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A Multipurpose Sternum Instrumentation

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INTRODUCTION

The need to instrument the Manubrium Sterni with large sensors to perform repetitive tests or to apply high energy levels justified the development of an instrumentation methodology that reduces the risk of sensors becoming detached during testing.The desire to standardize the instrumentation in order to apply it to several kinds of test led us to take into account the pulmonary pressurisation required for some experimentations. The aims of this work is : 1) to reduce the relative motion between the sensors and the Manubrium Sterni, 2) to avoid the risk of disconnection during impact, 3) to avoid Pleura injuries when instrumenting if pulmonary pressurisation of the cadaver is required. The basic principle of the system is that the Manubrium Sterni is gripped between two plates like in a vice. To prevent Pleura injuries during the installation, a pre-shaped rod replaces the posterior clamping plate. So, it is not necessary to dissect the back of the Manubrium Sterni even with the finger.

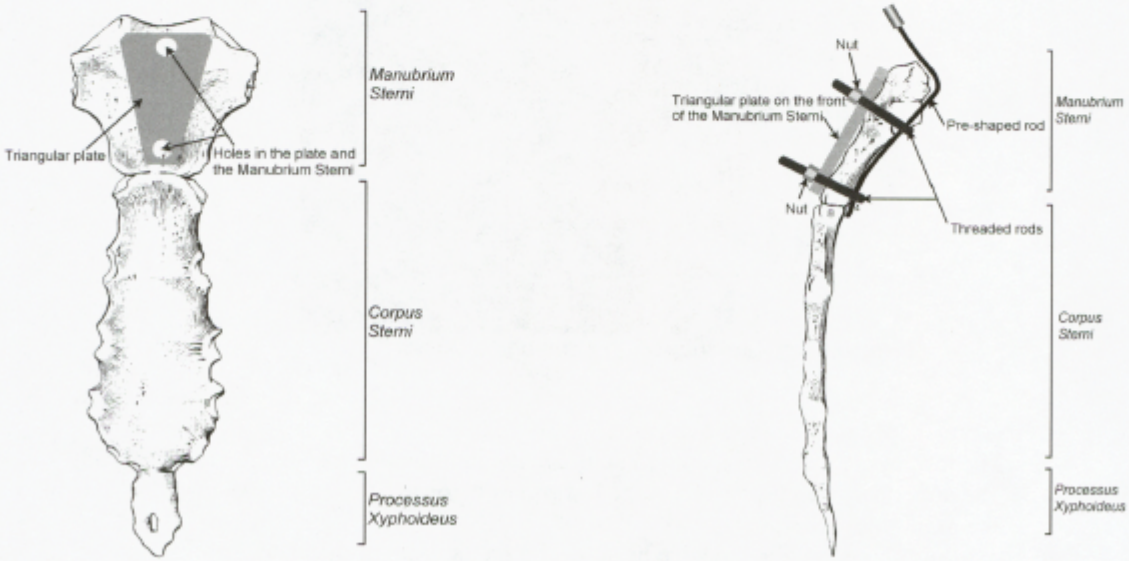

Figure 1 (From W. KAHLE, H. LEONHARDT, W. PLATZER [1])

MATERIAL

The device shown in figures 2 and 3 includes:

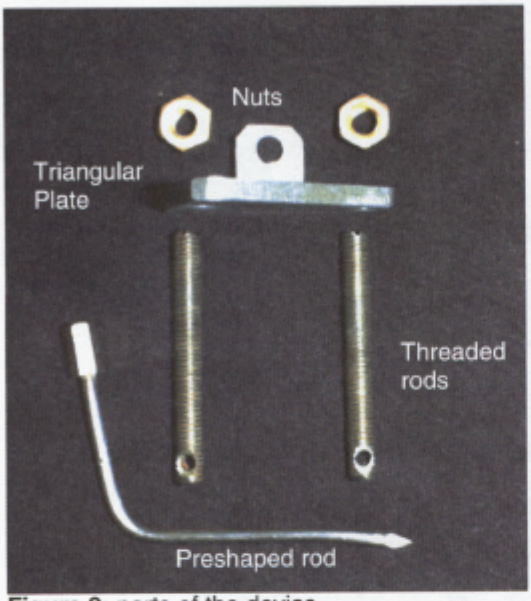

Figure 2: parts of the device

One triangular plate (figure 3) fixed on the front of the Manubrium Sterni. This plate is pierced with ne hole at the lower vertex and with one hole in the middle of the opposite base.

Figure 3:
triangular plate

Two threaded rods
passing through the holes in the plate and then through the Manubrium Sterni. Each threaded rod has a hole 5mm from its rearward extremity. The holes are chamfered to facilitate insertion of the pre-shaped rod.

- **One rod** pre-shaped on the back of a frozen Manubrium Sterni so that it follows the curvature when gripping the device (figure 4).

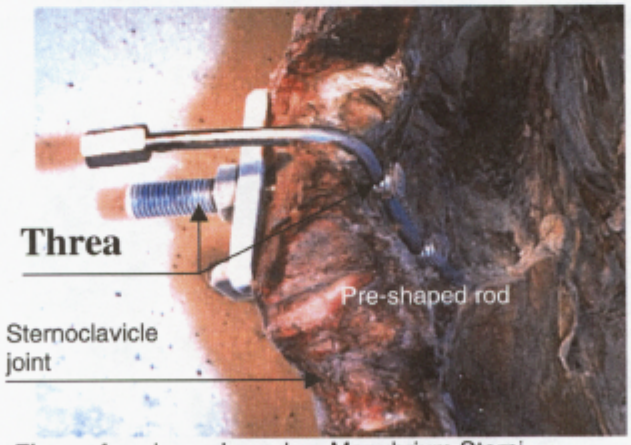

Figure 4: rod pre-shaped on Manubrium Sterni

The pre-shaped rod includes two parts:
- The lower part which is tapered to facilitate the introduction through the threaded rods.
- The upper part which is at 90° to the lower part helps to hold the rod when sliding it behind the Manubrium Sterni .

- **Two nuts** allow clamping of the device by screwing on the front of the plate.

METHODOLOGY

The skin is incised from the Cartilago Thyroidea to a point 2cm under the Angulus Sterni. A second perpendicular incision is carried out between both Sternoclavicule joints. The superficial plane is dissected to clear the front face of the Manubrium Sterni. The front Trachea tissues are dissected. The upper edge of the Manubrium Sterni is cleared to allow sliding of the pre-shaped rod along rear face. The triangular plate is placed on the front face of the Manubrium Sterni to locate the hole positions. The drilling is carried out carefully to avoid injuries at the rear. The threaded rods are inserted into the holes, then removed to clear the holes of any debris. The pre-shaped rod is slid over the upper edge and along the rear of the Manubrium Sterni. Its progress is checked by looking through the cleared out upper fixing hole with the help of a Clar mirror. The threaded rod is pushed through the upper hole and its orientation is checked with the help of the slotted end. The pre-shaped rod is pushed through the chamfered hole of the upper threaded rod. The same method is used for insertion into the hole of the lower threaded rod. When the pre-shaped rod has been fed through the two threaded rods, an external traction is applied to pull together the different parts of the device. The front plate is placed on the Manubrium Sterni. The nuts are screwed onto the threaded rod to clamp the device. The instrumentation is carried out having checked that no motion of the device is possible.

X-RAY CHECKING

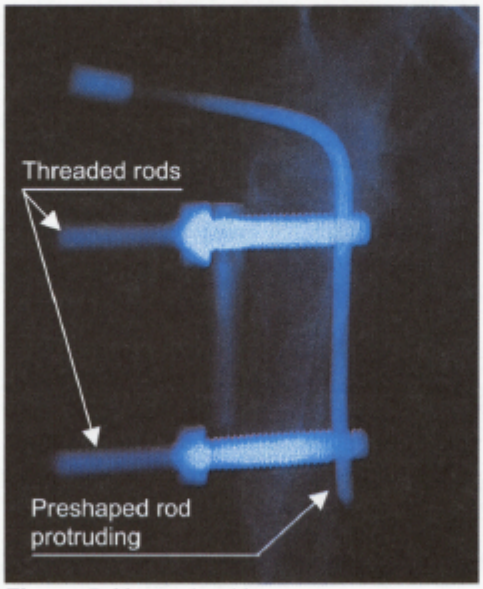

Figure 5: X-ray checking

An X-Ray allows the checking of the position of the pre-shaped rod which must protrude enough from the lower threaded rod (figure 5).

RESULTS

For the moment, this instrumentation has been applied in two kinds of experimentation:

- ***Upper extremity interaction with side impact airbag.***

Two cadavers were tested, with both the left and right arm being impacted.

The Sternum was instrumented with 3 accelerometers (figure 6).

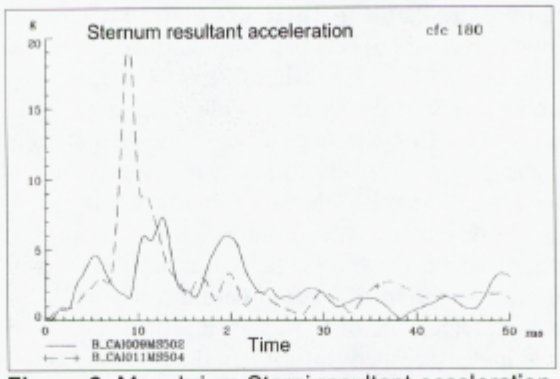

Figure 6: Manubrium Sterni resultant acceleration

No injury of the pleura was detected after instrumentation.

No play between the sensors and the Manubrium Sterni was detected when checking after each test.

- ***Human head neck response during low speed rear end impacts:***

Three cadavers were tested with a target on the triangular plate.

Nine impacts were applied on the first cadaver.

Eight impacts were applied on the second cadaver.

Eleven impacts were applied on the third cadaver.

Instrumentation of these cadavers was more difficult because of large sensors fixed on the front of the first thoracic vertebra. The time necessary to instrument the Manubrium Sterni was about fifteen minutes. No play between the sensors and the Manubrium Sterni was detected when checking after each test. In the future, high energy tests will be applied to cadavers with Manubrium Sterni instrumentation to check the strength of the fixing system. The front side of the plate can be adapted to different sensors. That is why this aspect is not described. In the future, the threaded rods will be shorter so that they don□t protrude from the nuts. The external parts of the threaded and pre-shaped rods used for manipulation will be removable.

REFERENCES

Anatomie, appareil locomoteur. W. KAHLE, H. LEONHARDT, W. PLATZER. Edition française dirigée par C. CABROL. Flammarion Medecine-Sciences.