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**Original Article**

# Demographic and clinical profiles of elementary versus associated acetabular fractures: insights from a single-center study

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## Abstract

**Background:** Acetabular fractures present a complex spectrum of injuries, often categorized as simple (elementary) or associated (complex) based on the Judet and Letournel classification. Understanding whether this morphological distinction correlates with demographic or perioperative clinical parameters remains an area of active investigation. **Methods:** This retrospective study included 51 patients who underwent surgical treatment for acetabular fractures at our institution. Patients were grouped as elementary or complex based on fracture type. Demographic data, injury mechanism, operative time, hemoglobin change, transfusion requirements, intensive care unit (ICU) admission, hospital stay duration, and presence of concomitant injuries were recorded and compared between groups. **Results:** Of the 51 patients, 31 (60.8%) had elementary fractures and 20 (39.2%) had complex fractures. The mean age, injury mechanism, operative time, hemoglobin change, transfusion needs, and presence of concomitant injuries did not significantly differ between the two groups ($p < 0.05$). However, patients with complex fractures had a significantly longer hospital stay and higher ICU admission rates ($p < 0.05$). Concomitant injuries were observed in 56.9% of all patients, with similar distribution across fracture types. **Conclusions:** While elementary and complex acetabular fractures share similar demographic and perioperative profiles in terms of trauma mechanism, age, and operative parameters, complex fractures are associated with increased postoperative care requirements, including longer hospitalizations and greater ICU utilization. These findings suggest that fracture morphology itself may influence early postoperative outcomes independently of classic trauma severity indicators.

**Keywords:** Acetabular fracture, demographic data, elementary acetabular fractures, associated acetabular fractures, intensive care

## Introduction

Acetabular fractures are complex injuries often associated with high-energy trauma, particularly in younger adults, while in elderly patients they typically result from low-energy mechanisms [1,2]. This bimodal distribution highlights the clinical relevance of acetabular fractures across a broad age spectrum [1,2]. The age-adjusted incidence of acetabular fractures has been reported to be approximately 40 per 100,000 person-years, with 36 cases in women and 51 in men [3]. In addition to its rising incidence, the rates of hospital admission and surgical intervention have also been steadily increasing [4,5].

To guide treatment strategies and improve outcome prediction, Judet and Letournel introduced a widely adopted classification system for acetabular fractures based on the columnar anatomy of the pelvis [6]. According to this system, the acetabulum is supported by anterior and posterior columns, which also define the anterior and posterior walls as their respective rims [6]. A column fracture is considered a complete structural injury, whereas a wall fracture is classified as incomplete [6]. Based on these principles, acetabular fractures are categorized into two major groups: elementary (simple) and associated (complex) types [6]. Elementary fractures include anterior wall, posterior wall, anterior

 

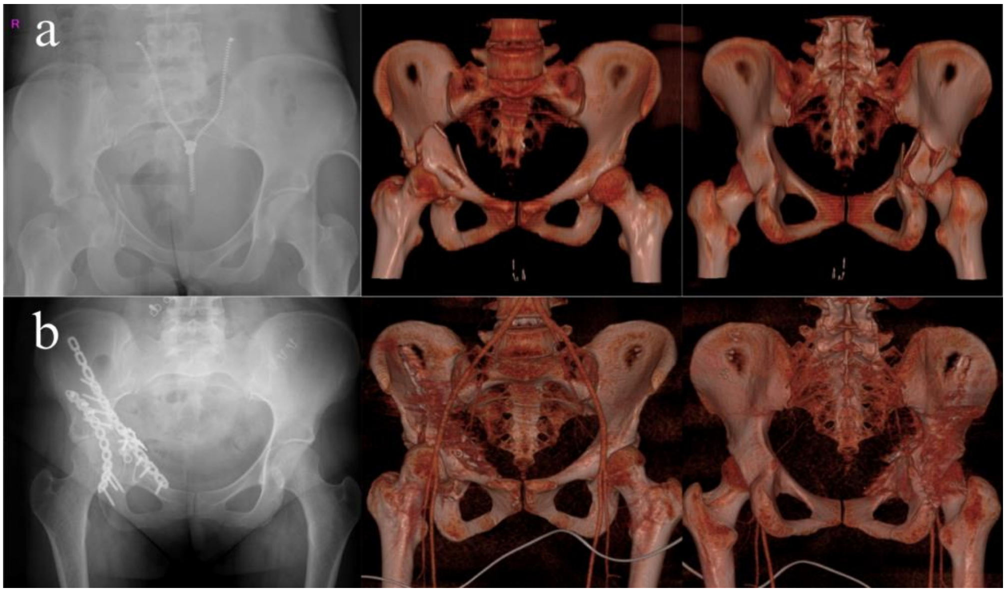


**Figure 1.** A 28-year-old female patient with an anterior column-posterior hemitransverse acetabular fracture, a subtype of complex fracture, resulting from a high-energy motor vehicle accident. **a.** Preoperative pelvic anteroposterior (AP) radiograph and 3D computer tomography (CT) reconstructions (anterior and posterior views) demonstrating fracture configuration and displacement. **b.** Postoperative pelvic AP radiograph and 3D CT reconstructions (anterior and posterior views) illustrating the achieved anatomical surgical fixation.

column, posterior column, and transverse fractures—typically two-part injuries involving a single structure [6]. In contrast, associated fractures consist of combinations of elementary patterns and involve at least three major fracture fragments, such as posterior column with posterior wall, anterior column with posterior hemitransverse, transverse with posterior wall, T-type, and both-column fractures [6] (Figure 1). Although ten distinct fracture types are defined, more than 90% of acetabular fractures fall into five common patterns: associated both-column, T- type, transverse, transverse with posterior wall, and elementary posterior wall fractures [6–8]. Despite the widespread adoption of the Judet and Letournel classification in both clinical and academic settings, the existing literature has largely focused on evaluating individual fracture types rather than comparing broader fracture groups [9–12]. Although many studies have attempted to analyze acetabular fractures in isolation, the clinical and perioperative differences between elementary and complex fracture patterns have not been fully elucidated.

The aim of this study is to compare the demographic characteristics and perioperative clinical parameters of patients undergoing surgical treatment for elementary and complex acetabular fractures, as defined by the Judet and Letournel classification. We hypothesize that complex acetabular fractures are associated with longer operative times, greater perioperative blood loss, higher transfusion requirements, and increased postoperative care needs compared to elementary fractures.

## Materials and methods

This retrospective observational cohort study was conducted at Kayseri City Hospital, a trauma center, between January 2016 and January 2025. A total of 51 patients who underwent surgical treatment for acetabular fractures were included. Patients aged 18 years or older with a confirmed diagnosis of acetabular fracture, complete preoperative imaging and clinical data, and who underwent operative treatment at our center were eligible for inclusion. Patients were excluded if they had pathological fractures, incomplete records, conservative management, were younger than 18 years, or were lost to follow-up. Demographic and clinical data including age, sex, mechanism of injury, fracture type, intensive care unit (poICU) admission, and hospital stay were extracted from electronic medical records. Fracture classification was performed according to the Letournel and Judet system, based on radiographic and intraoperative findings.

Patients were categorized into two groups based on the Judet and Letournel classification system: elementary fractures and complex (associated) fractures. Comparative analyses were performed between these two groups to evaluate differences in demographic characteristics (e.g., age, sex, mechanism of injury) and perioperative clinical parameters, including operative time, hemoglobin drop, transfusion requireme0 Jnt, estimated blood loss, ICU admission, and length of hospital stay.

Postoperative computed tomography (CT) images were reviewed for assessment of reduction quality. Step-off and gap measurements were obtained from the most displaced axial or coronal slices. Reduction was categorized as anatomical (< 2 mm) or non-anatomical (≥ 2mm) based on established criteria. All evaluations were independently performed by two senior orthopedic trauma surgeons. In the event of any discrepancies, a third senior surgeon was involved to resolve conflicts and establish consensus.

Operative duration (in minutes) and intraoperative blood loss were recorded from surgical reports. Hemoglobin (Hb) levels were documented preoperatively and at 24 hours postoperatively, and the hemoglobin drop (ΔHb) was calculated. Total blood loss was estimated as: (ΔHb + number of transfused units) × 400 mL, where each transfused unit was approximated as 400 mL of blood volume. The study protocol was approved by the Clinical Research Ethics Committee of the University of Health Sciences, Kayseri City Training and Research Hospital. All procedures were conducted in accordance with the principles of the Declaration of Helsinki. This study adhered to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) reporting guidelines.

### Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics for Mac, Version 28.0 (IBM Corp., Armonk, NY, USA). Continuous variables were tested for normality using the Kolmogorov–Smirnov and Shapiro–Wilk tests. Normally distributed variables were compared using independent-samples t-tests, while non-normally distributed variables were analyzed using the Mann–Whitney U test. Categorical variables were compared using Pearson's Chi-square test or Fisher's exact test, as appropriate. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to assess the strength of associations between categorical variables. Effect sizes for continuous variables were reported using Cohen's d. A p-value < 0.05 was considered statistically significant.

## Results

A total of 51 patients who underwent surgical treatment for acetabular fractures between 2016 and 2025 were included in the study. The mean age of the cohort was 40.0 ± 16.1 years (range: 19–72 years), and the majority were male (76.5%, n = 39). The most common mechanism of injury was traffic accidents (68.6%), followed by falls from height (29.4%) and occupational accidents (2%). Concomitant injuries were observed in more than half of the patients (56.9%), including 58.1% in the elementary fracture group and 55.0% in the complex fracture group. These injuries consisted of various associated traumas such as thoracic, abdominal, cranial, and additional skeletal injuries. The mean follow-up period was 9.37 ± 7.5 months (range: 1–37), and the mean length of hospital stay was 10.78 ± 5.3 days (range: 3–29). ICU admission was required in 52.9% of patients (n = 27), with a mean ICU stay of 5.04 ± 4.3 days (range: 1–15). Preoperative neurological deficits were identified in 9.8% of cases (n = 5). Among patients with elementary fractures (n = 31), the most common fracture pattern was posterior wall (61.3%, n = 19), followed by anterior column (19.3%, n = 6), posterior column (12.9%, n = 4), and transverse fractures (6.5%, n = 2). In the complex fracture group (n = 20), anterior column with posterior hemitransverse fractures were the most frequent (40.0%, n = 8), followed by transverse with posterior wall involvement (35.0%, n = 7), and both-column fractures (25.0%, n = 5). Postoperative CT scans revealed anatomical reduction in 80.4% of patients (n = 41). Regarding surgical approach, the Kocher-Langenbeck approach was most commonly used (54.9%, n = 28), followed by the modified Stoppa approach (33.3%, n = 17) and the ilioinguinal approach (11.8%, n = 6). The overall mean preoperative hemoglobin level was 13.51 ± 1.53 g/dL (range: 10.2–17.1), while the mean postoperative hemoglobin was 11.4 ± 1.16 g/dL (range: 9.1–13.9), yielding a mean ΔHb of 2.1 ± 1.6 g/dL (range: –2.4 to 7.2). The mean number of transfused red blood cell units was 1.67 ± 1.5 (range: 0–7), and the estimated mean total blood loss was 1512 ± 847 mL (range: 320–3680). No patient in the cohort required transfusion due to vascular injury. Transfusion needs were based on estimated perioperative blood loss. The average operative time was 154 ± 60 minutes (range: 90–385).

The mean age was slightly higher in the complex fracture group (42.30 ± 16.27 years) than in the elementary group (38.52 ± 16.07 years); however, this difference was not statistically significant (mean rank: 28.30 vs. 24.52, p = 0.375, Mann–Whitney U test). The presence of concomitant injuries was evaluated in relation to fracture type. In the elementary fracture group, 58.1% of patients had concomitant injuries, compared to 55.0% in the complex fracture group. Although the rate was slightly higher in the elementary group, the difference was not statistically significant (p = 0.829, Chi-square test; p = 1.000, Fisher's Exact Test). Preoperative hemoglobin levels were also slightly higher in the complex group (13.92 ± 1.55 g/dL) compared to the elementary group (13.24 ± 1.49 g/dL), though not statistically significant (t(49) = –1.557, p = 0.126). Similarly, postoperative hemoglobin levels were 11.60 ± 1.09 g/dL and 11.27 ± 1.20 g/dL in the complex and elementary groups, respectively (t(49) = –0.983, p = 0.331). The mean ΔHb was greater in the complex group (2.32 ± 1.50 g/dL) than in the elementary group (1.97 ± 1.68 g/dL), though this difference was not significant (mean rank: 28.28 vs. 24.53, p = 0.380, Mann–Whitney U test). There were no significant differences between the groups in transfusion requirement (mean rank: 27.73 vs. 24.89, p = 0.487), estimated total blood loss (mean rank: 27.93 vs. 24.76, p = 0.457), or operative time (mean rank: 29.03 vs. 24.05, p = 0.242), based on Mann–Whitney U tests. A higher proportion of patients with elementary fractures achieved anatomical reduction compared to those with complex fractures (87.1% vs. 70.0%), though this difference did not reach statistical significance (p = 0.133, Chi-square test; p = 0.163, Fisher's exact test). Among patients requiring ICU care, 55.6% had complex fractures, whereas only 20.8% of those without ICU admission had complex fractures. This association was statistically significant (odds ratio [OR] = 4.75, 95% confidence interval [CI]: 1.37–16.47; p = 0.021, Fisher's exact test), indicating that fracture complexity may increase the likelihood of postoperative ICU admission. Although the mean ICU stay was longer in the elementary fracture group (5.58 ± 4.80 days) compared to the complex group (4.60 ± 4.10 days), the difference was not statistically significant (mean rank: 15.08 vs. 13.13, p = 0.548, Mann–Whitney U test). Although some patients had additional comorbidities, ICU admission was primarily determined by surgical factors and fracture complexity rather than medical history. The time from hospital admission to surgery was longer in the complex group (mean rank: 29.95) than in the elementary group (23.45), although this difference was not significant (p = 0.120). In contrast, the length of hospital stay was significantly greater in the complex fracture group (mean rank: 32.28) compared to the elementary group (21.95, p = 0.015). The effect size, calculated using Cohen's d, was 0.70, indicating a moderate to large effect. These findings suggest that increased fracture complexity may be associated with prolonged hospitalization, possibly due to greater surgical burden, more intensive perioperative management, or elevated complication risk (Table 1).

## Discussion

This retrospective cohort study evaluated the demographic and clinical differences between elementary and complex acetabular

**Table 1.** Demographic and clinical characteristics of patients with elementary and complex acetabular fractures.

| Variable | Total (n = 51) | Elementary (n = 31) | Complex (n = 20) | p-value |
|---|---|---|---|---|
| Age, years (mean ± SD) | 40.0 ± 16.1 | 38.52 ± 16.07 | 42.30 ± 16.27 | 0.375* |
| Male sex, n (%) | 39 (76.5) | 23 (74.2) | 16 (80.0) | 0.633¥ / 0.743§ |
| Traffic accident, n (%) | 35 (68.6) | 20 (64.5) | 15 (75.0) | 0.446¥ |
| Concomitant Injury, n (%) | 29 (56.9) | 18 (58.1) | 11 (55) | 0.829¥ / 1.000§ |
| Time to Surgery, days (mean ± SD) | 3.02 ± 2.17 | 2.77 ± 2.26 | 3.40 ± 2.03 | 0.120* |
| Hospital stay, days (mean ± SD) | 10.78 ± 5.3 | 9.39 ± 4.45 | 12.95 ± 6.03 | 0.015* |
| ICU admission, n (%) | 27 (52.9%) | 12 (38.7%) | 15 (75.0%) | 0.011¥ / 0.021§ |
| ICU stay, days (mean ± SD) | 5.04 ± 4.3 | 5.58 ± 4.80 | 4.60 ± 4.10 | 0.548* |
| Preop Hb, g/dL (mean ± SD) | 13.51 ± 1.53 | 13.24 ± 1.49 | 13.92 ± 1.55 | 0.126¤ |
| Postop Hb, g/dL (mean ± SD) | 11.4 ± 1.16 | 11.27 ± 1.20 | 11.60 ± 1.09 | 0.331¤ |
| ΔHb, g/dL (mean ± SD) | 2.1 ± 1.6 | 1.97 ± 1.68 | 2.32 ± 1.50 | 0.380* |
| Transfusions, units (mean ± SD) | 1.67 ± 1.5 | 1.65 ± 1.60 | 1.70 ± 1.20 | 0.487* |
| Estimated blood loss, mL (mean ± SD) | 1512 ± 847 | 1449 ± 857 | 1610 ± 843 | 0.457* |
| Operative time, min (mean ± SD) | 154 ± 60 | 149 ± 62 | 161 ± 57 | 0.242* |
| Anatomical reduction, n (%) | 41 (80.4%) | 27 (87.1%) | 14 (70.0%) | 0.133¥ / 0.163§ |

*Mann–Whitney U test, ¥Pearson's Chi-square test, §Fisher's exact test, ¤Independent-samples t-test

fractures in a cohort of surgically treated patients. While no significant differences were observed between the two groups regarding age, sex distribution, injury mechanism, pre- and postoperative hemoglobin levels, estimated blood loss, transfusion requirement, or operative time, two key findings emerged. First, patients with complex fractures had significantly longer hospital stays compared to those with elementary fracture patterns. Second, complex fractures were significantly associated with a higher likelihood of postoperative ICU admission. Although a greater proportion of patients with elementary fractures achieved anatomical reduction, this difference did not reach statistical significance. Similarly, the duration of ICU stay and time from admission to surgery did not differ significantly between the groups. These findings suggest that fracture complexity may contribute to increased postoperative care requirements, even in the absence of notable differences in intraoperative parameters.

Although the majority of studies report that elementary fractures are more common, there are also publications indicating the opposite [2,5,9–11,13–15]. In large series conducted at high- volume trauma centers, the average patient age typically ranges between 60 and 70 years [3–5,14]. In contrast, smaller series often report younger patient populations, with mean ages around 40 years [9]. After matching for relevant variables, the mean age was found to be comparable between patients with elementary and complex fractures [14]. With the aging of the population, the incidence of acetabular fractures in elderly individuals is expected to increase [3–5]. Although male predominance in acetabular fractures is a well-established finding in the literature, with both elementary and complex fractures more frequently observed in male patients, recent studies have reported a rising incidence among elderly female patients [3–5,14]. In our study, male dominance was evident in both elementary and complex fracture groups, with no statistically significant difference between the two. This consistency with earlier reports reinforces the ongoing male predominance in acetabular fractures, at least within our regional population, despite global demographic shifts. In patients with acetabular fractures, the mean age is generally higher in females compared to males [5]. Among all acetabular fractures, posterior wall fractures—an elementary fracture type—are commonly observed; however, in geriatric acetabular fractures, the most frequently encountered patterns are anterior column and posterior hemitransverse fractures, which are components of complex fracture types [1,12]. While this type of fracture typically occurs in geriatric patients as a result of a simple fall, it is usually seen in younger patients following high- energy trauma [1,12]. In elementary fractures, an increase in anterior acetabular pathologies has been observed with advancing age [5]. With increasing age, there is a noticeable shift toward more complex acetabular fracture patterns [5]. In our study, we observed that the mean age was similar between elementary and complex fracture groups, and that high-energy trauma was the most common cause of injury in both groups.

In the study conducted by Wojcicki et al., no significant differences were found among the Judet and Letournel fracture types in terms of BMI, mean blood transfusion volume, or length of hospital stay [10]. However, a significant difference was observed in operative time, with posterior wall fractures having the shortest surgical duration [10]. In the comprehensive study by Tannast et al., which included 816 surgically treated acetabular fractures, the rate of anatomical reduction was significantly higher in simple fracture types (83%) compared to associated fractures (72%). Among the different fracture patterns, posterior wall and posterior column–posterior wall fractures demonstrated the highest rates of anatomical reduction, whereas both-column fractures had the lowest rates of anatomical reduction [13]. Additionally, it has been reported that patients with elementary fractures exhibit higher SF-36 Physical Component Summary (PCS) scores at six months and one year postoperatively compared to those with associated fractures; however, this difference was not observed at two or five years, suggesting that the early functional recovery advantage may diminish over time [15]. In our study, anatomical reduction was achieved in 87.1% of elementary fractures and 70.0% of complex fractures, with an overall anatomical reduction rate of 80.4%. Although these results closely mirror those reported by Tannast et al. [13], the difference was not statistically significant—possibly due to the smaller sample size or heterogeneity in fracture complexity and surgical challenge.

Other studies have explored technical factors affecting outcomes. One report found that the choice of plate type, when used for the same fracture pattern and approach, did not significantly influence intraoperative blood loss or hospital stay, though it was associated with shorter operative times [16]. Similarly, in a 1,330-patient series, an initial difference in hospital length of stay and time to surgery between elementary and complex fractures became insignificant after matching for confounders [14]. Complex fractures were also associated with significantly longer operative times and higher intraoperative transfusion requirements in that study—findings not replicated in our cohort [14].

In the series by Wittenberg et al., the time from admission to surgery was reported to be shorter in patients with elementary fractures compared to those with complex fractures, with a mean duration of 4.7 and 5.1 days, respectively [5]. In our cohort, the time to surgery was likewise shorter in elementary fractures (2.77 vs. 3.40 days), but this difference was not statistically significant. While they reported no difference in blood loss between operative and non-operative management [5], our findings also showed no significant differences between elementary and complex fractures in terms of perioperative hemoglobin levels, transfusion needs, or operative time. Notably, however, hospital length of stay remained significantly longer in patients with complex fractures, possibly reflecting differences in postoperative monitoring and ICU utilization.

In the study by Vallier et al., which included both pelvic ring and acetabular fractures, ICU admission was required in over 90% of patients, with a mean ICU stay of 3.1 days. Patients operated within 24 hours had shorter ICU stays (2.8 days) and fewer complications than those treated after 72 hours (4.2 days) [17]. Among patients with complications, ICU stay rose to 10.6 days and hospital stay to 17.2 days [17]. Similarly, Enocson and Lundin reported ICU admission in 35% of surgically treated pelvic and acetabular fracture cases, with no significant difference in ICU stay between early and late surgery groups [18]. In a study evaluating orthopaedic trauma patients with spine, pelvis, acetabulum, and femur fractures, Dolenc et al. reported that even limited blood transfusions (1–3 units of PRBC) were independently associated with significantly longer ICU stays (4.5 vs. 1.5 days) and hospital stays (8.8 vs. 5.7 days) compared to patients who were not transfused, despite no increase in complication rates [19]. These findings are relevant to our study, in which complex fractures were associated with a significantly higher ICU admission rate, yet ICU stay duration did not differ significantly between groups. This suggests that fracture complexity may influence ICU indication but not necessarily prolong ICU stay—possibly due to uniform postoperative care protocols or standardized early mobilization strategies.

This study has several limitations that should be acknowledged. First, its retrospective design inherently carries the risk of selection bias and limits the ability to establish causal relationships. Second, the sample size was relatively small, particularly within the subgroup of patients with complex fractures, which may have limited the statistical power to detect significant differences in some variables. Third, although all radiological evaluations and classifications were performed by experienced orthopedic surgeons, the absence of formal interobserver reliability assessment may introduce interpretation bias. Furthermore, postoperative CT-based assessment of reduction quality, while widely used, may not fully capture long-term functional outcomes. Finally, this study was conducted at a single tertiary center, which may limit the generalizability of the findings to other institutions or broader patient populations.

## Conclusions

This study highlights that while elementary and complex acetabular fractures share similar demographic and intraoperative characteristics, complex fracture patterns are associated with significantly longer hospital stays and a higher likelihood of ICU admission. These findings suggest that fracture morphology, independent of traditional perioperative risk factors, may influence the intensity of postoperative care. The observed association between fracture complexity and ICU requirement may assist surgeons in preoperative planning, resource allocation, and informing patients and their families about the anticipated postoperative course. Future prospective studies with larger sample sizes and more diverse populations are needed to validate these findings and further explore the impact of fracture morphology on healthcare resource utilization

## Author contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by MAD and AYS. The first draft of the manuscript was written by MAD and AYS. All authors commented on previous versions of the manuscript. All authors read and approved of the final manuscript.

## Statements and declarations

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### Conflict of Interest

The authors declare that they have no conflict of interest.

## Ethical statement

The University of Health Sciences Kayseri City Training and Research Hospital Education Planning Board approved the study protocol (Approval No: 5.27.2025/456). The authors confirm that this retrospective study was conducted in accordance with the ethical standards of the Declaration of Helsinki and its later amendments.

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