

Comparison of MRI of the neck with external findings in survived manual strangulation

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Target audience:

Radiologists and clinicians in the fields of neuroradiology and musculoskeletal radiology as well as forensic experts who are interested in traumatic findings of the neck.

Purpose:

The diagnosis of strangulation in surviving victims based on objective findings is important for the criminal proceeding of the assault. Actual gold standard in clinical forensic medicine is an external examination which often shows no injury signs despite a credible history of strangulation. It has been shown that MRI findings such as edema or bleedings in the structures of the neck can be found in strangulation victims^{1,2}, and that radiologic reading according to predefined criteria allow to diagnose strangulation based on MRI with a sensitivity of 70% and a specificity of 100%³. However, for a use in court a higher sensitivity and, additionally, information allowing a reconstruction of the strangulation attack would be desirable. The aim of this study was to compare radiological findings of a native MRI scan with external findings in strangulated subjects regarding forensic reconstruction of the event.

Methods:

15 subjects (group A: 5 males, 10 females; median age 25 range 20-63 y) who survived a manual strangulation incident (time between incident and MRI 0-6 days, median 1d) and 8 non-injured controls (group B: 4 males, 4 females; median age 34, range 27 – 60 y) underwent a native MRI scan at 3T (TIM Trio, Siemens AG, Erlangen, Germany) using a 12-channel head coil, a 4-channel neck coil (Siemens AG, Erlangen, Germany) and a 4-channel phased-array carotid coil (Machnet BV, Eelde, The Netherlands) using a defined protocol [(T2w TSE, FS, TR/TE 7660/87ms, slice thickness 4mm, in 3 orientations) (T1w TSE, TR/TE 824/10ms, slice 3.5mm, coronal) (T1w TSE, FS, TR/TE 930/11, slice 3.5mm, axial) (T1w MP-Rage, TR/TE 1800/2.2ms, slice 1mm, sagittal) (PDw FS, TR/TE=3540/35ms, slice 3mm, axial)]. Subjects of group A additionally underwent an external examination including photodocumentation of the neck by a forensic medical examiner. MRI data were read by two blinded board certified radiologists according to a predefined diagnostic scheme³. Data of radiological and external examination were analyzed regarding the morphology and localization of findings, and correlated with information concerning the strangulation event. Additionally, sensitivity and specificity of the diagnosis "strangulation" were calculated based on all, internal and external findings.

Results:

In total 82 findings were detected in the strangulated victims, including 48 external findings, e.g., reddening or intracutaneous, subcutaneous hematoma, or abrasion, and 34 radiological findings such as subcutaneous edema or bleedings into musculature, glands or lymph nodes. The agreement between the reported external and internal findings was very low (n=3). The evaluation of the findings in group A showed that 4 of 15 subjects did not present with external findings, but only with MRI findings. Fig. 1 shows one example of a strangulated subject with exclusively internal findings. In contrast, 4 subjects had only external findings. On the basis of both, MRI and external findings, the sensitivity for the diagnosis of strangulation was 97% at a specificity of 100%. Regarding reconstruction radiological findings, in contrast to external injuries, were mostly localized on the right side of the neck (Fig. 2). In case of an attack by one hand (n=9), radiological findings were present in about 44% on the right side (p=0.2), while 11% were found bilaterally and on the left side of the neck. There was no significant correlation between the number and grade of injury and the interval between the assault and the scan.

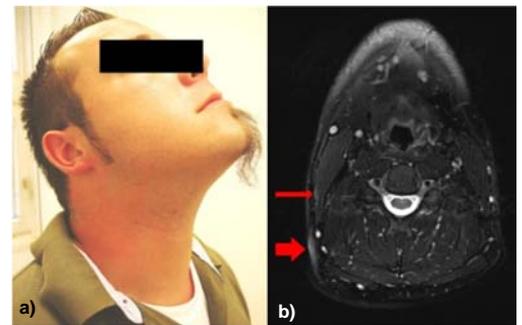


Fig. 1: Example of a strangulated victim with a) no external findings, and b) with subcutaneous edema (big arrow) and a muscular bleeding (small arrow) in the T2w image

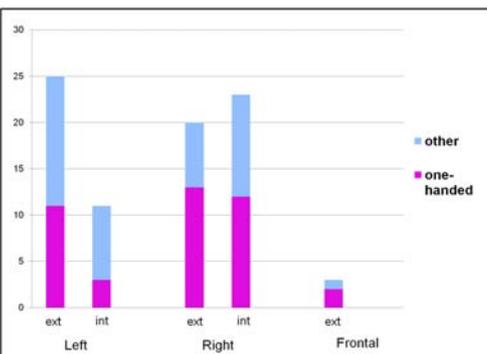


Fig. 2: Number of internal and external findings at different locations of the neck depending on the type of attack

Discussion & Conclusion: External findings in case of a survived manual strangulation mostly do not correlate with internal injury detected in non-enhanced 3T MRI. Thus, only an additional examination with the potential of revealing internal findings can assure an assault including strangulation as a valuable proof in court. Additionally, only the combination of both, external and radiological findings leads to a sufficiently high sensitivity. Regarding reconstruction, internal findings were mostly detected on the right side of the neck. Their relationship with attacks performed with a single hand of the assailant suggests that – given the fact that most people are right-handed⁴ – it is mainly the pressure of the thumb which leads to a soft tissue injury of the neck. Thus, MRI findings of the neck are not only a complement to the forensic external examination to achieve a high sensitivity and specificity for the diagnosis of strangulation, but also add important information on the attack and the assailant himself. Non-enhanced MRI might thus become a standard procedure in forensic radiology for the examination of living victims of strangulation in the next few years.

References: 1. Yen et al. Clinical forensic radiology in strangulation victims: forensic expertise based on magnetic resonance imaging (MRI) findings. *Int J Leg Med* 2007;121:115-123; 2. Christe et al. Life-threatening versus non-life-threatening manual strangulation: are there appropriate criteria for MR imaging of the neck? *Eur Radiol* 2009;19:1882-9. 3. Pivec et al. Identification of living victims of manual strangulation by MR imaging of the neck. *Proc. ISMRM* 2012. 4. Cashmore L et al. The evolution of handedness in humans and great apes: a review and current issues. *Journal of Anthropological sciences* 2008; 86:7-35.