Forensic FE study of skull fracture

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Forensic FE-Study of Skull Fracture

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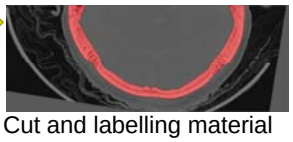
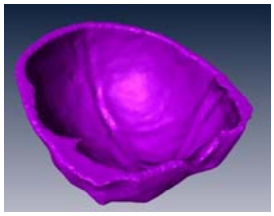
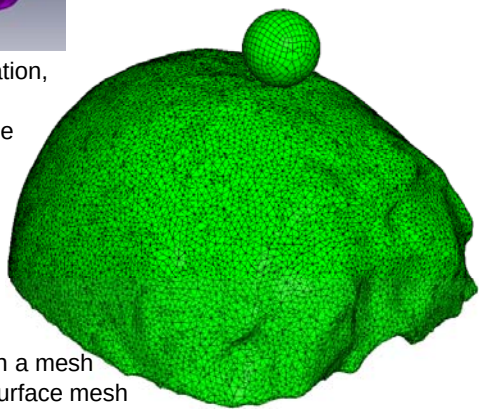
An important issue in forensic medicine is to determine how a specific skull fracture arose. This information can be critical for establishing if a criminal offense has taken place. Based on CT-scan of an autopsy case, a full 3-D finite element model of a skull was built up in the commercial dynamic finite element code Abaqus/Explicit. The skull was exposed to a short dynamic impact from a blunt object and a simple element-removing algorithm describing the fracture process in the finite element model was used. Based on the simulations, a large sensitivity of the fracture modes was found even for small changes in the initial speed of the incoming object.


CT-scan as DICOM

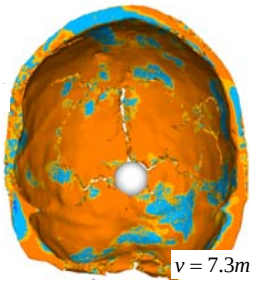

Cut and labelling material

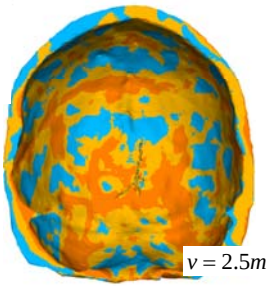
Built up 3-D structure


Surface representation, smoothening and exported as STL-file

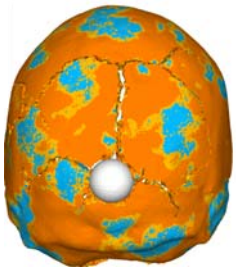

Dynamic 3-D finite element model in Abaqus/Explicit with a mesh fixed to a triangle surface mesh from the STL representation

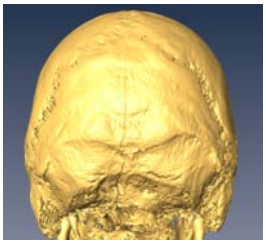
Dependency on speed of incoming object





Predicted and observed crack pattern





Conclusion

The predicted and observed fracture patterns differ from each other for the specific case. This may be due to some of the simplifications used in the model as well as the representation of the actual dynamic impact. A more realistic finite element model should take into account the real cranial vault structure, incorporating a spongy bone layer with a low density between two compact bone layers. In addition, the effects of the sutures between the single cranial bones should be included, as well as a more realistic dynamic fracture process simulation.