THE PATTERNS OF DIAPHYSEAL FRACTURES OF THE LOWER LIMBS IN VULNERABLE PARTICIPANTS IN REAL WORLD TRAFFIC ACCIDENTS

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THE PROTRUDING BUMPERS and sharp edges of the hood of pontoon car bodies in older types of vehicles often caused characteristic fractures of diaphyses with wedge-shaped fragments whose base indicated the place of force application and apex showed the direction of its action. However, the changes in the car body's shape and construction of bumpers introduced at the end of the previous century resulted in decreased frequency of this "classical" marker (Teresiński and Mądro, 1999).

To date a great number of biomechanical dynamic load tests on the long bone fractures mechanisms and morphology have been performed using the fragments or whole fresh bone specimens collected from cadavers (Kress et al., 1995, Rabl et al. 1996). However, the latest studies concerning fracture patterns in real world accident casualties (with bone maceration to visualize additional crack fissures) were conducted in the 70s, i.e. when the vehicle construction and traffic structure significantly differed from the one found today (Mittmeyer et al., 1974).

The aim of the present study was to assess the character of diaphyseal fractures of the lower limbs occurring nowadays in vulnerable road users and the possibilities of determining the direction of action of the external force (the direction of impact) on the basis of such fractures.

MATERIAL AND METHODS

The study material included the diaphyses of the lower limbs collected from the cadavers of 122 pedestrians (without run over cases) and 10 cyclists whose postmortem examinations were performed in our Department between 1999-2003. The bones were subjected to special maceration procedure to visualize the lines of any additional cracks invisible on fresh shafts (Fig. 1). The bone fragments were glued with the cyanoacryl glue. The selected material consisted of the cases whose autopsy results and case files (obtained by courtesy of the Courts and Prosecutor's Offices) enabled us to reconstruct the direction of impact onto the victim's body. Having eliminated the fractures of epiphyses we analysed the diaphyseal fractures of 51 femoral bones (59 fractures), 119 tibial bones (150 fractures) and 118 fibular bones (190 fractures).

RESULTS

The analysis showed that 55% of oblique fractures assessed on autopsy as non-characteristic ones, after maceration were found to be flexion fractures in which "the Messerer`s wedge" was complemented by additional fissures. Furthermore, in 70% of transverse fractures the pattern of additional fissures formed the contour of a triangular fragment. On the basis of the course of fissures of fractures and cracks the most common morphological forms of fractures were determined and their taxonomy was proposed according to the way of distinguishing the "classical", "incomplete" and „phantom" wedges (Fig. 2).

The base of the distinguished wedge fragments usually correlated with the force application place and direction of impact of the vehicle into the victim's body. Beside the "true" Messerer`s wedges (with sharp apices and edges concave in relation to the bases), 16 "false" triangular fragments were found with the edges convex towards the base, which was most often situated opposite the force application place. However, 36 "true" flexion fractures were also "reversed" (their apices were directed towards the impact side) – usually in the regions distant from the force application place and probably caused by the lever mechanism. The fractures close to metaphyses were mostly non-characteristic (comminuted).

The pattern of fractures (except comminuted ones) depended mostly on the vehicle's front shape and not on impact velocity (98% of cases concerned high velocity hits >50 km/h and 53% of them -

>70 km/h). About 22% of cars involved in the analysed accidents were manufactured before 1990, 25% and 40% in the first and second half of the 90-ties, respectively, and about 8% in the years 2000-2003 (however, truly "new" models introduced to the market during the last 5 years were almost absent). Most of "classical" Messerer's fractures were produced by old pontoon-shaped cars with protruding and stiff bumpers and sharp hood leading edge.

CONCLUSIONS

The changes in the construction and shape of bumpers and front contours of modern vehicles only apparently reduced the percentage of flexion fractures since in the majority of cases the process of maceration of bones has disclosed some additional fissures of cracks, which "complemented" the contour of the Messerer`s wedge in oblique fractures or even constituted the whole edge in transverse fractures ("phantom wedges"). Therefore, flexion fractures are still valuable biological markers provided that suitable postmortem preparation is carried out. Moreover, the results of the present study may be used to reconstruct the accident circumstances in survival cases as some of the fractures may be found intravitally on high quality X-ray pictures.

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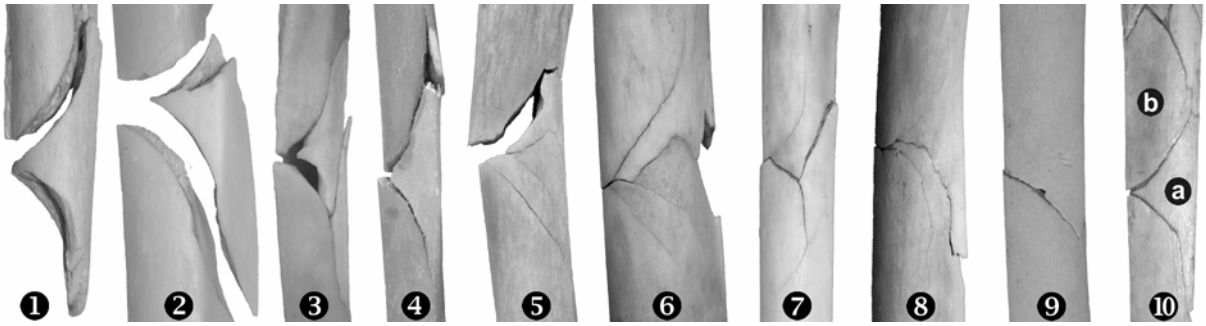

Fig. 1 - Various patterns of "classical" (1-3) and "incomplete" (4-9) bending fractures.
10 – "true" (a) and "false" (b) wedges. Direction of bending from right to left side of the figure.

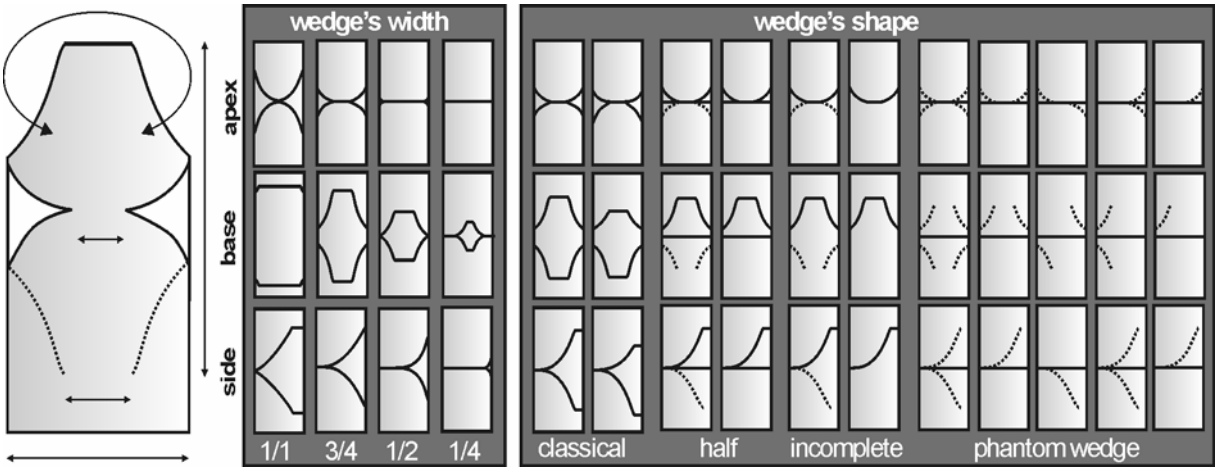

Fig. 2- The classification of the most common morphological forms of long bones bending fractures.