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ORIGINAL PAPER

Age and "general health"—beside fracture classification—affect the therapeutic decision for geriatric pelvic ring fractures: a German pelvic injury register study

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Abstract

Purpose Pelvic ring fractures in the elderly gain increasing importance. Nonetheless, data on factors influencing treatment decision in relation to fracture classification, age, and the resulting treatment are still rare.

Methods Prospectively collected data of the German Pelvic Injury Registry from patients aged over 65 years with a pelvic ring fracture were evaluated retrospectively. Acetabular fractures, as well as type A1 and A3 fractures, were excluded. The variables age, injury pattern, type of treatment, the reason for conservative treatment, and Orthopaedic Trauma Association (OTA)/Tile classification were analyzed. Furthermore, the fracture distribution was examined after dividing patients into six age groups.

Results A total of 1814 patients with a mean age of 80.7 ± 7.6 years, predominantly female (79.0%), were available for evaluation. The majority of patients suffered from isolated pelvic ring fractures (70.1%) and 8.2% were severely injured (ISS > 16). The most common fracture types were type A2 (35.4%), type B2 (38.0%), and type C1 (7.3%). Especially pelvic ring fractures of type A2 (96.9%) and type B2 (83.0%) were treated conservatively (overall 76.9%). Fracture instability according to the OTA/Tile classification increased the probability for an operative treatment (generalized odds ratio [OR] 6.90 [5.62; 8.52]). In contrary, increasing age independent of the fracture pattern decreased this probability (OR 0.47 [0.41–0.53]). With increasing fracture instability, general health conditions were up to 50% of the reasons for conservative treatment.

Andreas Höch and Philipp Pieroh contributed equally to this work.

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Conclusion The results of the present study underline the importance of the factors age and general health besides fracture classification for therapeutic decision-making in the treatment of pelvic ring fractures in the elderly.

Keywords Pelvic fracture · Fragility fracture · Pelvis · Treatment · Epidemiology

Introduction

Pelvic ring fractures, reflecting an own entity of osteoporotic fractures common in a geriatric population [1], display an increasing incidence with higher age and enhanced mortality [1–3]. Currently, only a few population-based/multicentre studies exist analyzing injury severity, length of hospital stay, and mortality of elderly patients suffering from a pelvic ring fracture [2–6]. However, data influencing the surgeon's decision regarding a conservative or operative treatment like the fracture classification are still rare [7].

A recent study of the German Pelvic Injury Registry [8] yielded the following distribution of pelvic ring fractures according to the Orthopaedic Trauma Association (OTA)/Tile classification: 43.9% type A, 41.8% type B, and 14.3% type C, but subgroup analyses were not performed [8] which might be crucial, especially for type B fractures [9]. The authors report an overall increase of operatively treated patients over time, but less frequent operative treatments in patients with higher age, even if a similar fracture pattern was present [8]. One reason might be the associated morbidity and mortality with increasing age compared with younger patients [5, 10–13]. The present study was carried out to determine the fracture patterns and related therapeutic decision as well as causes for conservative treatment. Our hypothesis was that classification, general health, and age determine the therapeutic decision as independent factors and in combination.

Materials and methods

The present study was approved by the local ethics committee (151/17-ek).

Patients and methods

The German Pelvic Trauma Registry represents a multicenter registry and was developed by the pelvic injury work group of the German Society of Traumatology (Deutsche Gesellschaft fuer Unfallchirurgie, DGU) and the German section of AO International in 1991 to prospectively collect anonymized in-hospital data of patients suffering from a pelvic fracture. From this registry with 30 participating hospitals, data of the period from January 2010 to December 2014 were investigated (Fig. 1). Data sets from patients aged ≥ 65 years suffering from pelvic ring fractures were analyzed. In the present study, the OTA/Tile classification was used [14]. In this classification, the following fracture types are distinguished: type A (stable pelvic ring fractures without affection of the posterior pelvic ring), type B (partially unstable with affection of the posterior pelvic ring, rotational instability, vertical stable), type C (unstable with affection of the posterior pelvic ring, rotational and vertical instability). Patients with type A1 or A3 pelvic ring fractures, acetabular fractures, or combined pelvic ring and acetabular fractures, as well as data sets with incomplete records, implausible, or incorrect values, were excluded. Data of 1814 patients were available for evaluation from ten level 1 trauma centers. Seven items were exported to Microsoft Excel (Microsoft Corp, Redmond, WA) from the original data for further evaluation: gender, age, injury pattern (isolated/accompanied injuries/polytrauma), treatment (conservative/operative), reasons for conservative treatment ("general health"/polytrauma/stable/minimal dislocated/other/unknown), OTA/Tile classification, and the presence of a complex pelvic fracture (yes/no). A complex pelvic fracture was defined as pelvic fracture with accompanied pelvic soft tissue injuries (open fracture, Morel-Lavallee´ lesion, lesions of pelvic vessels including retroperitoneal haematoma), urogenital injuries, or neurological deficits related to the pelvic ring fracture [15]. The frequencies and reasons of conservative treatment in relation to the fracture classification and previously used age groups (65–69 years; 70–74 years; 75–79 years; 80–84 years; 85–89 years; > 90 years [2]) were determined to investigate their dependency in decision-making regarding a conservative treatment.

Statistical analyses

IBM® SPSS® Statistics for Windows (version 24.0, Armonk, NY, IBM Corp. USA) was used for statistical analyses. Data are presented as mean ± standard deviation (SD); for non-Gaussian distributed data, the range was included. Gaussian distribution was examined using the Shapiro-Wilk test. For all statistical investigations comparing conservative and operative treatment, a non-Gaussian distribution was revealed. Generalized odds ratios (OR) were calculated using a previously established approach [16]. For calculation of confidence intervals, a boot-strapping approach was used. OR and confidence intervals were determined using specific MatLab scripts (MATLAB, Version 2013b, MathWorks, Natick, Massachusetts, USA).

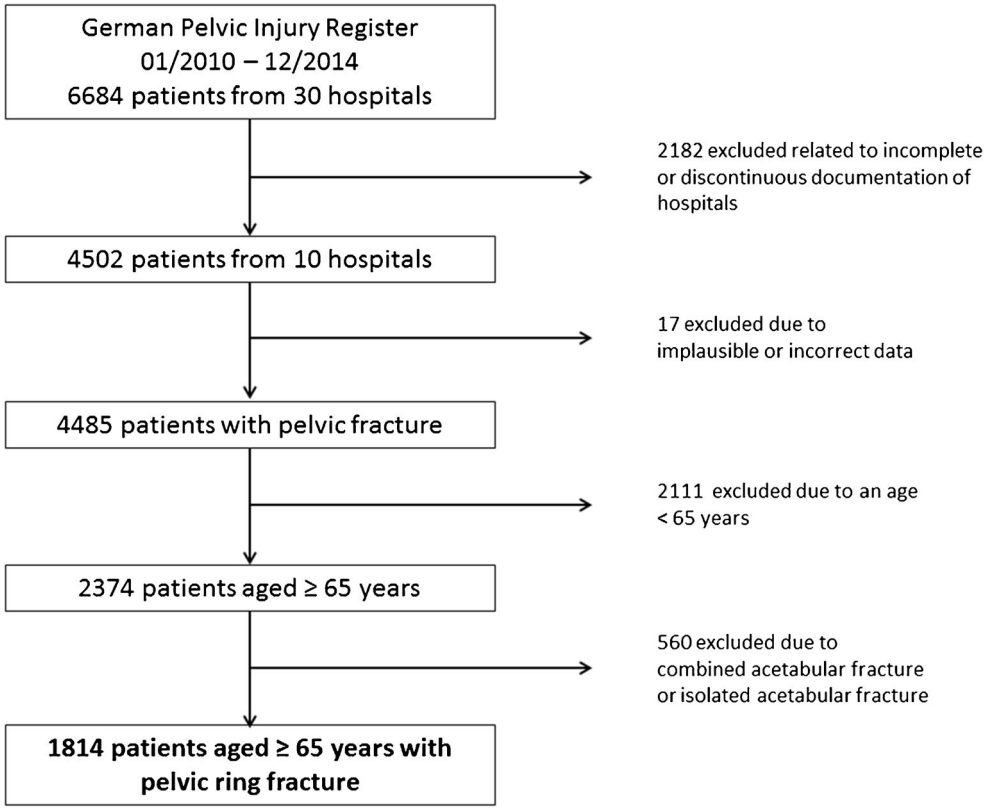

Fig. 1 Study protocol. From the German Pelvic Injury Registry data between 01/2010 and 12/2014 were evaluated. Incomplete, incorrect, or implausible data, and data from patients aged < 65 years, as well as patients suffering from an acetabular, combined acetabular, and pelvic ring fracture or type A1 or A3 fractures were excluded

Results

Epidemiology (Table 1)

The 1814 patients revealed a mean age of 80.7 ± 7.6 years and were predominantly female (79.0%). A total of 1271 patients yielded an isolated pelvic ring injury (70.1%), whereas 394 patients displayed accompanied injuries (20.7%) and 149 patients were severely injured (8.2%) (Table 1). Fracture distributions for the predefined age groups are summarized in Fig. 2.

Isolated sacral fractures were recorded in 63 patients (3.5%). Here, 27 Denis I, 13 Denis II, and 23 Denis III fractures were detected. According to the OTA/Tile classification, the majority of fractures were classified as type A2 ($n = 643$, 35.4%) and type B2 ($n = 689$, 38.0%). Of A2 fractures, 34 patients had an iliac wing fracture (A2.1; 5.3%), 574 patients a unilateral pubic rami (A2.2; 89.3%), and 35 patients a

Table 1 Baseline data (gender, age, injury pattern [i = isolated pelvic fracture; a = accompanied injuries; m = multiple injured]), the frequency of complex fracture, and conservative treatment in relation to the fracture classification (OTA/Tile)

Fracture type	Number [*n* (%)]	Gender [female /male]	Age [years, mean ± SD (range)]	Injury pattern [*n* (%)]			Complex fracture [*n* (%)]	Conservative treatment [*n* (%)]
				i	a	m		
Overall	1814 (100.0)	1433/381	80.7 ± 7.6 (65–103)	1271 (70.1)	394 (21.7)	149 (8.2)	50 (2.8)	1395 (76.9)
Isolated sacral fracture	63 (3.5)	47/16	78.8 ± 7.5 (66–93)	44 (69.8)	18 (28.6)	1 (1.6)	1 (1.6)	41 (65.1)
OTA type A2	643 (35.4)	518/125	81.8 ± 7.6 (65–99)	459 (71.4)	155 (24.1)	29 (4.5)	8 (1.2)	623 (96.9)
OTA type B1	64 (3.5)	42/22	79.2 ± 8.4 (65–96)	41 (64.1)	11 (17.2)	12 (18.8)	6 (9.4)	35 (54.7)
OTA type B2	689 (38.0)	569/120	81.3 ± 7.6 (65–103)	487 (70.7)	155 (22.5)	47 (6.8)	13 (1.9)	572 (83.0)
OTA type B3	91 (5.0)	72/19	78.9 ± 6.9 (65–99)	69 (75.8)	16 (17.6)	6 (6.6)	1 (1.1)	48 (52.7)
OTA type C1	132 (7.3)	91/41	77.8 ± 7.0 (65–96)	76 (57.6)	23 (17.4)	33 (25.0)	8 (6.1)	41 (31.1)
OTA type C2	49 (2.7)	33/16	77.8 ± 7.4 (65–91)	33 (67.3)	6 (12.2)	10 (20.4)	9 (18.4)	8 (19.5)
OTA type C3	83 (4.6)	61/22	78.6 ± 6.8 (66–96)	62 (74.7)	10 (12.0)	11 (13.2)	4 (4.8)	27 (32.5)

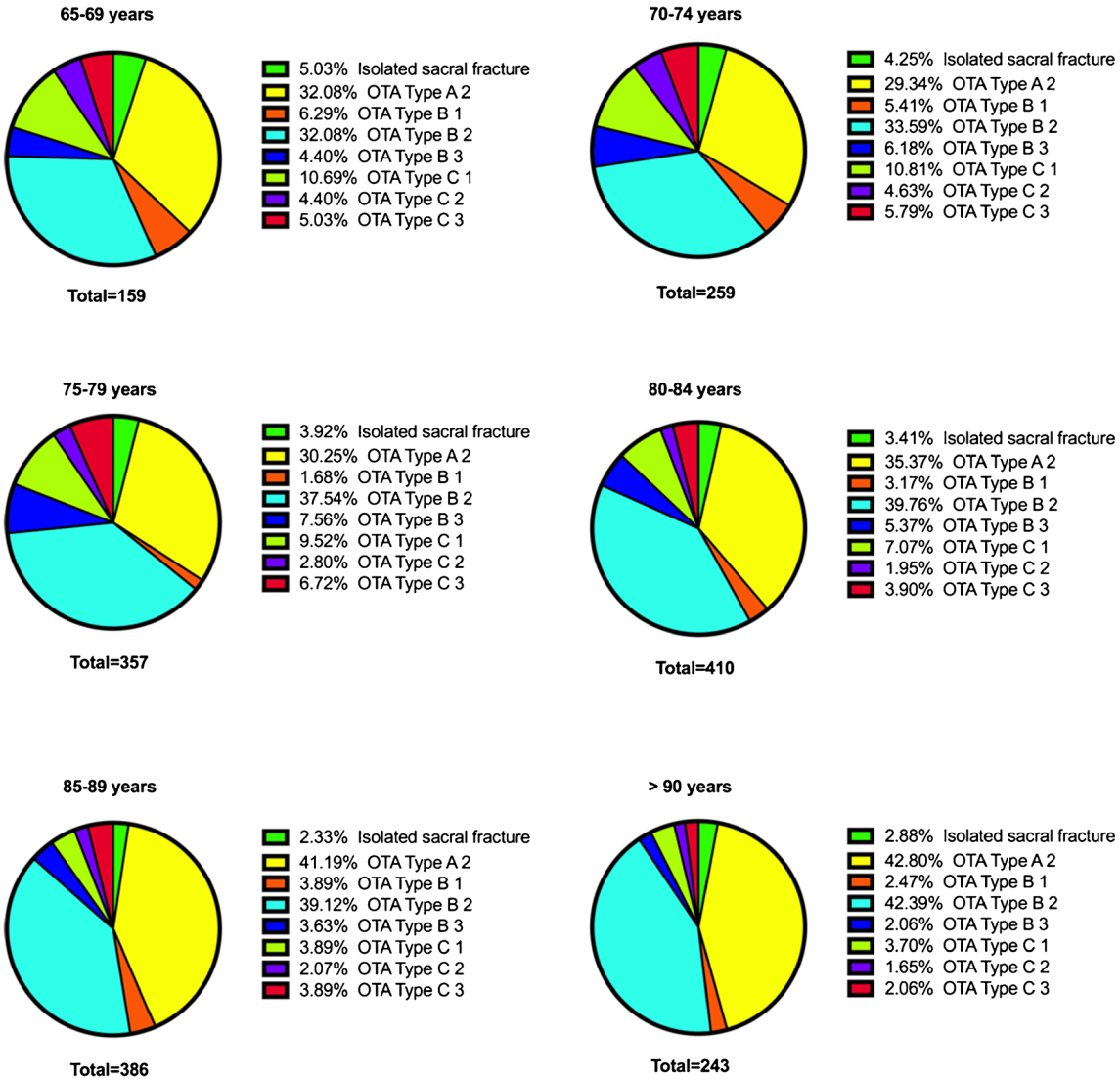

Fig. 2 Distribution of patients by fracture type within the predefined age groups [2]

bilateral pubic rami fracture (A2.3; 5.4%). The remaining fracture types displayed a frequency of less than 10% of the overall study cohort. A complex pelvic fracture was detected in 50 patients (2.8%). For isolated sacral fractures as well as for fractures of the OTA/Tile type A2, B1, B2, and B3, at least half of the patients were treated conservatively. For fractures of the OTA/Tile type C, operative treatment was preferred.

Impact of fracture classification and age on the treatment decision

With increasing age, the patients were more frequently treated conservatively independent of the fracture type (Fig. 3, Supplementary Table 1). Except for the age group 85–89 years, the majority of sacral fractures were treated conservatively independent of the patient's age. For stable pelvic ring fractures according to the OTA/Tile classification (type A), no differences regarding treatment decision in relation to the patient's age were found (> 90% conservatively treated). Pelvic ring fractures of type B, partially unstable according to the OTA/Tile classification, were more frequently treated conservatively with increasing age.

With regard to the fracture subtype, B2 fractures independent of the age group were treated conservatively, and only a slight increase of conservative treatment with increasing age was determined.

In contrast, B1 and B3 fractures until the age of 80 years were predominantly treated operatively. However, in the older age groups, even these fractures were treated in majority conservatively. Even for unstable type C fractures, the amount of conservatively treated patients increased with a higher patient's age independent of the fracture subtype.

With increasing fracture instability (A to C) according to the OTA/Tile classification, the probability for an operative treatment increased (OR 6.90 [5.62; 8.52]). On the

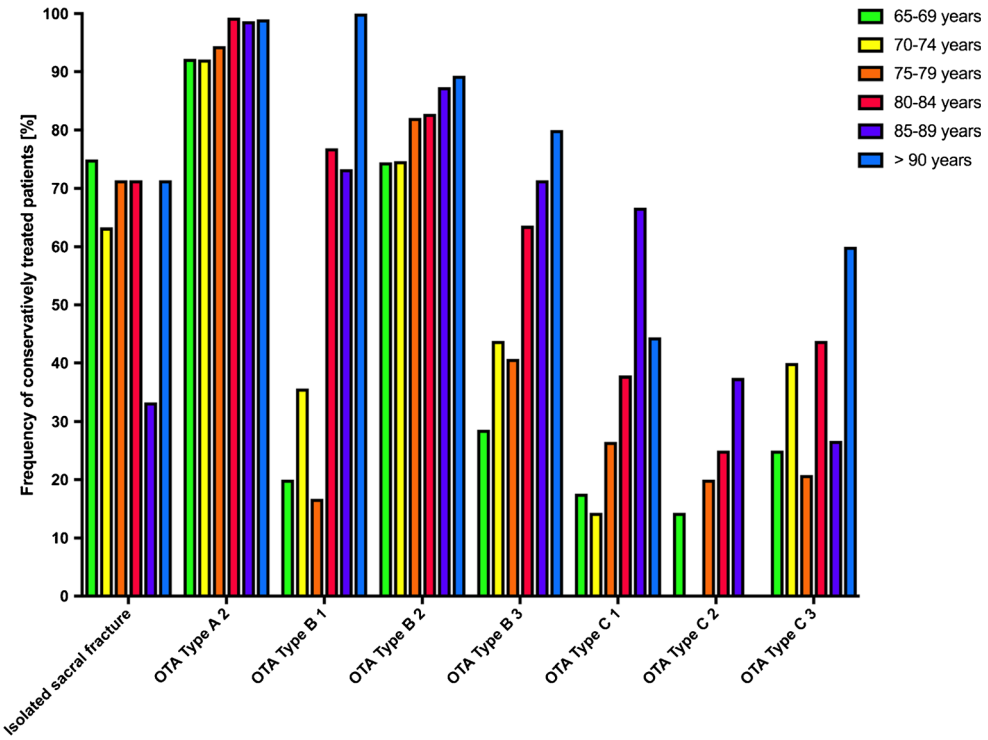

Fig. 3 Distribution of patients and the frequency of conservative treatment stratified by fracture type and predefined age groups [2]

other hand, with increasing age, the decision for an operative treatment decreased independently of the fracture type (OR 0.47 [0.41; 0.53]).

Reasons for conservative treatment (Table 2)

The majority of patients were treated conservatively (n = 1395, 76.9%), with the highest percentage for fracture subtypes A2 (n = 623, 96.9%) and B2 (n = 572, 83.0%). Both fracture subtypes together represent 73% of the study population and 85.7% of all conservatively treated patients. Reasons for conservative treatment are summarized in Table 2. A stable fracture pattern (64.5%) and/or a minimal fracture displacement (21.5%) were reported as a cause for conservative treatment (predominantly A2, B1, B2, B3, and isolated sacral fracture types). In almost every 10th case, "general health"(9.5%) was stated as the reason. For fractures of types A2, B1, B2, and isolated sacral fractures, "general health" was less often cited as an impediment (< 15%). With increasing fracture instability based on the OTA/Tile classification, the "general health" became more frequently stated. Especially for type C fractures, the frequency raised to 50%. Reasons such as unknown, polytrauma, and others were named less than 10%.

Discussion

The present data revealed that pelvic ring fractures of the subtype A2 and B2 are most frequent in the elderly. Apart from the fracture classification, patient's age and their "general health" influence the treatment decision pro or contra an operative treatment.

Elderly patients suffering from a pelvic ring fracture become a growing group of patients requiring specific and precise therapeutic decisions, especially considering the risks of operative treatment [5, 17–19]. Analyzing elderly patients aged > 65 years after high-energy trauma revealed predominantly type B fractures (87.1%), followed by type A fractures (10%) [13]. In the study of Clement et al. [17], type A fractures were predominantly found, whereas Henry et al. [20] determined the type B2.1 as dominating fracture type. In the present study, both fracture types were represented with similar frequencies. Recent studies showed the neglect of posterior pelvic ring injuries using solely plain radiographs, in contrast to additional CT investigations, which result in a significant upgrade of fracture classification [21]. Probably therefore, the frequency of type A fractures (e.g., isolated fractures of the pubic rami) was markedly lower in studies performing a CT scan routinely for pelvic ring fractures in the elderly [22, 23].

Our study supports the observation of Verbeek et al. [5] that patients with a geriatric pelvic ring fracture are less severely injured compared with younger patients. Moreover, only in 2.8% of patients, a complex pelvic fracture was observed. This frequency is lower compared with previous reports of the German Pelvic Injury Registry (8.2–11.4%) investigating patient data independent of age [10].

Table 2 Reasons for conservative treatment in relation to the fracture type according to OTA/Tile classification

Type of fracture	Isolated sacral fracture	OTA type A2	OTA type B1	OTA type B2	OTA type B3	OTA type C1	OTA type C2	OTA type C3	Overall
n	41	623	35	572	48	41	8	27	1395
Reasons for conservative treatment									
[*n* (%)]	5 (12.2)	10 (1.6)	3 (8.6)	9 (1.6)	3 (6.3)	4 (9.8)	-	1 (3.7)	35 (2.5)
Unknown	3 (7.3)	12 (1.9)	-	67 (11.7)	14 (29.2)	17 (41.5)	4 (50.0)	14 (51.9)	131 (9.4)
General health	-	1 (0.2)	2 (5.7)	2 (0.3)	1 (2.1)	4 (9.8)	-	2 (7.4)	12 (0.9)
Polytrauma	7 (17.1)	100 (16.1)	16 (45.7)	163 (28.5)	9 (18.8)	2 (4.9)	-	3 (11.1)	300 (21.5)
Minimal fracture displacement	26 (63.4)	498 (79.9)	14 (40.0)	324 (56.6)	18 (37.5)	10 (24.4)	4 (50.0)	6 (22.2)	900 (64.5)
Stable fracture	-	2 (0.3)	-	7 (1.2)	3 (6.3)	4 (9.8)	-	1 (3.7)	17 (1.2)
other									

The frequency of operatively treated patients suffering from a pelvic ring fracture increased during recent years [8]. Compared with the data of Rollmann et al. [8], we determined a slightly lower shift from conservative to operative treatment of OTA/Tile type C fractures. In contrast to previous studies reporting a conservative treatment of type B fractures in 64.5% [8], in the present study, the rate was higher for type B2 fracture (83%) and lower for the types B1 (45.3%) or B3 (47.3%) fractures. This difference might be related to the differentiation of fracture subtypes. Even prior, a decrease of operative treatment was associated with higher age [8]. This decrease was not solely found for B2 fractures and pronounced for type B1 and B3 fractures, indicating the need for differentiation between these fracture subtypes [8]. Although we did observe a slight decrease for the operative treatment of type C fractures, especially in the age group > 85 years, this observation was pronounced for type C1, whereas C2 and C3 yielded alternating treatment frequencies with increasing age. The decline of the operative treatment might be related to the reported increase in mortality with higher age [5, 11]. However, mobilization should be possible and was recently discussed as decisive for increased survival following operative therapy [24]. Currently, there are studies favoring operative treatment even for stable fractures [18, 25] and highlight their specific benefits, but no distinct treatment strategy is available. Although operatively treated patients yielded a higher complication rate, their two year mortality was lower [18].

In a previous study, using the German Pelvic Injury Registry, higher age was associated with increasing mortality [10] and Verbeek et al. [5] determined an age > 65 years as a most significant predictor for in-hospital mortality. The mortality rate for patients older than ≥ 70 years is fourfold higher compared with younger patients [11]. This might explain that we observed an increase for conservative treatment with increasing age independent of the fracture type, which also might be caused by comorbidities frequently seen in elderly patients as compared with younger patients [12, 13]. Recently, scores evaluating comorbidities like the Charlson Comorbidity Index or American Society of Anesthesiologists (ASA) score were identified as predictors for mortality [12, 13]. Hence, the influence of the "general health" was probably suggested as a factor influencing the decision for an operative treatment [8]. For fracture types A and B, stable or a minimally fracture displacements were stated as reasons for conservative treatment. In contrast, for unstable type C fractures, the reason for conservative treatment in at least 40% of the patients was "general health". Nevertheless, apart from the present study, this aspect was not investigated previously in terms of the surgeon's decision-making.

Limitations and strengths

The present results are limited due to the missing definition of the "general health" or its quantitative measurement, for example, by the Charlson Comorbidity Index [13]. Moreover, only patients requiring hospitalization in one of the participating trauma centres, specialized in pelvic fracture care, were included. Here, it should be emphasized that only level 1 trauma centres participated, possibly leading to a higher incidence of more unstable and surgically treated pelvic ring fractures which may not representatively reflect the whole population. Furthermore, the sample size investigating fracture subgroups with an additional separation to age groups is small.

Possibly, the study might have gained an advantage by the use of the fragility fracture of the pelvis (FFP) classification because here the changes of fracture morphology and the fracture dynamics are more specifically considered [22]. However, the start of the study was before the introduction of this classification and thus its application was not possible.

On the other hand, the use of the German Pelvic Injury Registry ensures evaluation of patients suffering from a pelvic ring injury and the coding of fracture types as well as reasons of decision-making pro or contra for a conservative/operative treatment by experienced pelvic surgeons [5, 26]. However, due to the missing data on the outcome of the patients, the presented data solely show the current strategy of German orthopaedics but cannot be used to determine treatment recommendations. Therefore, prospective trials are required.

Conclusion

The present study highlights the dominance of the fracture types A2 and B2 in the elderly as well as their predominantly conservative treatment. Furthermore, the data underline the decrease of operative treatment the older the patients are, possibly caused by accompanied comorbidities. The results report the influence of the "general health" and age on the therapeutic decision-making, especially for type C fractures. In this line, further studies should discuss the factors influencing the surgeon's therapeutic decision apart from the fracture classification more detailed.

Authors' contributions Conceived and designed the study: AH, PP, CJ, and FMS
Data acquisition: AH, FG, SM, FH, HK, HGP, SCH, HS, and FMS
Analyzed the data: AH, PP, TH, CJ, and FMS
Wrote and draft the paper: AH, PP, FG, HS, and FMS
Approved the final version of the manuscript: AH, PP, FG, TH, SM, FH, HK, HGP, SCH, HS, CJ, and FMS

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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