DETERMINATION OF BIOMECHANICAL LOADING OF THE LUMBAR SPINE BY COMPUTER SIMULATION

Schuller E., Schönpflug M., Praxl N., Muggenthaler H., Graw M.
Institute for Legal Medicine, Munich University, Germany.
Communicating author: Erich.Schuller@rechts.med.uni-muenchen.de

INTRODUCTION

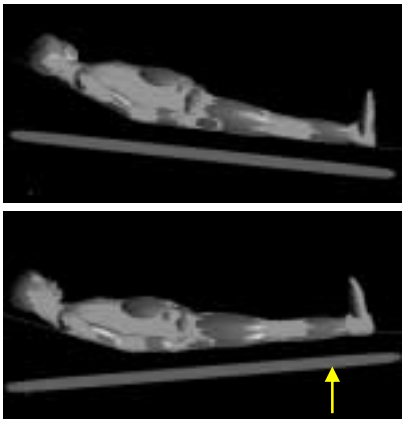
Forensic trauma cases often require examination of injury causation or injury probability. To solve that problem specific biomechanical loading parameters in body segments affected have to be determined and related to available tolerance limits. Numerical simulation using a human body model can provide this information needed, i.e. dynamics both of the whole body and of body segments and local loading parameters. As an example a lumbar spine loading situation is presented for which causation and probability of a repeated disc prolapse sustained shortly after L 4/5 disc surgery had to be examined.

METHODS

The MADYMO-Human-Body-Model Version 5.41 was used for numerical simulation of the following forensic case:

A few days after lumbar disc surgery (L 4/5) a 36-year old male patient was transferred to a rehabilitation clinic. The stretcher on which he was carried by two paramedics from the ambulance to the entrance hall of the clinic suddenly collapsed downwards about 27 cm at the head. Figure 1 shows the modelling of the initial and final position of the patient on the stretcher representing two snapshots of the whole sequence of the simulation. The acceleration of the system in vertical direction was 1g. The fixed axis of rotation was at the foot of the stretcher (c.f. arrow in Fig. 1)

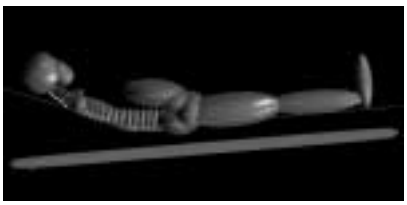
Figure 1: Initial and final position of the patient model



Immediately after the collapse the patient complained about severe pain in the lumbar spine similar as it had been before surgery and 14 days later a repeated prolapse of the L 4/5 disc was diagnosed requiring surgery once again at the same location. The question to be answered was the causation of the repeated disc prolapse related to the collapse of the stretcher.

In the MADYMO-Human-Body-Model applied for the simulation a detailed spine modelling is included as it is demonstrated in Figure 2 for an intermediate position during the collapse.

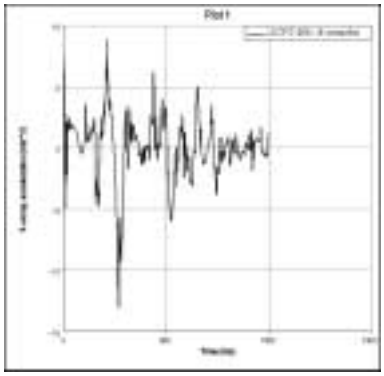
Figure 2. Spine modelling in the Human-Body-Model



RESULTS AND DISCUSSION

The axial loading (x-axis) calculated for the lumbar spine at L4/5 is shown in Figure 3. The highest acceleration peak occurring at the sudden stop after the collapsing downwards is 1,3 g (13 m/s²), followed by smaller peaks of 0,5 g and less related to oscillations in the final position. From this result it was concluded that the causation of the repeated disc prolapse can not be confirmed.

Figure 3. Axial lumbar spine loading at L 4/5.



SUMMARY

Numerical simulation with human body models provide specific loading parameters of body segments to examine injury causation and probability. As an example a lumbar spine loading situation has been presented for which causation and probability of a repeated disc prolapse sustained shortly after L 4/5 disc surgery had to be examined. From the simulation results it was concluded that the causation of the repeated disc prolapse can not be confirmed.

REFERENCES

MADYMO User Manual