Evaluation of impact factors in the regeneration process of hematomas in the subcutaneous fatty tissue

Kathrin Ogris[1,2], Eva Hassler[3], Andreas Petrovic[1], Bernhard Neumayer[1], Thomas Widek[1], and Eva Scheurer[1,2]
[1]Ludwig Boltzmann Institute Clinical-Forensic Imaging, Graz, Styria, Austria, [2]Department of Legal Medicine, Medical University of Graz, Styria, Austria,
[3]Department of Radiology, Medical University of Graz, Styria, Austria

Target audience:
This study is important for radiologists and clinicians interested in subcutaneous fatty tissue, and forensic medical experts evaluating soft tissue injuries using MRI.

Purpose:
As subcutaneous hematomas are usually not relevant for clinicians only limited knowledge and experience exists regarding the detection and dating of traumatic lesions in subcutaneous fatty tissue using MRI. Dating soft tissue injuries such as bruises is particularly important for the reconstruction of criminal acts, e.g. child abuse cases, where accurate timing of injuries can include or exclude potential suspects. However, visual assessment of hematoma color, the currently used method for estimating hematoma age, is unreliable due to its great variability[1], and is additionally affected by individually varying color perception[2]. First studies showed that the contrast of hematomas in MRI could be used to get objective information on hematoma characteristics[3, 4]. The aim of this study was to show quantitative changes in contrast between blood and subcutaneous fatty tissue over time as well as to explore factors influencing the contrast of subcutaneous hematomas in order to date traumatic lesions for the forensic reconstruction of events.

Methods:
In 20 healthy volunteers (11 females, 9 males, median age 26.07y, range 18.27-33.75y) 4 ml of freshly drawn autologous blood were injected into the subcutaneous fatty tissue of the thigh after a basis MRI scan. The artificial hematoma was scanned repetitively at different time points (directly after the injection and 3h, 24h, 3d, 7d and 14d after the injection). All measurements were performed on a 3T scanner (Tim Trio, Siemens, Erlangen, Germany) using a CPC-multifunctional coil (Noras MRI products GmbH, Hoechberg, Germany). The protocol consisted of a PDw TSE SPAIR FS (TR/TE 3400/11ms, resolution 0.5x0.5x1.5mm³) and a PDw watersat TSE (TR/TE 1540/10 ms, 0.5x0.5x1.5mm³) in oblique and axial orientation. Data evaluation was conducted on a post-processing workstation (MMWP, Siemens AG, Erlangen, Germany). Due to motion artifacts and study dropouts, 6 subjects had to be excluded from the contrast analysis. 3 ROIs (size 0.4-0.55cm²) were placed each in the hematoma and in the subcutaneous fatty tissue for a measurement of signal intensities. After pooling the three measurements of each tissue the contrast coefficient according to Michelson[5] for the contrast between blood and fatty tissue was calculated for the different time points. A visual evaluation of hematomas and lobular structure of the fatty tissue was performed, and the thickness of the subcutaneous fatty tissue was measured.

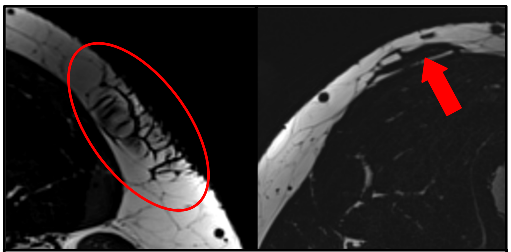

Fig.1 a) diffuse hematoma surrounded by sphere-cal fat lobuli; **b)** compact hematoma surrounded by fusiform shaped fat lobuli (PDw watersat)

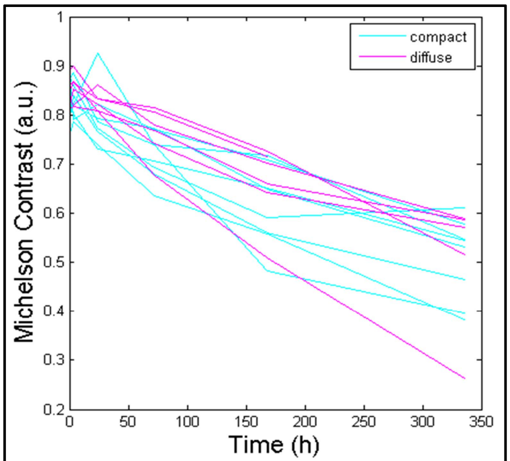

Fig.2: Behavior of the Michelson contrast in the PDw FS sequence over time

Results:
Two different shapes of subcutaneous hematomas a) compact and b) diffuse (see examples in Fig. 1) were identified. Fig. 2 shows shape-dependent differences of the contrast behavior of the hematomas versus fat over time. As a trend, the diffusely shaped hematomas show a slower contrast change compared to the compact hematomas where great inter-individual variation was observed. Diffuse hematomas were more frequently seen in women (7 of 11) than in males (3 of 9), and were associated with the thickness of the subcutaneous fatty tissue layer in the thigh of more than 1 cm (Fig. 3). In general, males had a thinner subcutaneous fatty tissue layer than women (f: mean 1.56 cm, SD 0.30 cm; m: mean 0.98 cm, SD 0.37 cm). In females diffuse hematomas were associated with spherical fat lobuli, and compact hematomas with fusiform lobuli, while in men only fusiform lobular structure could be found, showing both types of hematoma shapes.

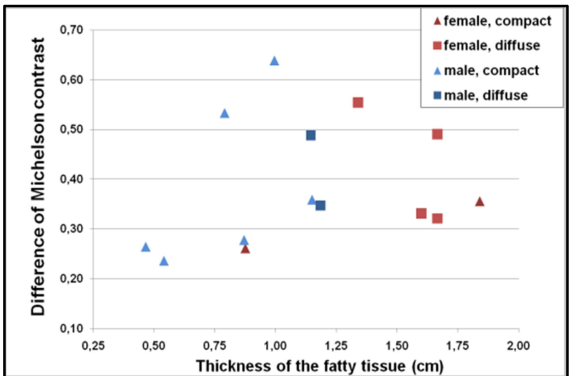

Fig.3: Correlation of the difference of the Michelson contrast after injection (t=0) and after 1 week with the thickness of the subcutaneous fatty tissue

Discussion&Conclusion:
Artificial hematomas investigated over 2 weeks showed differences in the contrast behavior depending on the shape of the hematoma in the subcutaneous fat. As potential impact factors on hematoma regeneration gender, the morphological structure of the fat lobuli and the thickness of the subcutaneous tissue were identified. The contrast changes in the different hematoma types indicated that the diffuse hematoma type seems to regenerate slower, which was rather unexpected. The outcome will be further investigated in a larger group of volunteers, although already these results suggest that the influence factors, such as hematoma shape, fatty tissue structure and hematoma regeneration must be taken into account in order to reliably assess the age of bruises for forensic reconstruction.

References:
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