275).

**Schlussfolgerung:** Das Flying-doctor-Konzept stellt beim akuten CSC behandelten P

---

**[270]** Diagnostic performance of ultra-high-resolution CT angiography for the detection of angiographically proven intracranial aneurysms: comparison with normal-resolution CT angiography

Marius Frenzel1, Sebastian Altmann1, Oliver Korczynski1, Marc A. Brockmann1, Sebastian R. Reder1, Carolin Brockmann1, Ahmed Othman1

1Universitätsmedizin der Johannes Gutenberg-Universität Mainz, Klinik und Poliklinik für Neuroradiologie, Mainz, Germany

**Purpose:** Ultra-high-resolution CT angiography (UHR-CTA) is a newly developed technology and may increase the detectability of small abnormalities. We aimed to compare image quality and diagnostic accuracy of UHR-CTA and normal-resolution CT angiography (NR-CTA) for detection of intracranial aneurysms.

**Methods:** A total of 62 patients (age 58.2 years; 24.5–87.7 years; F = 38, M = 24) who underwent CT angiography and cerebral DSA for suspected aneurysmatic subarachnoid hemorrhage (aSAH) were included in this study. 32 patients underwent NR-CTA (Toshiba Aquilion 32; detector element size: 0.5 mm; matrix: 512), and 30 patients underwent UHR-CTA (Canon Aquilion Precision; detector element size: 0.25 mm; matrix: 1024). Image quality, sharpness, noise, contrast and diagnostic confidence were evaluated for CTA datasets by two neuroradiologists on a 4-point Likert-scale. Readers assessed also CTA datasets for presence and localization of intracranial aneurysms. An interventional neuroradiologist assessed DSA datasets for presence and localization of intracranial aneurysms. Diagnostic accuracy for CTA was calculated with DSA serving as reference standard. Comparative analyses of UHR-CTA and NR-CTA were then performed.

**Results:** UHR-CTA revealed significantly superior overall image quality, sharpness, noise, contrast and diagnostic confidence as compared to NR-CTA (p < 0.001). DSA revealed 53 aneurysms in 43 of the 62 included patients (20 patients with NR-CTA; 23 patients with UHR-CTA). UHR-CTA categorized patients correctly, identified all positive patients (patient-based sensitivity = 1; specificity = 1) and enabled the detection of 25 of 27 angiographically proven intracranial aneurysms (segment-based sensitivity = 0.963). On the other hand, on NR-CTA 6 patients were misclassified as negative; 1 patient was misclassified as positive (patient-based sensitivity = 0.700; specificity = 0.917) and 15 of 26 angiographically proven aneurysms were detected (segment-based sensitivity = 0.577). Comparative analysis revealed significantly higher diagnostic accuracy for UHR-CTA as compared to NR-CTA (p < 0.01).

**Discussion:** Compared to NR-CTA, UHR-CTA has superior image quality and remarkably enhances diagnostic accuracy for the detection of angiographically proven intracranial aneurysms in patients with suspected aSAH.

**Conclusion:** UHR-CTA enhances the detection of intracranial aneurysms in patients with suspected aSAH.

---

**[271]** Preoperative IDH mutation prediction in glioma using 2-Hydroxyglutarate magnetic resonance spectroscopy

Tareq A. Juratli1*, Amir Zolali1, Mirko Peitzsch1, Graeme Eisenhofer1, Gabriele Schackert2, Jennifer Linn1, Annett Werner1

1Universitätsklinikum Carl Gustav Carus, Klinik und Poliklinik für Neurochirurgie, Dresden, Germany
2Universitätsklinikum Carl Gustav Carus, Institut für Klinische Chemie und Laboratoriumsmedizin, Labor Klinische Neurochemie, Dresden, Germany
3Universitätsklinikum Carl Gustav Carus, Institut und Poliklinik für Diagnostische und Interventionelle Neuroradiologie, Dresden, Germany

**Background:** Noninvasive and accurate diagnostic techniques to detect isocitrate dehydrogenase (IDH) mutant glioma have great potential in routine clinical practice. To date, only a few centers worldwide were able to establish 2HG detection by magnetic resonance spectroscopy (MRS) in glioma. Here, we report on the results of 2-Hydroxyglutarate (2HG) single-voxel spectroscopy (SVS) in a large glioma patient’s cohort.

**Methods:** A total of 72 glioma patients were prospectively investigated using point-resolved spectroscopy at 3 T in parallel with standard clinical magnetic resonance imaging and assessment. The 2HG mutation status was determined using next generation sequencing or/and immunohistochemistry in the glioma tissue. In addition, in a subset of patients (n = 8), 2HG concentrations were measured in the tissue by liquid chromatography-tandem mass spectrometry (LCMS).

**Results:** Only cases with histologic confirmation were included in the analysis (n = 50). The cohort consisted of 36 IDH mutant gliomas (17 astrocytomas, 13 oligodendrogliomas and 6 glioblastomas), 8 IDH wild-type glioblastomas, three radiation-associated necrosis and three other pathologies. All patients underwent a histologic tumor conformation with consecutive IDH mutation assessment. The 2HG concentration in the spectroscopy varied between 0.45 and 6.9 mM. IDH mutations were correctly predicted with 90.5 % sensitivity and 70.6 % specificity. The test accuracy was 84.7 %. Three out of five false positive cases and two out of four false negative cases were observed during the early period of establishing the study protocol. Importantly, all cases with a radiation-associated necrosis in IDH mutant gliomas were predicted correctly.

**Discussion:** Our findings suggest that 2HG spectroscopy is a reliable and reproducible method in IDH mutation prediction in gliomas, from indolent disease through post-treatment follow-up. We envision that 2HG MRS can be used as a biomarker for clinical trials in glioma.

---

**[272]** Diagnostic value of water and fat Dixon reconstructions and CT-like images extracted from a single ultra-short echo time sequence for the evaluation of vertebral fractures and degenerative changes of the spine

Georg Constantin Feuerriegel1, Sophia Kronthal1, Christof Boehm1, Yannik Leonhardt1, Martin Renz2, Kilian Weiss1, Thomas Liebig1, Dimitrios Karampinos1, Claus Zimmer1, Marcus Makowski1, Benedict Schwaiger1, Alexandra Sophia Gersing1

1Klinikum rechts der Isar der Technischen Universität München, Institut für diagnostische und interventionelle Radiologie, München, Germany
2Klinikum rechts der Isar der Technischen Universität München, Institut für Neuroradiologie, München, Germany
3LMU Klinikum, Institut für Neuroradiologie, München, Germany

**Background:** The aim of this study was to evaluate whether vertebral fractures including fracture age and morphology as well as degenerative bone changes of the spine can be accurately assessed on water and fat single echo Dixon reconstructions and computed tomography...
Of 54 fractures detected, 21 were identified as being acute. The inter-reader agreement of fractures and degenerative bone changes was substantial to almost perfect ($\kappa = 0.86 [0.65–1.00]$). Overall inter-reader agreement was substantial to excellent (Genant: $\kappa = 0.77 [0.48–1.00]$; AO/Magerl: $\kappa = 0.75 [0.28–1.00]$; Osteophytes: $\kappa = 0.78 [0.49–1.00]$; Sclerosis: $\kappa = 0.74 [0.34–1.00]$). Overall inter-reader agreement was substantial to almost perfect ($\kappa = 0.86 [0.65–1.00]$).

Detection of vertebral fractures as well as the morphological assessment of fractures and degenerative bone changes was feasible and accurate using a single-echo STIR sequence with water- and fat-Dixon reconstructions as well as CT-like images derived from the same sequence. The inter-reader agreement was substantial to almost perfect ($\kappa = 0.86 [0.65–1.00]$).

Acquiring all diagnostic important information from one sequence could be highly useful in clinical routine, since it could potentially replace STIR, T1w as well as a CT for initial assessment of certain spine pathologies, thus substantially reducing overall examination durations and radiation exposure.

[273] Utility of drug-eluting Coroflex ISAR stent in intracranial atherosclerotic disease: a single center experience in 147 patients

Amgad El Mekabaty1*, Victoria Hellstern1, Marta Aguillar Perez1, Hans Henkes1

1Katharinenhospital Stuttgart Klinik für Diagnostische und Interventionelle Neuroradiologie, Stuttgart, Germany

Introduction: Intracranial atherosclerotic disease (ICAD) is a major cause of stroke and particularly recurrent strokes worldwide. Different treatment regimens for ICAD, including medical treatment (e.g. dual antiplatelet inhibition) and endovascular treatment (e.g. balloon- and stent angioplasty). In this study we aim to investigate the safety and efficacy of the drug-eluting balloon-mounted Coroflex ISAR stent in treatment of ICAD.

Methods: A retrospective analysis of patients with attempted implantation of Coroflex ISAR stent suffering from ICAD in our institution from 2014 to 2020 was performed. Available demographic, angiographic, imaging and follow-up data were analyzed.

Results: A total of 147 patients were included (74.1% males, average age: 70 years). Median baseline modified Rankin score (mRS) was 0 (IQR 0–1) and median pretreatment mRS was 2 (IQR 1–4). Treated Lesions were located in the ICA (42.9%), V4 segment (36.1%), basilar artery (12.2%) and M1 segment (8.8%). The stent was successfully implanted in 92.6% (137/147) and the vessel stenosis was reduced from a mean of 76% “range 50–99” to 36% “range 0–82”. Short-term follow-up was available in 77.7% after a median of 3 months “IQR 1–5” and long-term follow-up was available in 63.3% (93/147) after a median of 24 months “IQR 14–40”. In-stent stenosis occurred in 13.9% (16/115), recurrent stroke in 9.5% (11/115) and asymptomatic intracranial hemorrhage in 3.4% (5/147). Overall mortality was 4.1% (6/147), of which 50% (3/6) were in-hospital and 50% (3/6) on follow-up.

Discussion: Treatment of ICAD remains controversial. While, aggressive medical management, including dual antiplatelet inhibition and tight control of blood pressure and cholesterol level, is the standard of care, our data show an acceptable outcome of Coroflex ISAR for ICAD.

Conclusion: The drug-eluting, balloon-mounted Coroflex ISAR is a safe and effective treatment option for ICAD. The overall recurrent stroke rate was 9.5% and mortality was 4.1%. Further work is needed to better delineate eligible ICAD patients for intracranial stenting.

References


[274] Developments in stent-retriever technology and their potential impact on safety and effectiveness in mechanical thrombectomy of large vessel occlusion stroke

Marius Vogt1*, Alexander Kollikowski1, Jörn Feick1, Marc Strinitz1, Franziska Weidner1, Fabian Essig1, Hermann Neugebauer1, Karl Georg Häusler2, Mirko Pham1, Alexander Márz1

1Institut für diagnostische und interventionelle Neuroradiologie, Universitätsklinikum Würzburg, Würzburg, Germany
2Neurologische Klinik und Poliklinik, Universitätsklinikum Würzburg, Würzburg, Germany

Introduction: Stent-retriever technology in mechanical thrombectomy remains controversial. While, aggressive medical management, including dual antiplatelet inhibition and tight control of blood pressure and cholesterol level, is the standard of care, our data show an acceptable outcome of Coroflex ISAR for ICAD.

Discussion: Treatment of ICAD remains controversial. While, aggressive medical management, including dual antiplatelet inhibition and tight control of blood pressure and cholesterol level, is the standard of care, our data show an acceptable outcome of Coroflex ISAR for ICAD.

Conclusion: The drug-eluting, balloon-mounted Coroflex ISAR is a safe and effective treatment option for ICAD. The overall recurrent stroke rate was 9.5% and mortality was 4.1%. Further work is needed to better delineate eligible ICAD patients for intracranial stenting.
**Background:** To investigate whether current developments in stent retriever technology have an impact on effectiveness and safety in mechanical thrombectomy (MT) of large vessel occlusion (LVO) stroke.

**Methods:** Retrospective data analysis of consecutive patients with LVO stroke treated with MT using either the APERIO® or the new generation APERIO® Hybrid stent-retriever device in the University hospital Würzburg between 01/19 and 09/20. Primary effectiveness endpoint was successful recanalization (mTICI ≥2b), primary safety endpoint was occurrence of hemorrhagic complications after MT.

**Results:** We enrolled 298 consecutive patients: 148 patients (49.7%) treated with AP device vs. 150 patients (50.3%) treated with new generation APH device. In the APH group, the pre-interventional ASPECT score was lower and there was a higher proportion of occlusions in the posterior circulation. In the AP group, more patients received stenting of the internal carotid artery. Other baseline characteristics were without significant differences. Rates of successful recanalization were not different between both groups (86.5% for AP vs. 82.7% for APH; \( p = 0.361 \)) but postinterventional hemorrhage, particularly subarachnoid hemorrhage (AP: 44 [29.7%] vs. APH: 16.0%; \( p = 0.005 \)) occurred significantly less frequent in the AP group. Rates of postinterventional hemorrhage with associated clinical deterioration (sICH) and in domo mortality were not statistically different between groups.

**Discussion:** Both the APERIO® and the APERIO® Hybrid achieved high rates of successful recanalization (mTICI≥2b) in MT of LVO. Detection of hemorrhage on the post-interventional CT scan regardless of its clinical relevance was significantly less frequent in the group treated with the new generation APH. This may be associated in part with refinements of the stent-retriever device, that come with better visibility under fluoroscopy. But when it comes to evaluation of post-interventional hemorrhage after MT, the clinical/neurological course of the patient has to be taken into consideration. By applying different definitions of sICH concomitant with clinical deterioration we found no statistical differences between the two groups.

**Conclusion:** Technological developments and refinements of new generation stent-retriever devices did not alter typical observational indicators of effectiveness but may have a positive impact on safety.

**[275] Risk for additional infarction in emergency carotid artery endarterectomy in thrombectomy acute stroke patients**

Ehsan Yousefian Jazi1*, Martin Wiesmann1, Arno Reich2, Alexander Gombert1, Drosos Kotelis1, Omid Nikouhashman1

1Uniklinik RWTH Aachen, Klinik für diagnostische und Interventionen Neuroradiologie, Aachen, Germany
2Uniklinik RWTH Aachen, Klinik für Neurologie, Aachen, Germany
3Uniklinik RWTH Aachen, Klinik für Gefäßchirurgie, Aachen, Germany

**Background:** Thromboembolic occlusion of the middle cerebral artery (MCA) with tandem occlusion of the internal carotid artery (ICA) is a life-threatening condition with unfavorable neurological outcome. We perform emergency carotid endarterectomy (CEA) in the same anesthesiology session as thrombectomy in our angiography suite whenever needed, despite the absence of electrophysiological neuronomonitoring and selective shunt.

**Methods:** We evaluated 47 thrombectomy patients with emergency CEA in our clinic between June 2013 and November 2020. To determine whether there were additional infarctions due to the surgical procedure, we assessed the initial diagnostic CT imaging for previously infarcted areas, cerebral perfusion, and vascular anatomy, including collateralization in the Circle of Willis (CoW). We then analyzed follow-up imaging with respect to new infarctions that could not be explained by the initial stroke.

**Results:** Five of 47 (11%) patients had a complete CoW. There was contralateral internal carotid artery (ICA) stenosis or occlusion in 18/47 (38%) patients. Surgical procedure was evasion CEA in 34 (72%) and with a patch graft CEA in 13 (28%) cases. Shunts were used during surgery in 17/47 (36%) patients. Two patients suffered from an additional infarction in a new territory, however this was due to embolism during cerebral thrombectomy. The final infarction size was significantly larger in patients with contralateral ICA stenosis or occlusion (\( p = 0.038 \)). Neither CoW anatomy nor the absence of a shunt during surgery could be identified as risk factors for additional infarction.

**Conclusion:** Emergency surgery in the angiography suite without neuronomonitoring did not lead to additional stroke risk in our study.

**[280] Clinical outcome after endovascular thrombectomy in 3 Triage concepts: a prospective, observational study (NEUROSQUAD)**

Fatih Seker1*, Jens Fiehler2, Markus Möhlenbruch3, Friederike Heimann4, Christian Herweh3, Fabian Flottmann4, Peter Arthur Ringleb4, Götz Thomalla5, Thorsten Steiner5, Christophra Kraemer6, Caspar Brekenfeld7, Martin Bendszus8

1Neuroradiologie, Universitätsklinikum Heidelberg, Germany
2Neuroradiologie, Universitätsklinikum Hamburg-Eppendorf, Germany
3Neurologie, Universitätsklinikum Heidelberg, Germany
4Neurologie, Universitätsklinikum Hamburg-Eppendorf, Germany
5Neurologie, Klinikum Frankfurt-Höchst, Germany
6Neurologie, Klinikum Lüneburg, Germany

**Background:** NEUROSQUAD is a prospective, observational, bicenter study comparing 3 triage pathways in endovascular stroke treatment: mothership, drip and ship (DS) and transferring a neurointerventionalist to a remote hospital for thrombectomy (drive the doctor [DD]).

**Methods:** Patients with anterior circulation stroke and premorbid mRS 0–3 that underwent thrombectomy within 24 h after stroke onset were included. Primary outcome measure was good clinical outcome defined as 90 day mRS 0–2 or clinical recovery to the status before stroke onset (i.e. equal premorbid mRS and 90 day mRS). Secondary outcome measures were successful reperfusion, NIHSS at discharge and mRS shift.

**Results:** In total, 360 patients were included in this study, of which 111 patients (30.8%) were in the mothership group, 204 patients (56.7%) were in the DS group, and 45 patients (12.5%) were in the DD group. Good clinical outcome was achieved similarly in all three groups (mothership 45.9%, DS, 43.1%, DD 40.0%, \( p = 0.778 \)). Likewise, frequency of successful reperfusion was similar in all three groups (moth- ership 86.5%, DS 85.3%, DD 82.2%, \( p = 0.714 \)). There was no significant difference among the groups regarding NIHSS at discharge (\( p = 0.115 \)) and mRS shift (\( p = 0.342 \)). In the multivariate analysis, triage concept was not an independent predictor of good outcome (unadjusted odds ratio 0.89, confidence interval 0.64–1.23, \( p = 0.479 \)).

**Discussion:** Our data suggest that clinical outcome after thrombectomy is similar in mothership, DS and DD.

**Conclusion:** Hence, “drive the doctor” can be a valuable triage option in acute stroke treatment.

**[281] CT-like MR-derived images for the assessment of craniosynostosis and further pathologies of the skull in children**

Yannik Leonhardt1*, Sophia Kronthaler1, Dimitrios C. Karampinos1, Benedikt J. Schweiger2, Georg Feuerriegel1, Marcus R. Makowski1, Inga K. Koerte3, 4, Thomas Lieb1, Marc-Matthias Steinbom1, Alexandra S. Gersing1, 5

1Department of Radiology, Klinikum rechts der Isar, Technical University of Munich, Munich, Germany
2Department of Neuroradiology, Klinikum rechts der Isar, Technical University of Munich, Munich, Germany
3Psychiatric Neuroimaging Laboratory, Brigham and Women’s Hospital, Harvard Medical School, Boston, United States
Background: To evaluate the diagnostic value of CT-like images derived from a 3D T1w spoiled gradient echo (T1SGRE) MRI sequences for the detection and assessment of craniosynostosis and other pathologies of the pediatric skull.

Methods: In 20 patients with suspected craniosynostosis (mean age: 1.26±1.38 years, 10 females), 3-T MR imaging was performed including CT-like images derived from a 3D T1SGRE sequence. Additionally, the skull of all patients was assessed for pathologies using either a radiograph, CT or ultrasound. The features overall image quality, contrast of bone and soft tissue, deformities, craniosynostosis and other pathologies of the skull were evaluated by two radiologists, blinded to the clinical information. Interrater agreement was calculated using Cohen’s κ.

Results: Of the 20 patients included in this study, 8 patients had a metopic, 4 a coronal and 2 a sagittal synostosis. Two patients showed a complex combination of craniosynostoses as manifestation of the Crouzon syndrome. One patient presented with a “ping pong” skull fracture and one patient with a fracture of the temporal bone. The affected synostotic sutures could be identified in all patients. Interrater agreement for rating the calvarial sutures was high (κ=0.81 [95% confidence interval 0.70–1.00]).

Discussion: The assessment of craniosynostosis, sutures and fractures of the pediatric skull using the CT-like T1SGRE MR-sequence was feasible and comparable to other imaging modalities.

Conclusion: The MRI protocol with the T1 GRE-sequence used in this study poses a promising alternative to CT when imaging children with suspected or confirmed craniosynostosis or fractures.

References

[282] Prediction accuracy of Derivo Embolization Device implanted length with PreSize neurovascular and comparison of device size selection between conventional manual planning and software simulations
Ngoc Tuan Ngo1*, Fabian Flottmann1, Francesco Iori2, Mirko Bonfanti2, Katerina Spranger2, Jens Fiehler1, Maxim Bester1
1Universitätsklinikum Hamburg-Eppendorf, Klinik und Poliklinik für Neuroradiologische Diagnostik und Intervention, Hamburg, Germany
2Oxford Heartbeat Ltd, London, United Kingdom

Fig. 1 281 Axial T1SGRE MR-sequence of a 5-months-old male patient with a metopic synostosis and trigonocephalus (a and b) and a 6-months-old male with a patent metopic suture (c)

Fig. 2 281 Axial CT (a) and axial T1SGRE sequence (b) of a 6-year-old patient with a fracture of the right temporal bone (indicated by the arrows). The inverted MR-image shows the CT-like impression of the osseous structures

†Department of Child and Adolescent Psychiatry, Psychosomatic, and Psychotherapy, University Hospital of Munich (LMU), Munich, Germany
2Department of Neuroradiology, University Hospital of Munich (LMU), Munich, Germany
4Department of Pediatric Radiology, Städtisches Klinikum Munich Schwabing, Munich, Germany
Fig. 1 282 (a) Maximum intensity projection of a pre-operative 3DRA co-registered with a post-operative VasoCT showing the deployed FD (Deriva 4.0×40; nominal length: 4.0 mm, nominal diameter: 40 mm). (b) Same FD deployed in the same case study using PreSize Neurovascular, showing an excellent comparison with the clinical data. (c) Optimal device (Deriva 4.5×20) chosen for the same case with the aid of PreSize Neurovascular. The shorter length of the optimal device led to a lower number of vessel bends covered by the device, while providing sufficient aneurysm coverage (white arrow). (d) Color-bar of the FD colouring in PreSize, indicating the oversizing of the stent diameter relative to the diameter of the blood vessel
Background: Evaluating the final length and positioning of flow diverting (FD) stents inside patient arteries for optimal device size selection remains a challenging, yet crucial, task in complex aneurysm treatment. This study reports the accuracy of PreSize Neurovascular software in predicting FD deployment length and impact of PreSize’s use on device size selection. PreSize (Oxford Heartbeat Ltd) is a visualisation/simulation software for neurovascular FD intervention planning in aneurysm treatment.

Methods: Imaging data from 80 FD cases using Derivo Embolisation Device (Acandis GmbH), collected from University Medical Center Hamburg-Eppendorf, were retrospectively analysed. Prediction accuracy was defined as agreement between PreSize simulation and actual deployed FD length measured in angiography. Two experienced interventional neuroradiologists (INRs), blinded to post-deployment angiographies, selected optimal sizes using PreSize in a subset (25 cases). PreSize-informed device choices (diameter/length) were compared to deployed devices (informed by conventional planning).

Results: Investigated FDs had a mean nominal length of 26.9 mm (15–50 mm). Mean change of 23 % (up to 62 %) was observed between actual deployed and nominal FD length. PreSize predicted deployed FD length with a mean accuracy of 94 % (95 % confidence interval [93 %, 95 %]). PreSize-informed devices were shorter (Wilcoxon signed-rank test, Z=27.5, p<0.01) by 6.6 mm on average (up to 25 mm) compared to conventionally chosen devices. In 35 % of cases, shorter PreSize-informed devices would have resulted in fewer FD-covered vessel bends while achieving sufficient aneurysm coverage. In 70 % of cases, PreSize’s automatic size suggestion was INR’s selection.

Discussion: Discrepancy between nominal and deployed FD length illustrates the sizing challenge with conventional planning. Conventionally choosing longer devices might prevent undersizing but could lead to inserted metal unnecessary for aneurysm coverage.

Conclusion: PreSize predicted deployed FD lengths with high accuracy. Results indicate INRs’ propensity to select shorter devices with PreSize, supported by its precise deployment simulation and visualisation.

[287] Vertebral bone marrow T2* mapping using chemical shift encoding-based water-fat separation in the quantitative analysis of lumbar osteoporosis and osteoporotic fractures

Yannik Leonhardt1*, Florian T. Gassert1, Georg Feuerriegel1, Felix G. Gassert1, Sophia Kronthaler1, Christof Boehm1, Alexander Kufner1, Stefan Ruschke1, Thomas Baum1, Claus Zimmer1, Marcus R. Makowski1, Dimitrios C. Karampinos1, Benedikt J. Schweiger2, Alexandra S. Gersing1

Fig. 2 | 282 Distribution of the deployment accuracy

Fig. 3 | 282 (a) Distribution of relative length change between the measured deployed length and the nominal stent length, (b) linear regression between the measured deployed length and the stent nominal length

Fig. 1 | 287 Color-coded T2* maps of the thoracolumbar spine of a 70-year-old female patient with a low-energy fracture of Th12 (a) and a 49-year-old male patient with a high-energy fracture of L3 (b). Panels a’ and b’ show the corresponding B0 field maps

Vertebral bone marrow T2* mapping using chemical shift encoding-based water-fat separation in the quantitative analysis of lumbar osteoporosis and osteoporotic fractures

Yannik Leonhardt1*, Florian T. Gassert1, Georg Feuerriegel1, Felix G. Gassert1, Sophia Kronthaler1, Christof Boehm1, Alexander Kufner1, Stefan Ruschke1, Thomas Baum1, Claus Zimmer1, Marcus R. Makowski1, Dimitrios C. Karampinos1, Benedikt J. Schweiger2, Alexandra S. Gersing1

[287] Vertebral bone marrow T2* mapping using chemical shift encoding-based water-fat separation in the quantitative analysis of lumbar osteoporosis and osteoporotic fractures

Yannik Leonhardt1*, Florian T. Gassert1, Georg Feuerriegel1, Felix G. Gassert1, Sophia Kronthaler1, Christof Boehm1, Alexander Kufner1, Stefan Ruschke1, Thomas Baum1, Claus Zimmer1, Marcus R. Makowski1, Dimitrios C. Karampinos1, Benedikt J. Schweiger2, Alexandra S. Gersing1

[287] Vertebral bone marrow T2* mapping using chemical shift encoding-based water-fat separation in the quantitative analysis of lumbar osteoporosis and osteoporotic fractures

Yannik Leonhardt1*, Florian T. Gassert1, Georg Feuerriegel1, Felix G. Gassert1, Sophia Kronthaler1, Christof Boehm1, Alexander Kufner1, Stefan Ruschke1, Thomas Baum1, Claus Zimmer1, Marcus R. Makowski1, Dimitrios C. Karampinos1, Benedikt J. Schweiger2, Alexandra S. Gersing1

Fig. 2 | 282 Distribution of the deployment accuracy

Fig. 3 | 282 (a) Distribution of relative length change between the measured deployed length and the nominal stent length, (b) linear regression between the measured deployed length and the stent nominal length

Fig. 1 | 287 Color-coded T2* maps of the thoracolumbar spine of a 70-year-old female patient with a low-energy fracture of Th12 (a) and a 49-year-old male patient with a high-energy fracture of L3 (b). Panels a’ and b’ show the corresponding B0 field maps

Vertebral bone marrow T2* mapping using chemical shift encoding-based water-fat separation in the quantitative analysis of lumbar osteoporosis and osteoporotic fractures

Yannik Leonhardt1*, Florian T. Gassert1, Georg Feuerriegel1, Felix G. Gassert1, Sophia Kronthaler1, Christof Boehm1, Alexander Kufner1, Stefan Ruschke1, Thomas Baum1, Claus Zimmer1, Marcus R. Makowski1, Dimitrios C. Karampinos1, Benedikt J. Schweiger2, Alexandra S. Gersing1

Fig. 2 | 282 Distribution of the deployment accuracy

Fig. 3 | 282 (a) Distribution of relative length change between the measured deployed length and the nominal stent length, (b) linear regression between the measured deployed length and the stent nominal length

Fig. 1 | 287 Color-coded T2* maps of the thoracolumbar spine of a 70-year-old female patient with a low-energy fracture of Th12 (a) and a 49-year-old male patient with a high-energy fracture of L3 (b). Panels a’ and b’ show the corresponding B0 field maps

Vertebral bone marrow T2* mapping using chemical shift encoding-based water-fat separation in the quantitative analysis of lumbar osteoporosis and osteoporotic fractures

Yannik Leonhardt1*, Florian T. Gassert1, Georg Feuerriegel1, Felix G. Gassert1, Sophia Kronthaler1, Christof Boehm1, Alexander Kufner1, Stefan Ruschke1, Thomas Baum1, Claus Zimmer1, Marcus R. Makowski1, Dimitrios C. Karampinos1, Benedikt J. Schweiger2, Alexandra S. Gersing1

Fig. 2 | 282 Distribution of the deployment accuracy

Fig. 3 | 282 (a) Distribution of relative length change between the measured deployed length and the nominal stent length, (b) linear regression between the measured deployed length and the stent nominal length

Fig. 1 | 287 Color-coded T2* maps of the thoracolumbar spine of a 70-year-old female patient with a low-energy fracture of Th12 (a) and a 49-year-old male patient with a high-energy fracture of L3 (b). Panels a’ and b’ show the corresponding B0 field maps
Background: Chemical shift encoding-based water-fat separation techniques have been used for fat quantification, but they also enable the assessment of bone marrow T2*, which has previously been reported to be a potential biomarker for osteoporosis and may give insight into the cause of vertebral fractures (i.e. osteoporotic vs. traumatic).

Methods: The 32 patients (78.1% with low-energy fractures, mean age 72.3±9.8 years, 76% women; 21.9% with high-energy traumatic fractures, 47.3±12.8 years, no women) were frequency-matched for age and sex to subjects without vertebral fractures (n=20). All patients underwent 3T-MRI of the lumbar spine including sagittally acquired spoiled gradient echo sequences for chemical shift encoding-based water-fat separation. BMD and trabecular bone parameters describing the three-dimensional structure of trabecular bone were derived from qCT.

Results: Mean T2* values of nonfractured vertebrae showed a significant correlation with BMD (r=−0.65, p<0.001), trabecular number (TbN; r=−0.56, p<0.001) and spacing (TbSp) (r=0.61, p<0.001); patients with low-energy fractures showed significantly higher mean T2* values than those with traumatic fractures (13.6±4.3 ms vs. 8.4±2.2 ms, p=0.01) and a significantly lower TbN (0.69±0.08 mm⁻¹ vs. 0.93±0.03 mm⁻¹, p<0.01) and a significantly larger TbSp (1.06±0.16 mm vs. 0.56±0.08 mm, p<0.01). When comparing the mean T2* of the fractured vertebrae, no significant difference could be detected between low-energy and high-energy fractures (12.6±5.4 ms vs. 8.1±2.4 ms, p=0.10).

Discussion: T2* mapping of vertebral bone marrow using CSE-MRI allows for assessing osteoporosis as well as the trabecular microstructure.

Conclusion: T2* mapping enables a radiation-free differentiation between patients with low-energy osteoporotic and high-energy traumatic vertebral fractures, suggesting its potential as a biomarker for bone fragility.

References

[289] Region-specific ASPECTS ratings of 100 investigators from the TENSION study: hypodensity thresholds and decision spread

Helge Kniep¹*, Noel van Horn¹, Gabriel Broocks¹, Lukas Meyer¹, Fabian Flottmann¹, Matthias Bechstein¹, Jens Fiehler¹, Uta Hanning¹, Andre Kemmling²
1Klinik und Poliklinik für Neuroradiologische Diagnostik und Intervention, Universitätsklinikum Hamburg-Eppendorf, Hamburg, Germany
2Klinik für Neuroradiologie, Westpfalzklinikum-Kaiserslautern, Kaiserslautern, Germany

Fig. 1 | 289 Median hypodensity (HU) vs. share of positive ratings (ischemic changes)
Introduction: Patients with acute ischemic stroke are often triaged according to the Alberta Stroke Program Early CT Score (ASPECTS). ASPECTS is assessed for therapeutic decision making and as inclusion criterion for clinical trials. However, studies have shown relatively low interrater reliability [1]. We aim to establish a better understanding of quantitative thresholds and spread in human visual ASPECTS assessments.

Methods: We analyzed ASPECTS ratings of 100 investigators who independently evaluated 20 NCCT scans as part of the TENSION study. Quantitative assessment of early signs of infarctions was performed through measuring the density difference of each ASPECTS region compared to the contralateral hemisphere in median Hounsefield Units (HU). The proportion of raters who evaluated a specific region as affected was plotted against the median hypodensity in HU and linear regression analysis was performed.

Results: We observed a significant linear relationship between the median hypodensity and the probability for raters to evaluate a region as affected. For all ASPECTS regions combined, a decrease of 0.4 HUs vs. the contralateral hemisphere resulted in an increase of 10% of infarction ratings ($p < 0.001$, $R^2 = 0.32$, Fig. 1). The plot shows that for the majority of regions the proportion of positive ratings was located in the continuum between 0% and 100%. It furthermore suggests a relatively broad distribution which might be due to region-specific effects.

Discussion: Our study shows a significant relationship between the degree of hypodensity and the proportion of positive (region is affected) ratings. The observed continuum between 0% and 100% positive ratings confirms the relatively low interrater reliability. Region specific patterns were observed with different sensitivities for quantitative density alterations. In addition, these patterns suggest different levels of rater confidence depending on the anatomic region and the region-specific assumed a-priori probability for ischemic affection.

Conclusion: Our results enhance the understanding of visual ASPECTS ratings. More objective decision making through establishing of specific hands-on guidelines for improved visual ASPECTS readings might increase reliability of clinical trials and patient benefit in clinical practice.

References

[290] Safety and clinical outcome after endovascular treatment of aneurysmal subarachnoid hemorrhage since the evolution of the EVT devices in a 14-year series from a single high-volume center
Ali Khanafé1*, Marta Aguilar Perez1, Victoria Hellstern1, Hansjörg Büznér2, Oliver Ganslandt1, Hans Henkes1
1Katharinenhospital Stuttgart, Neuroradiologie, Stuttgart, Germany
2Katharinenhospital Stuttgart, Neurologie, Stuttgart, Germany

Background: Endovascular treatment (EVT) of ruptured cerebral aneurysms has evolved significantly over the past 15 years with the rapid development of new treatment modalities and devices, such as flow diversion or bifurcation stents. We sought to evaluate the safety and outcome of EVT, especially after the use of the new devices in the treatment of ruptured aneurysms, based on a 14-year series from a single center with EVT-first strategy.

Methods: We retrospectively studied all patients with aneurysmal subarachnoid hemorrhage (aSAH), managed in a single center between 2007 and 2020 and divided them into a conservative, microsurgical (MSC), and an EVT group according to treatment decision and requirements. Clinical and radiological findings at admission, discharge, and after long-term follow-up were studied. Since several new devices were mainly introduced from 2012 in the treatment of aSAH, the outcome was compared between four groups of treated patients, namely MSC and EVT before and after 2012.

Results: A total of 983 patients with aSAH were studied (694 EVT, 205 MSC, 84 conservative). There were no significant differences in mean age or the Hunt and Hess grades between the four groups. The rate of EVT of ruptured aneurysms increased after 2012 from 67% to 72.2%, the MSC and conservative groups showed a slight decrease after 2012 from 23% to 19.7% and from 9.6% to 8%, respectively. There was no significant difference in clinical outcomes between the MSC groups before and after 2012. Both EVT groups showed a favorable and comparable outcome at discharge; more than 50% of aSAH patients were discharged with an mRS 0–2 (51% 2007–11 and 55.3% 2012–20). The long-term outcome of both EVT groups shows a significant decrease of morbidity (mRS 3–5) after 2012 from 25.9% to 18.3% ($p = 0.015$); mortality was comparable. Retreatment rates were higher in EVT than in MSC regardless of time periods.

Discussion: Our data show that the introduction of the new EVT devices and techniques allows the treatment in aneurysms that were not treatable with coiling alone, MSC, or both, while providing a good outcome.

Conclusion: With the introduction of new endovascular devices, EVT treatment continues to offer an excellent safety profile and good outcomes.
Fazit: Mit der spektralen CT mit kV-Switch-Technik können Thromben mit einem definierten Anteil von RBC und Fibrin differenziert werden. Die bestmögliche Unterscheidung erfolgt bei Thromben mit einem RBC-Anteil von >40% sowie auf Energieniveaus >80 keV. Diese Ergebnisse können als methodische Grundlage für weitere Studien mit dieser Technik dienen.
Autorenverzeichnis

A

Abello Mercado, Mario Albero to 144, 238, 240
Aguilar-Pérez, Marta 54, 177, 273, 290
Albers, Gregory 61, 64, 89
Altenmüller, Dirk-Matthias 111
Altmann, Sebastian 144, 238, 240, 252, 270
Aludin, Schekab 256
Arinrad, Soheil 20
Arnold, Philipp 33
Aruci, Merit 57, 208
Austein, Friederike 28
Avery, Emily W 163

B

Barreau, Xavier 54
Bartmann, Peter 126, 138, 191, 215
Bast, Thomas 111
Baum, Thomas 168, 235, 287
Baumann, Michael 151
Bäzner, Hansjörg 290
Bäzner, Haus-Jörg 177
Becherucci, Edoardo Aitall 235
Bechraakis, Nikolaos 183
Bechstein, Matthias 200, 289
Beck, Jürgen 33, 204, 205
Beer, Meinrad 90
Behland, Jonas 163
Behme, Daniel 109, 129, 140, 218, 246
Behrendt, Benjamin 129
Beliveau, Vincent 236
Bender, Benjamin 186
Bendszus, Martin 80, 98, 190, 225, 247, 280
Benke, Thomas 236
Berg, Ronja 88, 109, 129, 246
Berlis, Angar 54, 140
Berndt, Maria 234, 250, 267
Bernhardt, Denise 98
Bernkopf, Kathleen 134, 234, 267
Berthele, Achim 45
Bester, Maxim 282
Bettinger, Ole 28
Betray, Clemens 211
Beuing, Oliver 109
Beuscher, Vanessa 39
Beuthien-Baumann, Bettina 151
Bischl, Daria 45
Blazhenets, Ganna 23
Bleise, Carlos 54
Blum, Friederike 132
Boeckh-Behrens, Tobias 134, 152, 234, 267
Boehm, Christof 272, 287
Boese, Axel 218
Böhmer, Georg 233
Bonafé, Alain 54
Bonfanti, Mirko 282
Boxberg, Frederik 266
Brandes, Elin 215
Brassel, Friedhelm 266
Breckwoldt, Michael 225, 247
Breedlove, Katherine 162
Brekenfeld, Caspar 280
Brem, Christian 117
Brockmann, Carolin 144, 238, 252, 270
Brockmann, Marc A 144, 238, 240, 252, 270
Broocks, Gabriel 61, 64, 89, 200, 289
Brugnara, Gianluca 247
Buchalla, Rüdiger 232
Buchfelder, Michael 20
Buerkle, Eva 186
Bunse, Theresa 247
Bürger, Katharina 117
Burian, Egon 134, 168, 219
Bussas, Matthias 45

C

Carrington, Holly 162
Caspers, Julian 19
Cho, Chang Gyu 222
Christensen, Soren 61, 64, 98
Cocoen, Volker Arnd 108
Cornelius, Peter 219

D

Dahne, Robert 19
Danyel, Leon 233
Dechent, Peter 117
Deike-Hofmann, Katerina 183
Delazer, Margarete 236
Demeralh, Theo 22, 108, 110, 111, 113, 145
Deschauer, Marcus 235
Diamandidis, Elie 218
Dieckmeyer, Michael 168
Dieterich, Marianne 267
Dillinger, Daniel 252
Dimitriadis, Konstantin 267
Döper, Jörg 117
Dörfler, Arnd 20, 39, 113, 153, 211
Dovi-Akue, Philippe 33, 204, 205, 228
Drummer, Katharina 241
Duman Kavus, Ikram Eda 228
Dünnwald, Max 208
Düzel, Enrah 118

E

Eerikainen, Maija 183
Eisenhofer, Graeme 271
Eisenhuber, Felix 20
El Mekabaty, Amgad 273
Elshiekh, Sameer 140
Ergawi, Mostafa 218
Ernemann, Ulrike 51
Essig, Fabian 181
Essig, Fabian 274
Eves, Robert 126
Ewers, Michael 117

F

Faizy, Tobias 61, 64, 89
Falcone, Guido J 163
Fang, Xiaojing 237
Fava Sanches, Augusto 265
Feck, Jörn 181, 274
Feil, Katharina 267
Feuerriegel, Georg Constantin 272, 281, 287
Fiehler, Jens 61, 64, 89, 200, 280, 282, 289
Finck, Tom 127, 186
Fischer, Manuel 247
Fischer, Sebastian 210
Flatz, Wilhelm 117
Fliedbach, Klaus 117
Flotmann, Fabian 280, 282, 289
Flüh, Charlotte 28
Forbrig, Robert 117
Förster, Alex 222
Forsing, Michael 183
Frenzel, Marius 270
Frey, Dietmar 163
Frings, Lars 23
Fung, Christian 204, 205

G

Gaber, Khaled 154
Ganslandt, Oliver 177, 222, 290
Gascou, Grégoire 54
Gaser, Christian 19, 138
Gasperi, Christiane 45
Gassett, Felix G 287
Gassett, Florian T 287
Gawlitza, Matthias 221
Gerber, Johannes 221
Gersing, Alexandra Sophia 272, 281, 287
Gizewski, Elke Ruth 189, 236
Gleißner, Carina 224
Godward, Antony 54
Götz, Leonie 48
Gombert, Alexander 275
Göttler, Jens 224, 250
Grah, Sophia 45
Grieb, Dominik 266
Groden, Christoph 222
Grohle Hokamp, Nils 122
Grundl, Lioba 45, 127, 186

H

Hachem, Elie 265
Hagen, Nikolaus 28
Hager, Charlotte 132
Haider, Lukas 188
Hamerm, Hajo 153
Hanning, Uta 200, 289
Hauser, Till-Karsten 51
Häusler, Karl Georg 274
Haynes, John-Dylan 117
Hedderich, Dennis 19, 126,138, 191, 215
Heers, Marcel 111
Heiland, Sabine 225, 247
Heimann, Friederike 280
Heit, Jeremy 61, 64, 89
Helle, Michael 250
Hellström, Victoria 177, 273, 290
Hemmer, Bernhard 45
Henkes, Hans 54, 177, 273, 290
Henze, Simone 234
Herrmann, Andreas 117
Hernandez Petzche,莫iezitz 152, 234, 250
Herweh, Christian 190, 280
Herzberg, Moritz 267
Hesse, Nina 117
Heufel, Claus Peter 98
Heynold, Elisabeth 20
Hock, Stefan W 153, 211
Hoffmann, Karl-Titus 154
Hölter, Philip 39
Höning, Alexander 48
Hopf-Jensen, Silke 232
Hosp, Jonas 110
Howell, David 162
Huhn, Konstantin 211
Hung, Jessica 247
Hupertz, Hans-Jürgen 111
Huuseni, Malek 241

I

Ikenberg, Benno 234
Ingenever, Maria 117
Ingmar, Blümcke 113
Ingrisch, Michael 117
Iori, Francesco 282
Isensee, Fabian 98

J

Jähne, Kristine 247
Jamous, Ala 140
Janiga, Gabor 246
<table>
<thead>
<tr>
<th>Name</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schlamann, Marc</td>
<td>126</td>
</tr>
<tr>
<td>Schmidt, Manuel</td>
<td>129</td>
</tr>
<tr>
<td>Siebert, Eberhard</td>
<td>142</td>
</tr>
<tr>
<td>Schef</td>
<td></td>
</tr>
<tr>
<td>Schw</td>
<td></td>
</tr>
<tr>
<td>Schw</td>
<td></td>
</tr>
<tr>
<td>Schlamp, Kai</td>
<td>191</td>
</tr>
<tr>
<td>Schoene, Daniela</td>
<td>236</td>
</tr>
<tr>
<td>Seidlitz, Annekatrin</td>
<td>250</td>
</tr>
<tr>
<td>Sekubo</td>
<td></td>
</tr>
<tr>
<td>Schreiber</td>
<td></td>
</tr>
<tr>
<td>Sitz, Maximilian</td>
<td>250</td>
</tr>
<tr>
<td>Skalla, Elisabeth</td>
<td>252</td>
</tr>
<tr>
<td>Sollmann, Nico</td>
<td>252</td>
</tr>
<tr>
<td>Solyamik, Olga</td>
<td>210</td>
</tr>
<tr>
<td>Sorg, Christian</td>
<td>126</td>
</tr>
<tr>
<td>Sparenberg, Paul</td>
<td></td>
</tr>
<tr>
<td>Spottke, A</td>
<td>117</td>
</tr>
<tr>
<td>Spranger, Katerina</td>
<td>282</td>
</tr>
<tr>
<td>Spreer, Annette</td>
<td>252</td>
</tr>
<tr>
<td>Sprengel, Ulrike</td>
<td>129</td>
</tr>
<tr>
<td>Staack, Anke Maren</td>
<td>111</td>
</tr>
<tr>
<td>Stahl, J</td>
<td>129</td>
</tr>
<tr>
<td>Steiger, Ruth</td>
<td>189</td>
</tr>
<tr>
<td>Steinborn, Marc-Matthias</td>
<td>281</td>
</tr>
<tr>
<td>Steiner, Thorsten</td>
<td>280</td>
</tr>
<tr>
<td>Stockero, Andrea</td>
<td>132</td>
</tr>
<tr>
<td>Stöcklein, Sophia</td>
<td>117</td>
</tr>
<tr>
<td>Stockx, Luc</td>
<td>54</td>
</tr>
<tr>
<td>Stoll, Guido</td>
<td>181</td>
</tr>
<tr>
<td>Strinitz, Marc</td>
<td>181</td>
</tr>
<tr>
<td>Subburaj, Karuppasamy</td>
<td>168</td>
</tr>
<tr>
<td>Synofzik, Matthias</td>
<td>117</td>
</tr>
<tr>
<td>Synowitz, Michael</td>
<td>28</td>
</tr>
<tr>
<td>Tagatiba, Marcos</td>
<td>51</td>
</tr>
<tr>
<td>Tautif, Homan</td>
<td>132</td>
</tr>
<tr>
<td>Teipel, Stefan</td>
<td>117</td>
</tr>
<tr>
<td>Thomalla, Götz</td>
<td>280</td>
</tr>
<tr>
<td>Thomas, Marie</td>
<td>127</td>
</tr>
<tr>
<td>Thorsson, Maximilian</td>
<td>109</td>
</tr>
<tr>
<td>Thurow, Johannes</td>
<td>51</td>
</tr>
<tr>
<td>Tiedt, Steffen</td>
<td>267</td>
</tr>
<tr>
<td>Ting, Saskia</td>
<td>183</td>
</tr>
<tr>
<td>Troost, Esther</td>
<td>151</td>
</tr>
<tr>
<td>Turco, Verena</td>
<td>247</td>
</tr>
<tr>
<td>Turjman, Francis</td>
<td>54</td>
</tr>
<tr>
<td>Turowski, Bernd</td>
<td>19</td>
</tr>
<tr>
<td>Ulbrich, Philipp</td>
<td>57</td>
</tr>
<tr>
<td>Urbach, Horst</td>
<td>22, 23, 33, 108, 110, 111, 113, 140, 145, 204, 205, 228</td>
</tr>
<tr>
<td>Urbanek, Christian</td>
<td>80</td>
</tr>
<tr>
<td>Vajkoczy, Peter</td>
<td>163</td>
</tr>
<tr>
<td>Van de Ven, Kim</td>
<td>250</td>
</tr>
<tr>
<td>Van den Hoff, Jörg</td>
<td>151</td>
</tr>
<tr>
<td>Van Horn, Noel</td>
<td>61, 64, 89, 289</td>
</tr>
<tr>
<td>Villringer, Kersten</td>
<td>233</td>
</tr>
<tr>
<td>Vogt, Marius</td>
<td>274</td>
</tr>
<tr>
<td>Vollmuth, Philipp</td>
<td>98, 247</td>
</tr>
<tr>
<td>Von Lampe, Paula</td>
<td>183</td>
</tr>
<tr>
<td>Voß, Samuel</td>
<td>246</td>
</tr>
<tr>
<td>Wahl, Hannes</td>
<td>65</td>
</tr>
<tr>
<td>Wald, Tassilo</td>
<td>98</td>
</tr>
<tr>
<td>Waldeck, Stephan</td>
<td>252</td>
</tr>
<tr>
<td>Weber, Werner</td>
<td>210</td>
</tr>
<tr>
<td>Weidlich, Dominik</td>
<td>235</td>
</tr>
<tr>
<td>Weidner, Franziska</td>
<td>274</td>
</tr>
<tr>
<td>Weiskopf, Nikolaus</td>
<td>88</td>
</tr>
<tr>
<td>Weiss, Kilian</td>
<td>272</td>
</tr>
<tr>
<td>Wenz, Holger</td>
<td>222</td>
</tr>
<tr>
<td>Werner, Annett</td>
<td>271</td>
</tr>
<tr>
<td>Wésemann, Tim</td>
<td>151</td>
</tr>
<tr>
<td>Wick, Wolfgang</td>
<td>98, 247</td>
</tr>
<tr>
<td>Wiesmann, Martin</td>
<td>132, 275</td>
</tr>
<tr>
<td>Wiestler, Benedikt</td>
<td>224</td>
</tr>
<tr>
<td>Wiestler, Benedikt</td>
<td>45, 127, 186, 224, 241</td>
</tr>
<tr>
<td>Wiltfang, Jens</td>
<td>117</td>
</tr>
<tr>
<td>Wintermark, Max</td>
<td>61, 64, 89</td>
</tr>
<tr>
<td>Wischmann, Johannes</td>
<td>267</td>
</tr>
<tr>
<td>Wolf, Luisa</td>
<td>19</td>
</tr>
<tr>
<td>Wolke, Dieter</td>
<td>126, 138, 191, 215</td>
</tr>
<tr>
<td>Wörter, Klaus</td>
<td>281</td>
</tr>
<tr>
<td>Wunderlich, Arthur</td>
<td>90</td>
</tr>
<tr>
<td>Wunderlich, Silke</td>
<td>134, 267</td>
</tr>
<tr>
<td>Würtemberger, Urs</td>
<td>113</td>
</tr>
<tr>
<td>Yeung, Long Yu</td>
<td>168</td>
</tr>
<tr>
<td>Yousefian Jazi, Ehsan</td>
<td>275</td>
</tr>
<tr>
<td>Zaeske, Charlotte</td>
<td>122</td>
</tr>
<tr>
<td>Zamarian, Laura</td>
<td>236</td>
</tr>
<tr>
<td>Zarth, Teresa</td>
<td>152</td>
</tr>
<tr>
<td>Zerweck, Leonie</td>
<td>51</td>
</tr>
<tr>
<td>Ziganshyna, Svitalana</td>
<td>154</td>
</tr>
<tr>
<td>Zimmermann, Hanna</td>
<td>117</td>
</tr>
<tr>
<td>Zimmernann, Juliana</td>
<td>215</td>
</tr>
<tr>
<td>Zoff, Agnes</td>
<td>235</td>
</tr>
<tr>
<td>Zolal, Amir</td>
<td>271</td>
</tr>
<tr>
<td>Zopf's, David</td>
<td>122</td>
</tr>
</tbody>
</table>