

Anterior fixation of unstable pelvic ring fractures using the modified Stoppa approach: mid-term results are independent on patients' age

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Abstract

Purpose Open surgical management of unstable pelvic ring injuries has been discussed controversially compared to percutaneous techniques in terms of surgical site morbidity especially in older patients. Thus, we assessed the impact of age on the outcome following fixation of unstable pelvic ring injuries through the modified Stoppa approach.

Methods Out of a consecutive series of 92 patients eligible for the study, 63 patients (mean age 50 years, range 19–78) were evaluated [accuracy of reduction, complications, failures, Majeed-Score, Oswestry Disability Questionnaire (ODI), Mainz Pain Staging System (MPSS)] at a mean follow-up of 3.3 years (range 1.0–7.9). Logistic multivariate regression analysis was performed to assess the outcome in relation to increasing patient age and/or Injury Severity Score (ISS).

Results Out of 63 patients, in 36 an “anatomic” reduction was achieved. Ten postoperative complications occurred in eight patients. In five patients, failure of fixation was noted at the anterior and/or posterior pelvic ring. In 49 patients, an “excellent” or “good” Majeed-Score was obtained; the mean ODI was 14 % (range 0–76 %); 50 patients reported either no or only minor chronic pelvic pain (MPSS). Only an increasing ISS conferred an increased likelihood of the occurrence of a non-anatomical reduction, a “poor” or “fair” Majeed-Score, or an ODI >20 %.

Conclusions Increasing age did not impact the analysed parameters. Open reduction and internal fixation of the

anterior pelvic ring through a modified Stoppa approach in unstable pelvic ring injuries did not result in an unfavourable outcome with increasing age of patients.

Keywords Pelvic ring injury · Modified Stoppa approach · Outcome · Osteosynthesis

Introduction

For the management of pelvic ring fractures, open reduction and internal fixation has been noted to be the standard of care [1]. In the early management of these injuries, an open reduction and internal fixation using the ilioinguinal approach [2] was classically employed [3]; however the disproportionately high surgical access morbidity [4] was of grave concern. In contrast, the modified Stoppa [5, 6] approach has been introduced more recently for anterior reduction and fixation of unstable pelvic ring injuries, serving as a less invasive surgical access [7, 8].

The objective of this study was to establish whether the less invasive modified Stoppa approach could be beneficial in the definitive fixation of anterior pelvic ring fractures even in older patients. Accordingly, it was hypothesized that an adverse outcome (such as non-anatomical reduction, occurrence of complications and/or failure of the osteosynthesis, fair or poor clinical results, disability, and/or chronic pelvic pain) may be related rather to the severity of the injury than to increasing age.

Patients and methods

Between 07/2004 and 07/2013, 496 pelvic ring injuries were radiographically confirmed in all admissions

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suggestive for pelvic trauma at a University Level I Trauma Center. In general, CT scans were used for radiographic analysis and fractures were classified according to the Tile classification [4].

Of the 496 patients with confirmed pelvic ring injuries, 208 (42 %) were treated surgically. The focus of the presented study was to assess the outcome in fixation of anterior pelvic ring injuries by means of the modified Stoppa approach [5, 6] using 3.5 mm diameter cortical screws and reconstruction plates for fracture fixation at the anterior pelvic ring. For plate fixation in general, two screws were placed posteriorly to the hip joint, two further screws at the parasymphyseal anterior pelvic ring and one additional screw was placed at the infra-acetabular corridor [9]. Therefore, “open book” injuries with isolated symphysis ruptures were excluded as these injuries were stabilized using symphysis plates.

As a result, of the initial 208 patients identified, a consecutive series of 92 (44 %) patients (mean age 53 years, range 16–88; 46 male) met the inclusion criteria. Patients with a follow-up period of less than 12 months or whom were unable to be evaluated (e.g. dementia) were excluded from the study. This led to the exclusion of one patient with a follow-up period less than 12 months and one patient suffering from dementia. Nine patients were lost to follow-up, five patients moved overseas and ten patients died (as a result of suicide, multiple organ failure, tumour disease or craniocerebral injury) in the early follow-up. Additionally, three patients refused consultation as they were doing well. Data were therefore assessed in 63 of the 92 (68 %) patients identified (mean age 50 years, range 19–78) with a mean follow-up of 3.3 years (range 1.0–7.9).

The Tile classification included 25 (40 %) B-type fractures and 38 (60 %) C-type fractures. In 15 (24 %) of these, initially, temporary fixation was necessary (application of a C-clamp in 10 patients or an external fixator in 5 patients) and treatment included placement of a pelvic binder in 34 (54 %) patients. The definitive treatment of anterior fixation was performed in all cases with reconstruction plates placed unilaterally ($n = 48$) or bilaterally ($n = 15$) using the modified Stoppa approach [5, 6]. A horizontal skin incision was performed in 48 (76 %) and a vertical skin incision in 12 (19 %); in three cases, the incision type was not described in detail in theatre notes. In all patients, no detachment of the rectus abdominis muscles and no utilization of the first window of the ilioinguinal approach [2] was performed. In 55 cases (87 %) with distinct displacement and/or posterior instability, an additional posterior fixation was performed. This was performed using a variety of techniques including iliosacral screws, with unilateral ($n = 26$), bilateral ($n = 8$) or transiliosacral placement ($n = 3$); lumbopelvic stabilization ($n = 5$), 3.5 mm screws ($n = 2$), ventral plates ($n = 9$) or dorsal ilio-iliacal plates ($n = 2$).

Evaluation

For the purpose of this study, we retrospectively reviewed all records and re-evaluated patients at a minimum follow-up of 12 months. Data were collected and assessed including patient demographics, mechanism of injury, Injury Severity Score (ISS) [10], type of pelvic ring injury [4] and details of the initial management (such as the mean delay to surgery, blood loss, operation time, the occurrence of intraoperative and/or postoperative complications). Postoperative complications were classified according to the classification system of Dindo et al. [11] and its adaption for application to orthopaedic surgery [12]. Finally, a failure was defined as the need for revision surgery due to hardware failure at the anterior and/or posterior pelvic ring.

The accuracy of the reduction was assessed radiographically, using conventional radiographs (anteroposterior, inlet, outlet views), according to previously published criteria [13] and the union rates were assessed during follow-up. Clinically, these patients were evaluated using the Majeed-Score [14], the Oswestry Disability Questionnaire [15] and the Mainz Pain Staging System [16] (measuring pain chronicity) for functional outcome assessment.

Statistics

Logistic multivariate regression analysis was performed to reveal the likelihood for a specific adverse outcome (non-anatomical reduction, failure of osteosynthesis, complication, Majeed-Score categorized as “poor” or “fair”, Oswestry Disability more than 20 %, Mainz Pelvic Pain Score noted as “positive”) associated with one of the following effects which were considered in all models: Patient age (continuous) and ISS (continuous). Odds ratio estimates with 95 % confidence limits were calculated. All statistical analyses were conducted using SAS 9.4 (SAS Institute Inc., Cary, NC) with a significance level of 0.05.

Results

The patients’ demographics, mechanisms of injury, distribution of pelvic ring injury patterns, ISS, delay to definitive surgery are presented in Table 1, whereas accuracy of reduction, occurrence of postoperative complications, failures and functional outcome are summarized in Table 2. The mean \pm SD blood loss (in ml) was 851 ± 656 and the mean operating time (in min) was 148 ± 74 .

Two of the 63 patients (3 %) sustained an intraoperative complication. A small peritoneal perforation was noted in a 69-year-old patient and directly revised by sutures, and a small bladder perforation was noted in a 73-year-old patient which was also revised with sutures. In 8 of 63 (13 %)

Table 1 Demographics and surgical data by number or mean \pm SD and *percentage or range* in 63 cases

Parameter		
Age	50 \pm 16	(190–78)
Male gender	36	(57)
Mechanism of injury		
MVC	11	(17)
Sports	10	(16)
Fall (<3 m)	2	(3)
Fall (>3 m)	20	(32)
Crush injury	13	(21)
Others	7	(11)
Pelvic ring fracture type		
B2	11	(17)
B3	14	(22)
C1	22	(35)
C2	3	(5)
C3	13	(21)
Injury Severity Score (ISS)	22 \pm 11	(9–57)
Delay to definitive treatment (days)	4 \pm 6	(0–40)

patients, 10 (16 %) postoperative complications occurred which were classified as follows: (1) Grade I (one complication, 2 %): One patient had an asymptomatic inguinal hernia detected one year postoperatively with no further treatment. (2) Grade II (two complications, 3 %): one patient suffered from transient paraesthesia of the lateral femoral cutaneous nerve which recovered completely during follow-up; another patient required antibiotic treatment for acquired pneumonia. (3) Grade III (six complications, 10 %): three patients presented with deep infection requiring surgical intervention, one patient developed a prevesical haematoma which needed to be evacuated, another had an abdominal wall hernia requiring surgical revision and a further patient showed an intra-articular screw in the hip joint with the need for revision. Grade IV (one complication, 2 %): one patient developed a segmental pulmonary embolism.

Failures at the anterior and/or posterior pelvic ring requiring revision surgery were noted in 5 out of 63 (8 %) patients as follows: a failure occurred at the anterior pelvic ring in two (3 %) patients aged 53 and 73 years, respectively. In the 53- and the 73-year-old patient, non-union occurred and required revision surgery (due to non-compliance in the 73-year-old patient). Non-union of the posterior pelvic ring was noted in only one patient (2 %), aged 75, possibly as a result of an anterior fixation with initially no posterior treatment in a C-type unstable pelvic fracture. This patient required revision surgery with bilateral lumbopelvic stabilization. In two patients (3 %), aged 47 and 72 years, a failure of the anterior and posterior pelvic ring

Table 2 Accuracy of reduction and outcome at a mean follow-up of 3.3 years (range 1.0–7.9 years), by number or mean \pm SD and *percentage or range* in 63 cases

Parameter		
Accuracy of reduction		
Anatomical (0 cm)	36	(57)
Non-anatomical	27	(43)
Nearly anatomic (<1 cm)	23	(36)
Moderate (1–2 cm)	3	(5)
Poor (>2 cm)	1	(2)
Occurrence of complications		
Grade I	1	(2)
Grade II	2	(3)
Grade III	6	(10)
Grade IV	1	(2)
Grade V	0	(0)
Failures		
Anterior pelvic ring	2	(3)
Posterior pelvic ring	1	(2)
Both	2	(3)
Majeed scoring		
"Excellent"	37	(59)
"Good"	12	(19)
"Fair"	9	(14)
"Poor"	5	(8)
Oswestry disability index (in %)	14	(0–76)
Mainz Pain Staging System		
No pelvic pain	33	(52)
Stage 1	17	(27)
Stage 2	9	(14)
Stage 3	4	(6)

fixation was noted. Both failures required revision surgery, in the 47 year old for management of a non-union (due to non-compliance in an alcoholic) and in the 72 year old to revise for loss of reduction with secondary displacement (due to insufficient posterior fixation). In summary, in older patients failure at the anterior pelvic ring occurred in only one patient as a consequence to non-compliance and in one patient as a consequence to insufficient treatment at the posterior pelvic ring. However, all fractures consolidated in the further postoperative course. Hardware removal at the anterior pelvic ring was performed as a planned procedure in two (3 %) younger patients.

In 36 of 63 (57 %) patients, an "anatomic" reduction was achieved. At a mean follow-up of 3.3 years (range 1.0–7.9 years), 37 of 63 (59 %) patients reported their outcome as "excellent", with 12 of 63 (19 %) reporting a "good" outcome, 9 of 63 (14 %) reporting a "fair" outcome and 5 of 63 (8 %) reporting a "poor" outcome according to the Majeed-Score. Using the Oswestry Disability

Table 3 Multivariate logistic regression analysis to calculate the likelihood for a specific adverse outcome (non-anatomical reduction, failure of osteosynthesis, complication, Majeed-Score categorized as

“poor” or “fair”, Oswestry Disability more than 20 %, Mainz Pelvic Pain Score noted as “positive”) associated with either patient age (continuous) and/or Injury Severity Score (continuous)

Effect	Age			Injury Severity Score		
	Odds ratio	95 % CI	<i>p</i> value	Odds ratio	95 % CI	<i>p</i> value
Non-anatomical reduction	0.998	0.966–1.030	0.882	1.050	1.000–1.102	0.049
Postoperative complication	1.019	0.982–1.057	0.323	0.958	0.896–1.024	0.203
Failure of osteosynthesis	1.064	0.992–1.140	0.437	0.951	0.838–1.079	0.437
Majeed-Score (poor or fair)	1.013	0.971–1.057	0.552	1.073	1.015–1.134	0.013
Oswestry disability (>20 %)	1.002	0.962–1.043	0.927	1.094	1.034–1.158	0.002
Mainz pelvic pain (positive)	1.018	0.987–1.051	0.308	0.976	0.932–1.022	0.307

Statistical analyses were conducted with a significance level of 0.05

Questionnaire the mean level of impairment was 14 % (range 0–76 %). In the assessment of chronic pelvic pain in relation to their pelvic ring injury, 33 of 63 (52 %) patients did not suffer from any pelvic pain, 17 of 63 (27 %) presented with a MPSS stage I, 9 of 63 (14 %) with a MPSS stage II and 4 of 63 (6 %) with a MPSS stage III.

The results of the logistic multivariate regression analysis are presented in Table 3. The analysis revealed that only an increasing ISS conferred an increased likelihood of the occurrence of a non-anatomical reduction, a poor or fair scoring in the Majeed-Score and a disability of 21 % or more in the Oswestry Disability Index. All other adverse outcome parameters were not influenced by the severity of the injury. Increasing age was not of a significant impact on the analysed adverse outcome parameters.

Discussion

In the management of pelvic trauma, chronic pain—defined as pain at the present time which was related back to the pelvic fracture—occurs frequently, can significantly affect the patients' quality of life and has recently been considered to be deserving of increased attention [17, 18]. Chronic pain may be related to non-anatomic reduction, non-union with residual instability and potential access morbidity. Moreover, an additional impact on the outcome may be the need for re-operation, either as planned procedure for hardware removal or as a required procedure to revise failures of the osteosynthesis (e.g. due to hardware loosening or breakage). The latter may be of particular concern for patients with increasing age and decreasing physiological reserves who represent an upcoming challenge for surgeons due to the reported increasing incidence [19].

With regard to less invasive management of unstable pelvic ring injuries using open reduction and internal fixation of the anterior pelvic ring, the literature is scarce and differences in the outcome according to age are not considered

[7, 8]. The largest series was reported by Hirvensalo et al. [7] who provided a study of 101 unstable lateral compression or C-type pelvic injuries treated with open reduction and internal fixation using the modified Stoppa approach [7]. At a mean follow-up time of 1.8 years (range 1–8) generally good radiographic results and functional recovery were obtained in 92 and 83 % of patients, respectively. In this series as a whole, complications occurred in 26 % of patients, however this included complications related to posterior pelvic ring fixation and patients presenting with an open book injury. Ponsen et al. achieved anatomic reduction in 100 % of patients presenting with an unstable pelvic ring injury [8]. In their consecutive series of 25 patients, 13 complications were noted in nine patients, however within the study the authors did not distinguish between pelvic and acetabular fractures even though the majority of their cases presented with fractures of the acetabulum.

In most cases in our series (94 %), an anatomic or nearly anatomic reduction was achieved. Moreover, clinical results were excellent or good in most cases and disability or severe chronic pelvic pain was reported only seldomly. The access morbidity was considered as being low since intra- and postoperative access-related complications occurred infrequently and only one case of transient paraesthesia was noted. Hardware removal at the anterior site due to patient complaint was not required in older patients. Revision surgery was necessary in five (8 %) patients. In summary, our overall reported results are at least in accordance with the available literature. Moreover, increasing age was not predictive for an adverse outcome in the mid-term. Thus, the modified Stoppa approach provided secure access and a stable osteosynthesis even in older patients.

In contrast to open reduction and internal fixation, percutaneous techniques may be an alternative—especially in older patients. Almost 25 years ago [4], external anterior fixation was considered to be successful for the stabilization of the anterior pelvic ring in the definitive treatment of unstable pelvic ring fractures. However, the use of an external

fixator in definitive treatment of an unstable anterior pelvic ring injury was associated with high complication and failure rates, a lack of patient comfort, potential soft tissue breakdown and was discouraged in elderly patients [20–22]. Alternatively, for the fixation of the anterior pelvic ring, percutaneous anterior internal fixation [20, 23–26] or placement of a retrograde transpubic screw [27] have also been described. However, complications reported in the use of these techniques remain high and include: paraesthesia of the lateral cutaneous femoral nerve in up to 37 % of cases [28], wound infections in 3–5 % [20, 23, 25], non-union in 4 % [20], the necessity for revision surgery secondary to technical errors in 3 % [25] and mandatory hardware removal [24, 25]. In addition, the use of retrograde transpubic screws carried the risk of screw misplacement or an inability of screw insertion in case of anatomical variations [27]. Moreover, as with all percutaneous procedures, the techniques cannot facilitate the fixation of associated acetabular fractures, repair of associated intra-abdominal injuries (e.g. bladder) or decompression of potential retroperitoneal haematomas.

The strength of this study is the detailed assessment and presentation of the outcome in relation to age since previous reports failed to distinguish between older and younger patients. A further strength might be the use of outcome measures appropriate for pelvic surgery. To classify the outcome after pelvic ring fractures, the validated MPSS, the Oswestry Disability Questionnaire (as recommended previously [16]) and the Majeed Functional Score (as most scores are based on Majeed's specifications) were used. Limitations of the study might be the retrospective study design and the relatively short follow-up period. However, according to the guidelines of the multicentre study of the German Pelvis Study Group, a period of at least 12 months with clinical and radiological follow-up was considered to be adequate, especially in older patients [17].

In summary, the modified Stoppa approach provided adequate exposure for the reduction and fixation of pelvic ring injuries. In contrast to an increase in the ISS, no impact in morbidity or outcome relative to age was observed. However, whether the presented technique might be applicable to geriatric patients with fragility fractures of the pelvis as newly classified recently by others [29] remains unknown as in our series only two patients sustained their injuries by a low-energy trauma mechanism. However, surgical treatment with open reduction and internal fixation of pelvic ring injuries appears to be an adequate technique not only in younger but also in older patients and represents an alternative to percutaneous techniques with an favourable outcome.

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Compliance with ethical standards

Conflict of interest Johannes Dominik Bastian, Alexandre Ansoorge, Salvatore Tomagra, Klaus Arno Siebenrock, Lorin Michael Benneker, Lorenz Büchler, Marius Johann Baptist Keel declare that they have no conflict of interest.

Ethical approval The study was approved by the Institutional Review Board and was performed in compliance with ethical requirements.

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