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# Injuries of Foot and Ankle in Front Seat Passengers

The number of injuries sustained by car occupants involving the head, thorax, spine, pelvis and the upper limbs have been reduced significantly during recent years. This is probably due to better safety features in the cars, especially the availability and usage of safety belts, airbags etc. Therefore one can notice clinically a relative increase in survivors of severe frontal crashes, but many of them have injuries to the lower extremities [1]. To verify this, we analyzed the foot and ankle injuries of front seat passengers.

## Material and Methods

We analyzed all accidents registered by the Accidental Research Unit of the Technical University of Dresden from July 1999 to December 2002 with regard to foot and ankle injuries of front seat passengers of cars, buses and lorries.

## Results

A total of 5.218 front seat passengers of four wheel vehicles were involved in accidents. 2.221 sustained an injury. 40 patients of 34 accidents sustained 49 foot/ankle injuries (AIS ≥2). The mean age was 41.7 years (17 to 75 years). There were 31 male and 9 female patients. The injured anatomic regions involved 19 ankle, 9 hindfoot, 7 midfoot and 14 forefoot fractures. The four anatomical groups were further analyzed and this showed that:

a) 19 fractures at the level of the ankle were simple fractures of the malleoli, 6 were severe fracture dislocations of the malleoli and 2 were pilon fractures.

b) 11 fractures of the hindfoot involved the calcaneus (n=5), talus (n=3), subtalar dislocation (n=2) and 1 severe hindfoot degloving injury.

c) 7 fractures of the midfoot were naviculare fractures (n=2), cuboid fracture (n=1), Chopart-fracture dislocations (n=3) and 1 subtotal amputation at the level of Chopart's line.

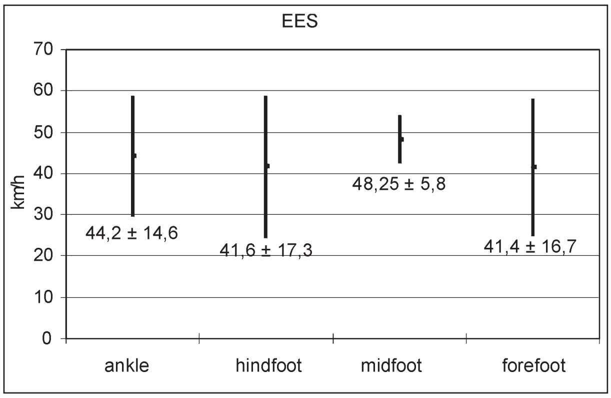


**Figure 1:** The 4 different anatomic levels of injured ankle and foot (n=49) show in comparison a slightly higher rate of Energy Equivalent Speed (EES) related to midfoot fractures

d) 14 fractures of the forefoot consisted of 13 fractures of the metatarsals and 1 open dislocation of MP 1-joint.

10 patients out of 40 were classified as polytraumas. 6 of them died at the scene of the accident or during transportation to the hospital. There were 4 open injuries. 4 patients broke both feet. The foot lying externally was more often injured than the one lying internally. Only 8 of 34 vehicles were equipped with an airbag, and it was deployed in 7 of 8 cases. 8 of 40 patients did not use the seat-belt. 24 accidents were frontal and 12 were offset crashes. There were no differences in speed changes ($\Delta_V$) and in EES (Energy Equivalent Speed) between the injured foot regions. However in midfoot fractures (48.25 ±5.8km/h) as shown in Figure 1, we observed a tendency towards ankle and hindfoot injuries at level 20 to 40 EES and more forefoot injuries at higher EES between the levels of 40 to 60 EES. Midfoot fractures seemed to be mainly due to torque forces as a result of incarceration of the feet in between the pedals. Furthermore we noticed a tendency towards higher intrusion of the toepan in cases of hindfoot and midfoot fractures because of axial loading as compared with ankle and forefoot injuries (Figure 2). Foot and ankle fractures were seen in 27 drivers but only in 7 front seat passengers. 3 out of 20 injuries in vehicles with low intrusion were AIS II-injuries, but in cases of high intrusion we registered 7 out of 14 AIS III-injuries. There were no significant differences in speed changes $\Delta_V$ and EES between high and low intrusion events.

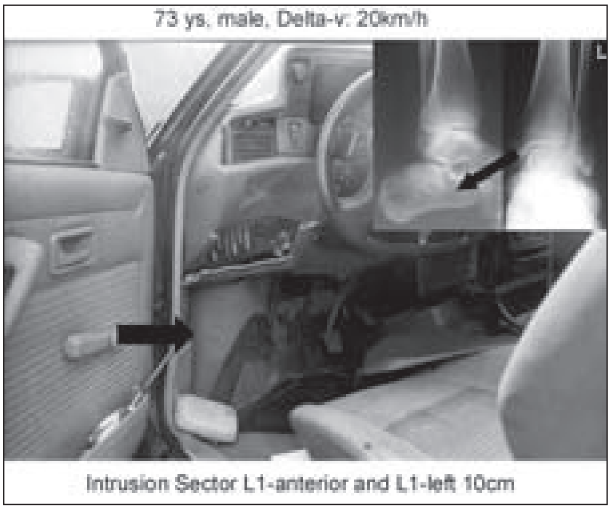


**Figure 2:** High intrusion of the toepan L1 left frontal of more than 10cm (see arrow)

## Discussion

Foot and ankle fractures in vehicle passengers are uncommon but they often cause significant late disability [2]. Foot and ankle fractures occured four times more often in car drivers than in front seat passengers in our study. This was not seen in a previous study [3]. Therfore it is likely that besides intrusion of the toepan, impaction and the torque sustained by the feet in between the pedals significantly influences the dissipation of trauma energy.

## Conclusion

Although foot injuries in car accidents are rare, there is a high incidence of late disability [3]. This has significant social-economic consequences. There is a need to stress technical improvements like stiffening the toepan or developing better alternatives to the mechanical pedals so as to prevent these injuries.

## References

[1] P.C. DISCHINGER, T.J. KERNS, J.A. KUFERA (1995): Brief Communications and Research Notes. Lower Extremity Fractures in Motor Vehicle Collisions: The Role of Driver Gender and Height. Accid. Anal. and Prev., vol. 27, no. 4: 601-606

[2] G. REGEL, A. SEEKAMP, J. TAKACS, S. BAUCH, J.A. STURM, H. TSCHERNE (1993): Rehabilitation und Reintegration polytraumatisierter Patienten. Unfallchirurg 96:341-349

[3] M. RICHTER, H. THERMANN, H. von RHEINBABEN, E. SCHRATT, D. OTTE, H. ZWIPP, H. TSCHERNE (1999): Frakturen in der Fußregion bei Pkw-Insassen. Häufigkeit, Ursachen und Langzeitergebnisse. Unfallchirurg 102:429-433