

# Early Outcomes of Pelvic Trauma Patients – Complications, ICU Stay and Treatment Concepts in Two ATLS Compliant Trauma Centers: Germany and Qatar

Časné výsledky u pacientů s pánevním traumatem – komplikace, pobyt na JIP a koncepce léčby na dvou ATLS traumacentrech: Německo a Katar

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## ABSTRACT

### PURPOSE OF THE STUDY

Pelvic trauma causes severe threats especially to polytraumatized patients. Not only it is in itself a possible cause for significant bleeding, but it also indicates a high risk for intra-abdominal injuries. The initial treatment of patients with pelvic trauma follows the ATLS principles of priority-oriented treatment. To examine the value of this highly standardized concept and to evaluate the effect of different patient collectives on early outcome parameters, two large collectives from Germany and Qatar were analyzed regarding injury parameters and early outcomes.

### MATERIAL AND METHODS

Patients were recruited in Hamad General Hospital, Doha, Qatar (HGH) and BG Trauma Center Ludwigshafen, Germany (BG). All patients that were treated with a pelvic fracture between 2013 and 2016 were included in this retrospective analysis. Demographic parameters were collected as well as type of injury and the frequency of complication parameters as pneumonia, acute kidney failure, ARDS, sepsis and amount of blood transfusion. 1436 patients with pelvic fracture (645 from BG and 791 from HGH) were recruited. The mean age was 57.4 years in the BG and 33.6 years in the HGH group ( $p < 0.000$ ). The mean ISS was 17.81 in the BG and 15.88 in the HGH group ( $p = 0.009$ ). The mean pelvic AIS was 2.65 in the BG and 2.25 in the HGH group ( $p < 0.000$ ).

### RESULTS

The mean frequency of complications was 9.3% in the BG and 9.9% in the HGH group ( $p = 0.128$ ). The mean frequency of ARDS was significantly higher in the BG group than in the HGH group (5.6% vs. 1.8%,  $p < 0.000$ ). The mean frequency of blood transfusion was significantly lower in the BG group than in the HGH group (28.8% vs. 39.2%,  $p < 0.000$ ).

### CONCLUSIONS

Despite significant differences in the two collectives, this analysis shows comparable results regarding early outcome parameters in patients with pelvic injuries. In total, pelvic injuries are accompanied by a relatively high complication risk and need to be evaluated and treated according to priority-based algorithms.

**Key words:** ATLS®, pelvic injury, complications, polytrauma.

## INTRODUCTION

Although pelvic fractures make up only 2–3% of all fractures, they regularly pose high demands for institutions and surgeons treating these injuries. Despite advances in injury prevention as well as diagnostics and treatment strategies, pelvic trauma remains a challenging entity due to high association of significant abdominal and vascular injuries as well as high potential for massive retroperitoneal hemorrhage. In polytraumatized

patients, mortality of pelvic trauma is high, reported up to 45%. Driven by a high morbidity and mortality after severe trauma, American College of Surgery developed a priority-orientated diagnostic and treatment strategy for the first hours after trauma called ATLS (Advanced Trauma Life Support) (9). ATLS principles were introduced in the 1970s and was steadily evolved from then. In ATLS courses doctors are taught a structured approach to address the immediate life-threatening trauma quickly by diagnosing the underlying causes for

hemodynamic instability. Pelvic fracture is one of the main sources for massive blood loss. In ATLS principles, diagnosis and initial treatment of unstable pelvic fractures have a central role in managing circulation disorders ("C-Problems"). Diagnosing a pelvic fracture is possible through clinical examination and available radiography. Elements of initial care are giving blood transfusions and stabilization of the pelvic (external or internal) in order to minimize the blood loss by establishing stability and reducing the pelvic volume. The ATLS concept is widely adapted in Level-I Trauma Centers worldwide, standardizing approaches and enabling hospitals and staff to treat such injuries similarly – regardless of the geographic location. With its principles ATLS is practiced transnationally.

To evaluate the efficacy of standardized concepts in different settings; in this study large collection of pelvic injuries were compared between a Level-I Trauma center in a German urban area (BG Trauma Center Ludwigshafen; BG group) and a Qatari Level-I center in the metropolitan area of Doha (Hamad General Hospital, Doha; HGH group). The wider urban area of Ludwigshafen in Germany covers around 700,000 citizens in comparison to 590,000 in Doha, Qatar. Both countries belong to high income economies. Beside the political system there are big differences in demographics, migration, religion, health system and infrastructure between Ludwigshafen and Doha (26). The Department of Economic and Social Affairs of the United Nations reports regularly about migration all over the world. It is described that Qatar is with an average annual rate of change in the number of international migrants over 6% one of three countries with the highest rate between 2000 and 2017. In contrast, Germany was one of 35 countries with an average annual rate of change in the number of

international migrants less than 2%. Next to the differences in migration where Qatar has a high percentage of expatriates (which are typically young males) and thus, there are large differences in demographic profiles of the two countries. There is an imbalance in the ratio of female and male citizens in Qatar, the main population is made up by young people aged 20–40 while in Germany, the age distribution is more homogenous from ages 20–70 with a peak between 50–60 years (15).

Beside the differences in society, there are differences in the health system as well. In Qatar, health care is free for locals and financed by the state. In Germany there is a mandatory health care insurance established. The financing of costs in health care is given by social security and social health insurance.

In conclusion both health care systems compete with totally different circumstances. Nevertheless, we hypothesized that, despite the previously mentioned differences between Germany and Qatar, a standardized approach for managing trauma associated injuries like the ATLS being used in both countries, that there are no relevant differences in morbidity and mortality of pelvic injury.

## MATERIAL AND METHODS

A retrospective review of the registry of patients with pelvic trauma treated and followed up at the trauma department at Hamad Medical Corporation, Doha, Qatar, and BG Trauma Center Ludwigshafen, Germany (BG) from January 2013 to December 2017. The local ethics committee was addressed and gave consent to this study (BG 837.500.17, HMC 16395/16).

In both centers, all patients that were treated between 2013 and 2016 and met the following inclusion criteria were included:

- pelvic trauma with clinical suspicion of a fracture,
- admitted and managed in the respective center.

We collected data on demographic variables (age, gender, nationality), mechanism of injury (fall from height, road traffic accident, rollover trauma), trauma-associated factors (ISS – Injury Severity Score, associated injuries, severity of injury (AIS – Abbreviated Injury Score), classification of the fracture (AO), management plan (operative, conservative), and early complications (ventilator-associated pneumonia (VAP)), acute respiratory distress syndrome (ARDS), acute kidney failure and sepsis, length of stay (overall hospital and ICU), ventilator days and blood transfusion.

A standard treatment protocol was used in all cases in both centers, which included: ATLS protocol, pan CT, admission in ICU or ward, orthopedics consultation and intervention.

To compare the effect of early diagnosing and treatment after trauma in the way of ATLS on complication rate and mortality first of all two patient collectives called BG group and HGH group were compared. A total of 1436 patients were recruited (645 patients of the BG group and 791 patients of the HGH group). The descriptive data are shown in Table 1.

Table 1. Descriptive analysis

		BG group amount (ratio)	HGH group amount (ratio)
Age (years)		57.35	33.58
Gender	male	357 (55.3%)	701 (88.6%)
	female	288 (44.7%)	90 (11.4%)
Nationality	locals	636 (98.6%)	119 (15.0%)
	foreigners	9 (1.4%)	672 (85.0%)
Trauma mechanism	road traffic	258 (40.0%)	471 (59.5%)
	fall	355 (55%)	237 (30%)
	pedestrian	28 (4.3%)	59 (7.5%)
	other	4 (0.6%)	24 (3%)
AO classification pelvic fracture	no fracture	95 (14.7%)	148 (19.7%)
	61A	238 (36.9%)	423 (56.3%)
	61B	238 (36.9%)	108 (14.4%)
	61C	74 (11.5%)	73 (9.7%)
Pelvic operation	Yes (OM)	226 (35.0%)	361 (45.6%)
	No (NOM)	419 (65.0%)	430 (54.4%)

For comparison of the trauma severity, the abbreviated injury scale (AIS) for pelvic injury was examined. The higher number of B- and C-type injuries in the BG group reflects in a statistically significant higher average AIS pelvis in the BG group (2.65 vs. 2.25,  $p<0.000$ ). The differences in AIS pelvis are drawn in Figure 1.

Furthermore, the Injury Severity Score (ISS) in total was examined. The comparison of the ISS of patients of the BG group with patients of the HGH group showed no statistically significant difference (17.81 vs. 15.88,  $p=0.067$ ). In the BG group 36.9% of the patients had an ISS > 16, in the HGH group it was 41.3%. In general, especially younger male patients had a higher severity in trauma with a higher ISS than female patients (17.42 vs. 14.88,  $p<0.000$ ). The differences in the ISS are shown in Figure 2.

Statistical analysis was done using the Statistical Package for the Social Sciences (SPSS 24) (IBM, Armonk, USA). For estimating the differences of the occurrence of early complications, statistical analysis using the chi square test. For variables with normal distribution, Student's t-test was used. Statistical significance was assumed when  $p<0.05$ .

## RESULTS

### Differences in early complications after pelvic injury

There was no significant difference in the mean frequency of complications between the BG and HGH group. A complications rate of 9.3% could be found in the BG group and one of 9.9% in the HGH group ( $p=0.128$ ). Divided in the certain complications, the mean frequency of ARDS was sig-

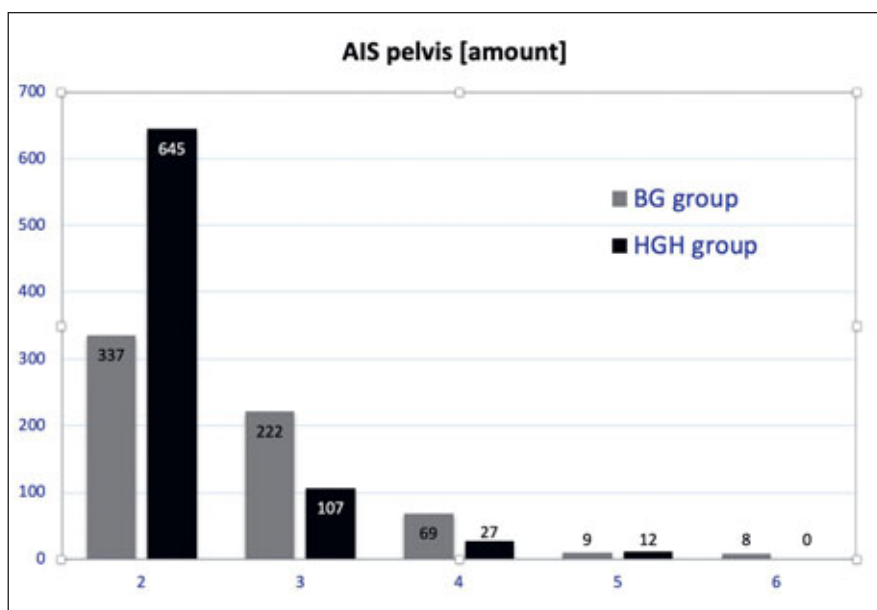


Fig. 1. Distribution of initial AIS as on presentation in trauma room.

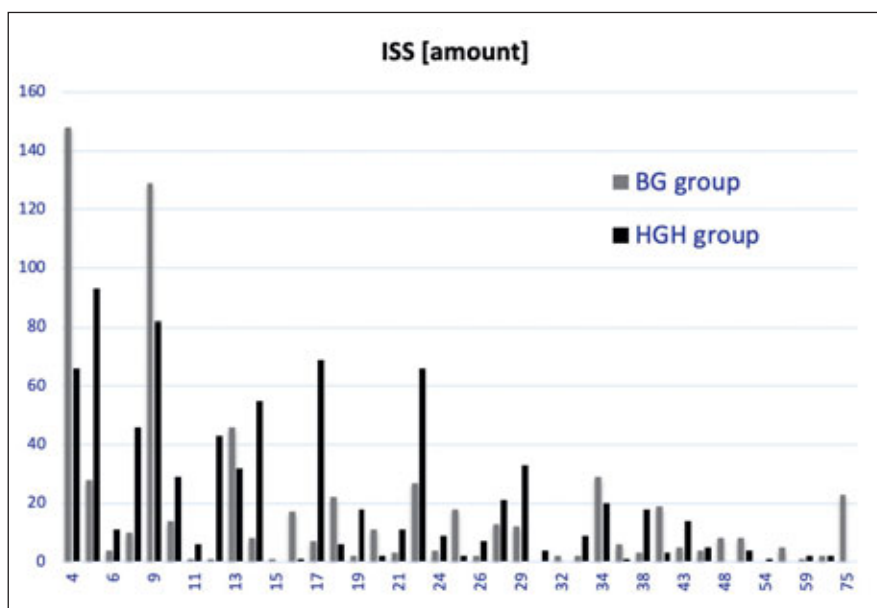


Fig. 2. Distribution of initial ISS as on presentation in trauma room.

Table 2. Complication rates

	BG group amount (ratio)	HGH group amount (ratio)	p-value
VAP	31 (4.8%)	56 (7.1%)	0.072
Acute kidney failure	22 (3.4%)	20 (2.5%)	0.324
ARDS	36 (5.6%)	14 (1.8%)	0.000
Sepsis	20 (3.1%)	26 (3.3%)	0.842

nificantly higher in the BG group than in the HGH group (5.6% vs. 1.8%,  $p<0.000$ ). There was no significant difference in the occurrence of VAP (BG group: 4.8% vs. HGH group 7.1%,  $p=0.072$ ), neither in the occurrence of acute kidney failure (3.4% vs. 2.5%,  $p=0.324$ ) nor in the occurrence of sepsis (3.1% vs. 3.3%,  $p=0.842$ ). The mean frequency of blood transfusion was significantly lower in the BG group than in the HGH group (28.8% vs. 39.2%,  $p<0.000$ ). The median number of transfused units per affected patient was significantly higher in the BG group (6 vs. 4,  $p<0.000$ ). Mortality was low in both centers and amounted for the BG group 4.3% and for the HGH group 4.9% ( $p=0.598$ ). Data are summarized in Table 2.

## DISCUSSION

Nearly 40 years after establishing the concept of ATLS, Mohammad et al. have shown in a review that ATLS significantly improves the knowledge of participants managing multiple trauma patients (16). To evaluate the efficacy of standardized approach in different settings, in this study large collections of pelvic injury patients with different epidemiologic data were compared. On the one side the population of the BG group was generally older and there was almost the same amount of male and female patients. On the other side, the population of the HGH group mainly consisted of young males. In accordance to the different groups, the main trauma mechanism causing pelvic fracture differs matching the structure of the population; the patients from the HGH group mainly suffered from a road traffic related, whereas patients from the BG group mainly fall related (not regarding the height of the fall). The reason for this may be given by age-dependent living conditions. Young males are overrepresented in road crashes around the world (1, 4, 22). As described in literature, mainly older people get actually injured following a fall from standing height (3, 25).

Despite the trauma mechanism an – although not significant – tendency to higher ISS values in the BG group could be found. Moreover, the average AIS pelvis was significantly higher in the BG group. Besides being hardly relevant from a clinical point of view, this difference is not solely explainable from the epidemiologic data. However, when regarding the classification of the injuries, patients in the BG group were more likely to suffer from a higher-level injury (B- or C-type) what may explain the higher values in the AIS. Regarding the higher proportion of potentially osteopenic patients (elder females), the probability for a more severe rated pelvic injury can be expected to be elevated as well.

Regarding the primary outcome parameter, the incidence of complications during the inpatient stay, no statistically significant difference in the complication rate could be found. To the best of our knowledge, this is the first study to explicitly examine the frequency of typical complications of prolonged bedridding and ICU treatment.

The major part of these complications is made up by pulmonary affections. In the BG group there were significant more cases with the diagnosis of ARDS during post-traumatic ICU treatment. Furthermore, patients of the BG group have received significant more blood transfusions when they received any. A correlation in this observation might be, that allogenic blood transfusions can lead to lung injury (19, 23). Acute kidney failure was low in both groups and much lower than reported rates in literature that go up to 50% in critically injured trauma patients (6, 7, 10). A reason for this discrepancy might be the inclu-

sion of more stable non-ICU patients in this study and the early use of fluid resuscitation in trauma patients according to the ATLS protocol. None of the patient was in need of dialysis. Sepsis was as well observed in frequencies comparable to those in literature (12, 13).

Regarding mortality the observed rates were comparable low with 4.3% and 4.9% respectively. Mortality rates of pelvic injuries vary in literature from comparable low rates up to around 60% mainly depending on accompanying injuries (2, 5, 8, 11, 20). In polytraumatized patients, overall mortality rates are reported around 20% in Germany (21). There are several studies showing the effect of optimizing trauma care in reduced mortality rates (14, 17, 18, 24). Regarding the fact, that in this analysis, all patients were included, not only the ones that met polytrauma criteria, the observed mortality rates seem reasonable.

## Limitations

One limitation is the retrospective design which might influence the generalizability of our results with some missing variables. Furthermore, preclinical data were not available from all patients, so there might be a bias due to limited data.

## CONCLUSIONS

With the comparison of two Level-1 Trauma centers in very different countries with a very different population, it was possible to demonstrate that by implementation of priority-based ATLS, strategies in trauma management. Morbidity and mortality could be kept comparably low in patients with traumatic pelvic injury.

## Abbreviations

ATLS	Advanced Trauma Life Support
ISS	Injury Severity Score
AIS	Abbreviated Injury Score
VAP	Ventilator Associated Pneumonia
ARDS	Acute Respiratory Distress Syndrome
ICU	Intensive Care Unit
CT	Computed Tomography

## Declarations

*Ethics approval was given by local ethics committees in Germany and Qatar as stated above. As analysis was anonymized and retrospective, individual consent of the patients was not necessary.*

*The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.*

*The authors declare that they have no competing interests.*

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*Author's contributions: HK wrote the manuscript, JD and FW gathered the data of BG patients, did the analysis and created figures, AEM, HA, AA, SIG, EB and HAT gathered data of HGH patients, BMW, PAG and MM supervised the study and proof-read the manuscript. All authors read and approved the final manuscript.*



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