Analysis of management of patients with multiple injuries of the locomotor system

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Abstract Body injuries are very serious problems in industrialised countries and they are frequent causes of fatalities in our times. The variety and multiple combinations of body injuries are a challenge for the trauma team. On the basis of clinical and radiological documentation 315 patients with multiple injuries of the locomotor system (MILS) were included in the study. The criterion for inclusion of the patients into the study group was identification of MILS. The study showed that these injuries often involve young people (53%) (predominantly men) aged between 16 and 45 years. Road accidents were the most frequent cause of injuries —80.6%. MILS affected the lower limb in 49.4%, upper limb in 33.2% and pelvis in 14.1%; 75% of the patients studied also suffered from concomitant injuries. The head and brain were involved in 92.9%, chest in 31.5% and abdomen in 21.3%. The mortality index for the population studied was 14%. An increasing value of the Injury Severity Score (ISS) or New Injury Severity Score (NISS) caused delay in surgical management of bone injuries and correlated with prolonged hospitalisation. Analysis emphasised the usefulness of the NISS as a valuable prognostic instrument in assessment of severity of injuries in patients with multiple injuries of the locomotor system.

Résumé Les traumatismes corporels sont un problème important dans les pays industrialisés et sont de nos jours une cause fréquente de mortalité. La variété et la multiplicité des combinaisons de traumatismes représentent une

véritable difficulté pour les équipes trauma. 315 patients présentant un poly-traumatisme de l'appareil locomoteur (MILS) ont été inclus dans cette étude, le critère d'inclusion dans cette étude étant l'identification du poly-traumatisme. Cette étude a montré que ce type de traumatismes survient fréquemment chez une population relativement jeune (53%) avec une prédominance masculine entre 16 et 45 ans. La cause la plus fréquente de ces traumatismes est l'accident de circulation (80.6%). Les poly-traumatismes affectent les membres inférieurs dans 49.4% des cas, les membres supérieurs dans 33.2% des cas et le bassin dans 14.1% des cas. 75% des patients ont présenté par ailleurs des traumatismes combinés, têtes et encéphales dans 92.9% des cas, thorax 31.9% et abdomen dans 21.3% des cas. Le taux de mortalité pour cette population a été de 14% des cas. L'importance de la valeur des coefficients ISS ou NISS ont été une cause importante du retard à la prise en charge chirurgicale et ont également été un facteur de prolongation de l'hospitalisation. Cette analyse permet de mettre en évidence l'importance du coefficient NISS comme un instrument pronostic de la sévérité de tous les traumatismes survenant chez ces patients.

Introduction

The variety and multiple combinations of body injuries are a challenge for the trauma team. For a better evaluation of the severity of trauma both on the way to hospital and on arrival in hospital, numerical evaluation scales are applied to help the decision-making process regarding the therapy. This is helpful in a prognostic evaluation of patients as well as in a comparative evaluation of treatment results of different patient injuries in one centre or similar patient injuries in different centres. Although the prognostic value

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of these scales is not always accurate enough for prognosis of the individual patient, their value is sufficiently accurate to correlate with survival and mortality of larger patient groups [5, 7, 13, 23].

Limitations also concern a very popular system of the Abbreviated Injury Scale-Injury Severity Score (AIS-ISS) [1, 2]. The fault, particularly pointed out by many authors in the construction of this scoring system, is the lack of capability of summing up significant injuries within one anatomical body region [5, 17, 19]. At the same time, it is necessary to take into consideration less significant injuries from other areas of the body. The primary assumption of the ISS is to see the human body as an entirety, as opposed to a more fundamental thesis that severe injuries should be taken into consideration prior to lighter ones. This was the reason for creation of a modification of the ISS by Osler and Baker in the form of the New Injury Severity Score (NISS) [15].

In many studies, injuries of the musculoskeletal system are generally described in the context of a management strategy for surgical treatment in polytrauma patients, as well as their influence on the outcome in these patients. There are few reports that solely analyse patients with multiple injuries of the locomotor system (MILS), whose injuries can be classified only in part as multiple body injuries (MBI).

The objective of this study was to analyse the influence of the severity of body injury among patients with MILS measured by the ISS and NISS on therapeutic management of those patients by using selected parameters.

Materials and methods

In the hospital discharge database we retrospectively identified a group of 315 patients with MILS, who were treated from 1 January 1995 to 31 December 1999 at the Medical University Hospital in Bydgoszcz. The criterion for inclusion of the patients into the study group was identification of MILS, with at least one of them being the cause of hospital treatment. Patients, who were admitted immediately after trauma to the Intensive Care Unit or Neurosurgery Department, and then moved to the Orthopaedic Department, were analysed as one patient. A patient solely with skeletal injuries was allocated to the group with MILS, although patients with bony injuries and concomitant injuries of other organs were assigned to the group with MBI.

Patients' individual hospital records let us collect data for each patient on the basis of clinical and radiological documentation. The epidemiological analysis included gender and age, mechanism of trauma, type and localisation of injuries of the locomotor system taking into consideration AO [14] and Gustilo classifications [10], injuries of other organs and methods of treatment of bony

injuries. On the basis of the AIS we calculated the ISS and its modification—NISS—for every patient. Then the created database was analysed by applying statistical tests [chi-square test (χ^2), Student's *t*-test, Pearson's linear correlation index].

Results

In the study group there was a significant predominance of men—192 patients (60.9%)—over women, who accounted for 123 patients (39.1%) ($p < 0.001$). The average age of the patients was 38.9 years (± 19.9) and ranged from 3 to 87 years; 81% of men and 55% of women were hurt in the period of their greatest life activity at an age between 16 and 60 years of life.

The most frequent reasons for MILS were traffic accidents (80.6%); 149 casualties (47.8%) were injured in car or motorbike accidents, whereas 105 (33.3%) were pedestrians. At the time of injury one fourth of patients were alcohol intoxicated. Injuries caused by traffic accidents and falls from heights were the most severe. The average value of the ISS for the study population was 24.3 (± 15.7) and for traffic injuries 26.6 (± 13.6) and of the NISS it was 28.6 (± 14.6) and 30.3 (± 12.7), respectively. Mortality in the study population was 14%; 38 casualties died as a consequence of traffic accidents, the main reason of death. The average mortality in this population was 15% and ranged from 6.6% for bike riders up to 21% for pedestrians.

In our group of patients we diagnosed 796 injuries of the locomotor system. The average number of injuries per patient was 2.5 and ranged from 2 to 7. The distribution of bone and joint lesions is shown in Fig. 1. Among the MILS the most frequently diagnosed injuries were fractures of the lower limbs (39.9%), the upper limbs (21.6%) and pelvis (14.1%). Simultaneously the most

Fig. 1 The distribution of bone and joint injuries

Fig. 2 The distribution of fractures in accordance with AO and Gustilo classifications for open fracture

frequent type of lesion was closed fracture (81.9%), then open fracture (12.1%) and dislocation (6%). We observed a close correlation between soft tissue damage related to fracture and frequency of complex fractures (AO type C). The percentage of type C fractures ranged from 14.5% for closed fractures to 52.6% for Gustilo type III° open fractures (Fig. 2). Of 19 grade III° open fractures with extensive lesions of soft tissue in different sites in the locomotor system where blood vessels and nerves were damaged, 12 cases led to traumatic amputations.

Among 315 patients the injuries of 90 patients concerned solely the locomotor system (28.6%), whereas in the other 225 patients (71.4%) we diagnosed both MILS and different grades of concomitant injuries of other organs. We assigned those patients to the group with MBI. In this group of patients 59.6% suffered from injuries of two regions of the body, 29.3% of three body regions and in 11.1% from injuries to as many as four anatomical regions of the body according to the AIS classification. The percentage of concomitant injuries of patients with MBI

in cases of head and neck injuries was 92.2%, chest injuries 31.5% and abdominal and urogenital injuries 21.3%.

Surgical treatment was performed in 275 cases of the bone and joint injuries (34.6%). The frequency of surgery in the primary and secondary period was similar with stable osteosynthesis as the most frequent procedure; 482 injuries (60.7%) were treated conservatively. Surgical treatment was dominant in cases of femur fractures. In cases of tibia fractures both methods were used to an equal degree, and arm, forearm and pelvis injuries were treated mainly conservatively. Our analysis found a significant statistical correlation between the severity of trauma and methods used regardless of the scoring system, but for the NISS the level of statistical significance was higher ($p < 0.001$) (Fig. 3). Regardless of the score employed, the use of primary surgical treatment was statistically significant in trauma of minor severity.

In the group of 315 patients with MILS, 179 persons were treated surgically; 275 orthopaedic surgical procedures were carried out on these patients at different periods

Fig. 3 The correlation between the severity of trauma measured by ISS and NISS and applied methods of treatment

Fig. 4 The correlation between time of orthopaedic surgical treatment and total duration of hospitalisation ($n=173$)

after trauma. The time of surgical treatment was defined by us as the number of days, after trauma, up to the day when the last orthopaedic surgical procedure was performed. Delay of final surgical treatment of bony injuries led to increased duration of hospital stay. The correlation between time of orthopaedic surgical treatment and total period in hospital was reflected in the coefficient of Pearson's linear correlation, the value of which was 0.43 ($p<0.001$) and showed an existence of a positive statistically significant correlation (Fig. 4).

The presence of concomitant head, chest and abdominal injuries, classified as MBI, influenced the delay in surgical treatment of bone injuries. These injuries often required priority in surgical treatment. In the group of 83 patients with 143 injuries in other parts of the body, there were 44 neurosurgery procedures of the head, 35 laparotomies and 4 acute laryngological procedures for facial injuries. For 67 patients surgical treatment of concomitant injuries was carried out in most cases within the first day; the other 16 patients were treated during the next few days.

A total of 271 patients were discharged from hospital either home or to other departments for further therapy. The mean period of hospital stay of patients with MILS was 50.8 days (± 44.4). The mean value of both ISS and NISS scores increased with the duration of hospitalisation.

In the whole study population we noted a significant statistical difference between the mean value of the ISS,

which was 24.3 points (± 15.7), and mean value of the NISS, which was 28.6 points (± 14.6), hence higher by 4.3 points than the ISS ($p<0.0002$). The same results for both scores were found in 116 patients (36.8%), whereas in 199 other patients (63.2%) the value of the NISS was higher on an average by about 4.3 points. This was represented in the move of 19% of patients from an interval up to 20 points for the ISS to an interval above 20 points for the NISS. It is also resulted in a significant statistical difference between percentage of patients with severity of injuries calculated on both scales below 10 points and from 21 to 30 points.

The results of this study confirmed only predictably higher values of the NISS than ISS. This is the result of different algorithms used in calculation of these trauma scores on the basis of quantification of the same injuries according to the AIS.

We determined the existence of statistically significant differences between mean values of both scores in the groups of discharged patients with both MILS and MBI. Simultaneous lack of statistically significant differences was showed in the group of deceased patients (Table 1).

For comparison of the prognostic value of both methods to quantify the severity of trauma we analysed the correlation between mortality and severity of injury calculated for both scores in groups of patients with isolated MILS and with MBI. In the first group it was impossible to calculate the correlation because of the small number of deaths ($n=3$). However, in the second group we found a positive statistically significant correlation between mortality and severity of injuries for both scores. In the case of the NISS, the calculated coefficient of Pearson's linear correlation was minimally higher in relation to the one for the ISS (0.92 vs 0.91) followed by a minimally statistically significantly higher level for this score ($p<0.026$ vs $p<0.031$) (Tables 2 and 3).

Discussion

Our study confirmed known data from earlier studies provided in different countries on different continents, that multiple injuries affect mainly men [5, 8, 11, 18, 21]. The determination of a higher risk of trauma for men, especially

Table 1 Mean values of ISS and NISS in groups of patients with isolated MILS and MBI with division into discharged patients and deaths

Type of trauma score	Isolated MILS		MBI	
	Discharged ($n=87$)	Deaths ($n=3$)	Discharged ($n=184$)	Deaths ($n=41$)
ISS	12.3 $\pm$ 4.5	18.0 $\pm$ 10.0	24.0 $\pm$ 9.2	52.8 $\pm$ 20.3
NISS	18.9 $\pm$ 6.4	25.3 $\pm$ 11.7	27.8 $\pm$ 9.2	54.3 $\pm$ 18.9
<i>p</i> value	<0.000001	NS	<0.0001	NS

Table 2 Mortality of patients with MBI and severity of trauma measured by the ISS

ISS Interval	I (≤10)	II (11–20)	III (21–30)	IV (31–40)	V (>40)	Rate of correlation 0.91
Number of patients	4	79	66	37	39	<i>p</i> value 0.031
%	1.8	35.1	29.3	16.4	17.3	
Deaths	0	1	2	14	24	
Mortality (%)	0.0	1.3	3.0	37.8	61.5	

between 16 and 45 years of age, showed that the average age of our patients was 38.9 years. Mazurkiewicz and Zuk on the basis of their own studies revealed that 65% of patients, in selected series, who suffered MILS were aged between 21 to 49 years [12]. In this age group men were hurt two times more often than women. These results were similar to our study.

In accordance with Regel et al.'s analysis, within their group of 3,406 patients with MBI, lesions of the locomotor system were diagnosed in 86% of patients, mostly involving fractures of the lower limbs (72.9%). They also confirmed that injuries of the pelvis were diagnosed in 27% of patients, but these accounted for only 2.2% of all bone and joint injuries in this group [18]. This extremely high percentage of injuries of the lower limbs and pelvis was also confirmed to the same degree with a substantially lower percentage of fractures of the locomotor system by Baker et al. [2]. They reported that the percentage of patients with fractures of the lower limbs and pelvis among the analysed group of 2,128 victims of traffic accidents was 59%, a number which is also similar in Poland. In a prospective study carried out by Brongel and Gedliczka, analysis of 2,485 trauma patients of the Cracow region showed that 75% of them sustained single and multiple injuries of the locomotor system. Among those lesions the percentage of fractures of the lower limbs and pelvis was 45% [5]. In our study we also noticed that these particular parts of the skeleton were the most susceptible to trauma (63%).

Current guidelines for trauma surgery recommend early surgical stabilisation of fractures [5, 6, 22, 24]. In accordance with these guidelines, since 1994, in our department we have changed our approach and this led to

a substantial increase in the number of early surgical stabilisations. But the differences between our data and those presented elsewhere is still high and particularly when we compare the number of injuries treated surgically at our department with data published by Johnson et al. [11]. In their group of 132 patients with severe MILS 60.5% of 511 bone fractures were treated surgically (2 osteosyntheses per patient on the average). In the study presented by Regel et al. the percentage of fractures of the femur treated by primary surgical intervention was 84%, of the tibia 78%, of the elbow 83% and of the forearm 64% [18]. These data presented in the literature may serve as a stimulus to increase the number of patients treated surgically within a short period of time from injury, at best within the first 24 h. We may expect that this tactic should lead to decrease the number and degree of permanent disability in young trauma victims with severe MILS.

The correct assessment of trauma severity gives the chance to avoid an unnecessary risk of deterioration of the patient's status during orthopaedic procedures. The Injury Severity Score, despite its popularity, has undergone many changes during the 30 years of its application, but these modifications have not met all the requirements so far. Poole et al. emphasised the lack of full reflection of multiple fractures of the long bones in this score. Although the point value of a pelvis fracture correlates well with the mortality, there is lack of this correlation in the case of multiple fractures of the femur and tibia [17]. Ostrum et al. came to similar conclusions in an analysis of patients with femur fractures. They pointed out that the reflection of bilateral femur fractures in the scoring system was not satisfactory, despite the more frequent negative findings of hypovolaemia and generally more severe condition of those

Table 3 Mortality of patients with MBI and severity of trauma measured by NISS

NISS Interval	I (≤20)	II (21–30)	III (31–40)	IV (>40)	Rate of correlation 0.92
Number of patients	38	88	49	50	<i>p</i> value 0.026
%	16.9	39.1	21.8	22.2	
Deaths	0	2	10	29	
Mortality (%)	0.0	2.3	20.4	58.0	

patients [16]. Thus, some authors who have applied the New Injury Severity Score created by Osler vouch for its superiority.

In our research we were unable to confirm such a fundamental advantage of the NISS in comparison to the ISS. Correlation of their value with mortality and other clinical parameters showed an insignificant higher sensitivity of the NISS in evaluation of severity of injury both for patients with isolated MILS and in the group of patients with MBI. On the basis of these results we conclude that the NISS as a modification of the ISS, which allows for the summary of the most severely injured organs regardless of the anatomical part of the body, and it should find more widespread application in clinical practice in comparison to others scoring injuries of the locomotor system.

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