

Outcome and 2-Year Survival Rate in Elderly Patients With Lateral Compression Fractures of the Pelvis

Geriatric Orthopaedic Surgery
& Rehabilitation
2017, Vol. 8(1) 3-9
© The Author(s) 2016
Reprints and permission:
sagepub.com/journalsPermissions.nav
DOI: 10.1177/2151458516681142
journals.sagepub.com/home/gos



Andreas Höch, MD¹, Orkun Özkurtul, MD¹, Philipp Pieroh^{1,2},
Christoph Josten, MD¹, and Jörg Böhme, MD¹

Abstract

Introduction: Osteoporotic pelvic ring fractures are a rising problem for surgeons in industrialized countries. There is no evidence-based treatment strategy especially for lateral compression (LC) fractures involving the sacrum. The aim of this study was to evaluate and compare outcome and survival rate of nonoperative and operative treatment strategies for lateral compression fractures. **Patients and Methods:** In a retrospective study, 128 patients (aged ≥ 65 years) with an Orthopedic Trauma Association (OTA) types B2.1 and B3.3 fracture were included and analyzed regarding demographic and treatment data and adverse events. After a follow-up period of at least 2-year survival rate, quality of life and pain were evaluated using the EuroQol-5D and Short Form-12 questionnaires and the visual analog scale. **Results:** Fifty patients (78.3 ± 7.6 years) obtained operative treatment and 77 patients (82.7 ± 7.9 years) obtained nonoperative treatment. One died within 24 hours after admission. High rates of complications occurred in both groups (operative group: 18% and nonoperative group: 8%). Eighteen percent (14 of the 77) of conservatively treated patients needed operative treatment after discharge due to worsening pain and mobilization. The 2-year follow-up showed a high overall mortality (30%), with a significant higher survival rate for operatively treated patients (2-year survival: operatively treated 82% vs conservative 61%). No difference was found in pain and quality of life. **Discussion:** Elderly patients display a high rate and variety of complications and mortality in the aftermath of lateral compression fractures of the pelvis. Although a significantly higher 2-year survival rate for operatively treated patients was found, this study cannot give proof of superior position for operative treatment. Due to lacking data for alternative treatment algorithms especially for fracture-related immobilized patients, we recommended operative treatment with the aim to reduce complications related to prolonged bed rest and ensure early mobilization.

Keywords

pelvic fracture, geriatric trauma, treatment, outcome, survival

Received December 9, 2015; revised September 12, 2016; accepted October 9, 2016.

Introduction

Osteoporotic pelvic ring fracture in elderly patients poses a challenge for trauma surgeons. Based on the data from the pelvic expert group of the German Society of Trauma Surgeons (DGU), more than 50% of all documented pelvic fractures occur in patients older than 65 years.¹⁻³ It is known that computed tomography (CT) is much more sensitive than X-ray to detect additional fractures in the posterior pelvic ring (ie, partial sacrum impression fractures).⁴ This has led to a much higher number of multiple fractures of the pelvis diagnosed than before.^{5,6} Our own data suggest that among elderly patients, more than 50% of all pelvic fractures are anterior and posterior fractures and mainly present a lateral compression fracture configuration involving the sacrum after low-energy trauma.⁵

Patients with pubic rami fractures and additional fractures of the posterior pelvic ring who are treated nonoperatively yielded a significantly longer hospital stay and a higher mortality rate compared to patients with isolated fractures of the pubic rami within the same age range.^{5,7-10} For those patients, operative stabilization may help reduce complications such as

¹ Department of Orthopedic, Trauma and Plastic Surgery, University of Leipzig, Leipzig, Germany

² Department of Anatomy and Cell Biology, Martin Luther University Halle-Wittenberg, Halle (Saale), Germany

Corresponding Author:

Andreas Höch, Department of Orthopedic, Trauma and Plastic Surgery, University of Leipzig, Liebigstraße 20, Leipzig 04103, Germany.

Email: andreas.hoech@medizin.uni-leipzig.de



thromboembolism, pneumonia, and others related to bed rest. The main focus of the current operative strategies after high-energy trauma is the reduction of instability. Actually, it is uncertain whether osteoporotic fractures with the similar fracture pattern as high-energy trauma result in the same instability.^{1,11,12} Even in young patients, the literature is dissent about treatment strategies for lateral compression fractures.¹³⁻¹⁵ For elderly patients with osteoporotic fractures, there is a paucity of data about treatment strategies to decrease comorbidity and avoid prolonged fracture healing due to osteopenia and osteoporosis.^{1,2,12} Therefore, the rationale of operative surgical treatment for elderly patients is to reduce the fracture-related pain first.

The aim of this study was to compare the outcome and survival rate after nonoperative and operative treatment in patients older than 65 years to a lateral compression fracture of the pelvic ring involving the sacrum.

Patients and Methods

Over a period of 7 years (January 2004 to December 2010), 128 patients older than 65 years with a lateral compression fracture of the pelvis (types B2.1 and B3.3 according to OTA) were admitted at a trauma level 1 center and included retrospectively in our study. The local ethic committee approved this study (133-13-03062013), and informed consent was obtained from all patients participating to the follow-up after 2 years.

Clinical Course

All patients were diagnosed according to the same clinical standard including a CT scan. In each patient, a conservative treatment was first recommended. Pain medication according to the World Health Organization standard scheme and thromboembolism prophylaxis and physiotherapy allowing full weight bearing were prescribed. Following our clinical course, we stabilized all prior mobile patients who could not be mobilized again under appropriate pain therapy and physical assistance after 3 days.

Various operative techniques were applied depending on pain level, fracture location/displacement, and bone quality. For incomplete impression fracture of the sacrum, percutaneous iliosacral screw fixation with either a 7.0 full-threaded or 7.3 partial-threaded screws (Depuy/Synthes, Zuchwil, Switzerland) was performed. Depending on the bone quality, additional sacroplasty or triangular fixation was used to improve the primary stability and allow full weight bearing. Anterior stabilization was performed with a 8- or 10-titanium 3.5-mm plate (Depuy/Synthes) via a modified Stoppa approach when displacement of pubic rami was greater than 1 shaft width.

Postoperatively, full weight bearing was practiced with the assistance of a physiotherapist. After hospital discharge, professional physiotherapeutic rehabilitation was continued for 3 weeks. Standard follow-up was performed after 6 weeks, 3, 6, and 12 months and included a clinical examination and plane X-ray radiographs. Further visits were organized on an individual basis. The patients were not exposed to additional radiation for this study.

Table 1. Recorded Patient Data.

Epidemiologic data
Injury mechanism and injury pattern
Comorbidities (ASA classification)
Length of hospital stay
Time to surgery
Surgical technique
Complications
Mortality

Abbreviation: ASA, American Society of Anesthesiologists.

Data

Patient-specific data (Table 1) were recorded into a database. For fracture classification, CT scans and X-rays were used. During the follow-up, long-term outcome was assessed by validated questionnaires (Short Form-12 [SF-12], EuroQol-5D (EQ-5D), and visual analog scale for pain) to evaluate mobility, pain symptoms, and quality of life. In patients who had died, the date of death was documented.

Statistics

The statistical analysis was performed with SPSS 20.0 for Windows (SPSS Inc, Chicago, Illinois) using χ^2 or Fisher exact test. For mean comparison, the *t* test was used. For survival, a Kaplan-Meier curve with the log-rank test (Mantel-Cox) was used. The significance level was set at $P < .05$.

Results

General Data

Demographic data, trauma mechanism, additional injuries, and American Society of Anesthesiologists score are presented in Table 2. One patient died within 24 hours after admission and was excluded from the further investigation. Operatively treated patients show a significant lower mean age ($P < .05$), whereas all other data are comparable in both groups.

Fracture Classification

One hundred fifteen (90%) patients had a unilateral fracture of the sacrum (B2.1 according to OTA), and 13 (10%) patients sustained a bilateral sacral fracture (B3.3 according to OTA). One hundred seventeen (91%) patients sustained unilateral pubic rami fractures, and 11 (9%) patients had bilateral pubic rami fractures of the anterior pelvic ring. Complex pelvic fractures were documented in 2 cases. There was no patient with a rupture of the symphysis.

Hospital Stay

Treatment. Seventy-seven (60%) patients obtained nonoperative treatment and 50 patients (40%) obtained operative treatment due to pain-related immobilization. On average, surgical stabilization was performed 6.4 ± 4.1 days after admission to the hospital.

Table 2. Presenting Epidemiological, Accidental, and Injury Data of the Patients.

	Treatment			Significance	Overall
	Nonoperative	Operative	Died Before Treatment		
n	77	50	1		128
Age	82.7 ± 7.9	78.3 ± 7.6	92	<i>P</i> < .002	81 ± 8.3
Sex	F 66, M 11	F 42, M 8	F 1, M 0	<i>P</i> > .05	F 109, M 19
ASA	2.8 ± 0.6	2.6 ± 0.5	Unknown	<i>P</i> > .05	2.7 ± 0.5
Accident mechanism					
• Minor trauma	63	40	0	<i>P</i> > .05	103
• High energy	7	5	1		13
• Unknown	7	5	0		12
Injury patterns					
• Isolated	56	33	0	<i>P</i> > .05	89
• Additional injury (ISS < 16)	15	16	0		31
• Multiple injured (ISS ≥ 16)	6	1	1		8
ISS	10.0 ± 3.9	9.4 ± 2.1	48	<i>P</i> > .05	10.1 ± 4.6

Abbreviations: ASA, American Society of Anesthesiologists; F, female; M, male; ISS, Injury Severity Score.

Minimally invasive posterior pelvic ring procedures were performed. Twenty-eight patients were treated with unilateral iliosacral screw fixation; 4 patients were treated with 2 screws in S1 and 2 patients with screws in S1 and S2. Fourteen patients were stabilized on both sides by iliosacral screws. Thirteen patients had an additional percutaneously sacroplasty from dorsal. In 2 cases, a triangular fixation was done. Navigation was used in 7 cases. Additional anterior fixation plate osteosynthesis was performed in 3 cases due to displacement greater than 1 shaft width.

Hospitalization period. The mean hospital stay of the nonoperative group was 9.2 ± 6.2 days, which was significantly shorter ($P < .001$) than in the operative group (18.1 ± 10.0 days).

Complications. Five (4%) patients died during the hospital stay. In the nonoperative group, 3 (4%) patients died due to respiratory insufficiency following either pneumonia ($n = 2$) or pulmonary embolism ($n = 1$). In the operative group, 2 patients (4%) died: 1 of pulmonary embolism and 1 of unknown cause with the suspicion of a heart attack.

In the nonoperative group, 6 (8%) patients were diagnosed with severe complications including pneumonia ($n = 2$), thrombosis ($n = 2$), mesenteric infarction ($n = 1$), and acute respiratory insufficiency syndrome ($n = 1$). In the operative group, 9 (18%) patients were diagnosed with complications including pneumonia ($n = 1$), thrombosis ($n = 1$), and diarrhea with deterioration of general condition ($n = 1$).

Three (6%) patients showed malpositioning of the iliosacral screw with neurological complaints (eg, pain syndrome). In all patients, complete remission of the symptoms was obtained after percutaneous correction of the screws. In 1 (2%) patient, wound infection led to revision surgery with salvaging of the osteosynthesis. Postoperative blood transfusions were required in 2 (4%) cases. Overall complications in both groups (nonoperative: 8% vs operative: 18%) did not show a significant difference ($P = .8$).

Clinical Course After Discharge

Fourteen (18%) of the 77 conservatively treated patients required surgery after failed conservative therapy within 3 weeks after discharge due to increasing pain with worsening mobility. One case of implant loosening with pain was documented 4 months after stabilization and 1 case of delayed union at the anterior pelvic ring with persistent pain occurred and needed an additional plate fixation. In 1 case, an intergrowth of callus with the front wall of the bladder with urological problems occurred, leading to an operative reconstruction of the bladder wall.

Subgroup Analysis of Failed Nonoperative Treatment and Delayed Surgery

The group of 14 patients with failed nonoperative treatment and delayed surgery did not differ from the overall nonoperative treatment group (Table 3). There was no objectifiable difference in fracture pattern or classification. Two complications were recorded in this subgroup (complication rate of 14%). In the following paragraphs, this group is compared to the operative group and the nonoperative group.

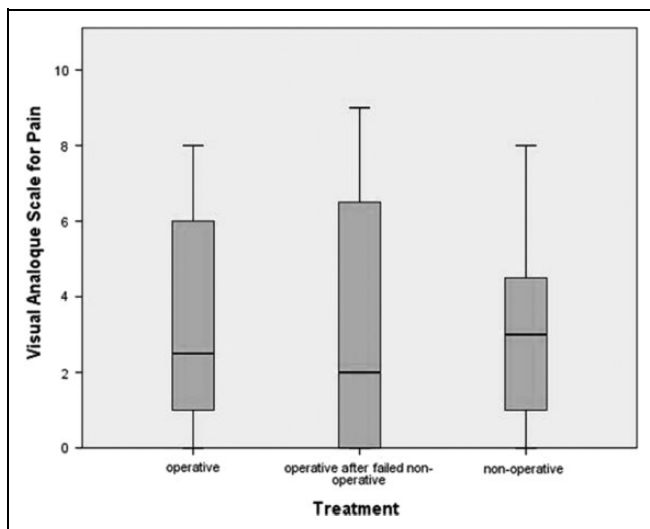
Two-Year Follow-Up

One hundred twenty-four (98%) patients or relatives were achieved (mean: 31, range 24-49 months). Sixty-eight (54%; nonoperative: 43%; failed nonoperative: 50%; operative: 66%) answered the questionnaires. Due to cognitive disabilities, 16 (13%; nonoperative: 13%; failed nonoperative: 14%; operative: 12%) questionnaires were not answered correctly and dropped out. Thirty-nine (30%; nonoperative: 43%; failed nonoperative: 21%; operative: 18%) patients died within 2 years after treatment. Seventeen (13%; nonoperative: 11%; failed nonoperative: 21%; operative: 14%) patients did not answer the

Table 3. Comparison of the Nonoperative Group and the Failed Nonoperative Group.

	Nonoperative	Failed Nonoperative	Significance
n	63	14	
Age	83.0 ± 7.2	81.4 ± 8.7	$P > .1$
Sex	F 53, M 10	F 13, M 1	$P > .05$
ASA	2.8 ± 0.6	2.6 ± 0.5	$P > .05$
Accident mechanism			
• Minor trauma	63	10	$P > .05$
• High energy	7	2	
• Unknown	7	2	
Injury patterns			
• Isolated	45	11	$P > .05$
• Additional injury (ISS < 16)	12	3	
• Multiple injured (ISS ≥ 16)	6	0	
ISS	10.0 ± 4.1	9.1 ± 2.8	$P > .05$

Abbreviations: ASA, American Society of Anesthesiologists; F, female; M, male.

**Figure 1.** Comparison of pain (visual analogue scale) between groups. No statistically significant difference was shown ($P > .3$).

questionnaires while alive or died later than 2 years after discharge. Totally, lost to follow-up were 3 (2%) patients.

Quality of life and pain. Comparison between the 3 groups yielded no significant difference in quality of life according to the EQ-5D (nonoperative: 75.1 ± 13.4 points; failed nonoperative: 76.3 ± 14.4 ; operative: 74.6 ± 15.5 points; $P > .3$). There was also no statistical difference regarding pain intensity score (nonoperative: 3.1 ± 2.3 ; failed nonoperative: 2.3 ± 2.8 ; operative: 2.6 ± 2.8 ; $P > .5$; Figure 1).

The analysis of the SF-12 questionnaire for physical and mental scores showed no significant difference between groups ($P > .2$), though the overall scores were lower for conservatively treated patients than that of the age-matched normal

population ($P < .05$; operative and failed nonoperative $P > .05$; Figure 2).¹⁶

Two-year survival. Overall, 2-year mortality was 30%. Nine (18%) of the patients treated operatively, 3 (21%) of failed nonoperative, and 26 (41%) of the patients treated nonoperatively died in the first 2 years after treatment. Figure 3 shows the Kaplan-Meier curve. The log-rank (Mantel-Cox test) showed a significant difference ($P < .05$) between patient deaths for the nonoperative and operative groups. There was no significant difference between the failed nonoperative patient group compared to the nonoperative and operative groups ($P > .05$).

Discussion

Osteoporotic pelvic ring fractures present an increasing problem in the aging societies of industrialized countries.^{12,17-20} Nevertheless, there is no evidence-based treatment strategy for osteoporotic pelvic ring fractures of partially unstable lateral compression type involving the sacrum. This study provides data from a large group of patients older than 65 years. Limitations of this study include the retrospective design and low clinical follow-up due to older age of patients, cognitive disabilities, and high mortality rate after 2 years.

The present study shows a significantly higher survival rate for operatively treated patients after 2 years. We did not find a difference in quality of life or pain during the follow-up.

Most studies on demographics of pelvic fractures report a comparably high mean age (81 years) and mainly female patients (85%). A low-energy trauma mechanism is common and is typically a fall from standing or within transferring accidents, for example, from bed to wheelchair. Therefore, most patients with a pelvic fracture sustain an isolated pelvic ring injury.^{3,8,9,21-23} For this study, the only significant difference in demographics between the operative and nonoperative groups was the mean age.

All patients were diagnosed with a pubic rami and sacral fracture (B2.1 or B3.3 according to OTA, lateral compression (LC) type I). To compare the types of fracture, classifications developed mostly for pelvic ring fractures after high-energy trauma must be used. Therefore, new classifications are recommended to develop a better understanding of instability and needed fixation technique.^{1,11}

Lateral compression-type fractures of the pelvic ring have a relative indication for surgical stabilization. Nevertheless, there is a trend toward more operative treatment in recent years.^{1,12-15} Nevertheless, for elderly patients, there is a lack of evidence for treatment strategies.

Overall, this study had a high rate of operatively treated patients compared to the literature. Lau and Leung and Alnaib et al treated all patients with sacral fractures conservatively.^{3,9} Following our clinical course, we stabilized all prior mobile patients who could not be mobilized again under suitable pain therapy and physical assistance after 3 days. In our opinion, if necessary, the decision for operative stabilization must be

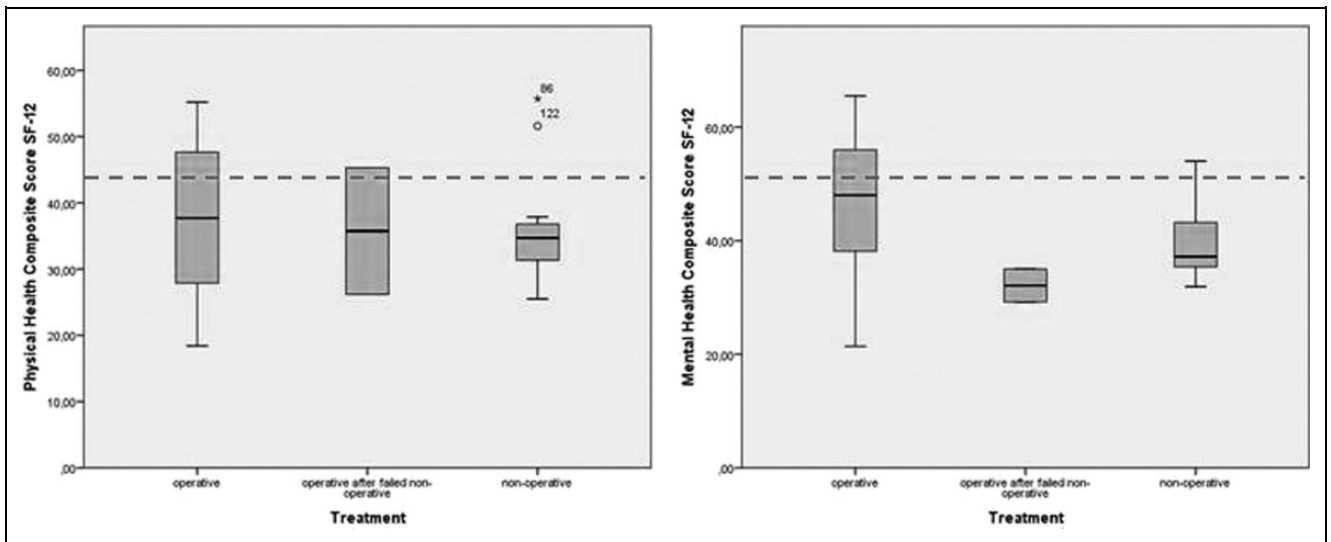


Figure 2. Comparison of quality of life between groups using Short Form-12 (SF-12). No statistically significant difference was shown (broken line shows the average score of the German population in this age group¹⁶).

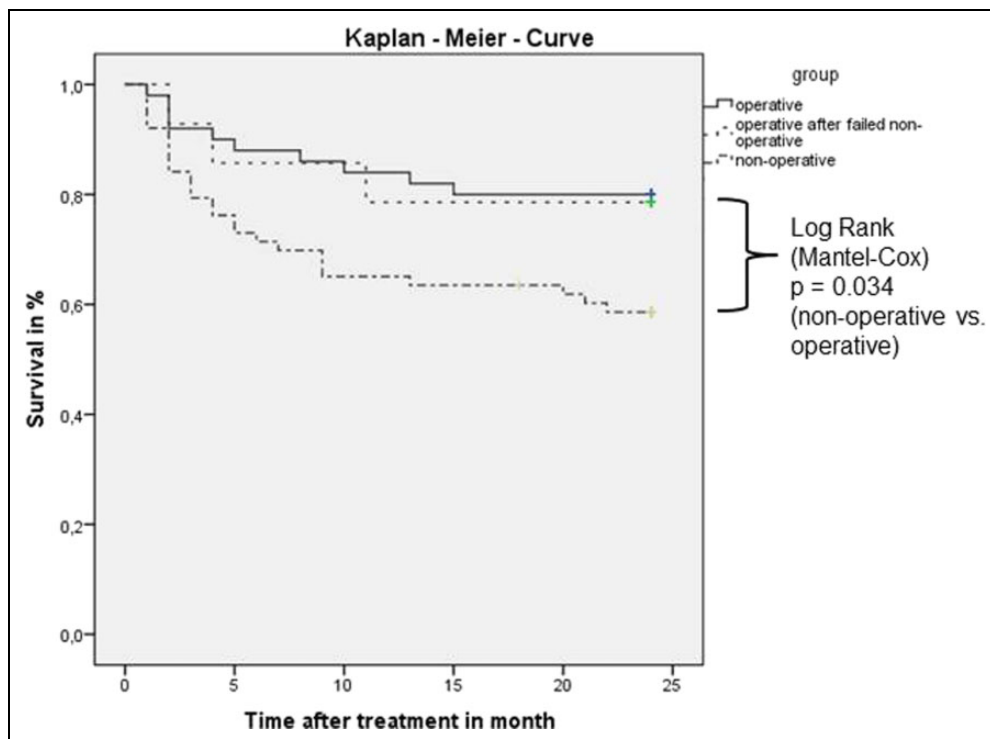


Figure 3. Comparison of the 2-year survival function (Kaplan-Meier curve) between groups. Significant difference in the log-rank test between the operative and nonoperative groups ($P < .05$). No significant difference between the failed nonoperative patient group compared to the nonoperative and operative groups ($P > .05$).

made quickly, because with each day patients at this age group are immobilized, the risk of complications increases (eg, thrombosis, loss of muscle function and mobility, cardiac and respiratory problems, and pneumonia).^{24,25}

In the majority of cases, less invasive techniques, such as percutaneous iliosacral screw fixation, were used to reduce the perioperative risk. Only in cases of very bad intraoperative bone quality, an additional triangular fixation or sacroplasty

was performed. Patients who received additional anterior treatment by the modified Stoppa approach showed preoperative displacement of more than 1 shaft width of the pubic ramus in accordance to the current literature recommendations.¹

However, as expected for elderly patients, we recognized a high rate of complications during hospital stay due to present comorbidities. van Dijk et al showed a similar rate of complications up to 20% in 99 elderly patients.²⁶

Prevalence of surgical complications was higher than published in younger patients.^{27,28} Reasons for an uncommonly high rate (6%) of malpositioned iliosacral screws could be the inappropriate quality of intraoperative fluoroscopy due to osteoporosis. Infection rate was not significantly higher than in younger patients due to mostly minimally invasive techniques.

As shown previously by studies from Hill et al and Koval et al, we found a long hospital stay for both operatively and nonoperatively treated patients.^{8,10} Operatively treated patients were hospitalized significantly longer (18.2 ± 10.1 days vs 9.4 ± 6.4 days). Assessing this result, we have to consider the average time from admission to surgery (6.4 ± 4.1 days). More knowledge on factors leading to a failure of nonoperative treatment might allow a quicker decision-making and earlier operative treatment if needed. Without proof, this also might lower the length of hospital stay and perioperative complication rate. Other reasons for a long hospital stay are on one side the preoperative preparations needed (eg, cardiac examinations for anesthesia) and postoperative management of further outpatient treatment and support.

An important finding is the rate of 18% of patients with failure of conservative treatment. Due to increasing pain and worsening of mobility, an operative treatment became necessary within 3 weeks after discharge in these patients. In the present study, no influencing factors leading to a failure of nonoperative treatment could be found.

Quality-of-life scores after at least 2 years showed no difference between groups. Also, functional outcome results were not statistically different. Many patients showed in follow-up examinations several reasons besides pelvic fracture for bad functional results, for example, other fractures in history, osteoarthritis, and degenerative spinal diseases.

The age difference between groups must be considered to give perspective to the significantly higher survival rate of operative stabilized patients. Patients were, on average, within the range of typical life expectancy, so an age difference of 4.4 years can explain the difference in survival rate. Overall, the 2-year mortality is 30% high and comparable with published data on patients with proximal femoral fractures.²⁹

Conclusion

Elderly patients with lateral compression pelvic ring fractures involving the sacrum have high risk for complications and mortality. Although operatively treated patients show potentially higher complication rates, the 2-year mortality suggests an advantage for operative treatment of lateral compressions fractures in the elderly patients. However, this advantage is possibly due to the lower mean age of the operatively treated group.

Indeed, based on this study, a clear superior position for operative treatment is not given but data are lacking for alternative treatment algorithms, especially for refractory nonoperative, immobilized patients. Hence, for these patients, operative stabilization is the recommended therapy with the

aim to reduce complications related to prolonged bed rest and ensure early mobilization. Thus, the authors suggest taking the risks of operative treatment into account is more favorable than decreasing mobilization and enhancing complications related to bed rest. Further prospective studies are needed to identify factors influencing the clinical course of these fractures in the elderly patients to develop an evidence-based treatment algorithm.

Acknowledgments

The authors acknowledge the support from Jocelyn Todd for proof-reading as native speaker.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

References

- Rommens PM, Ossendorf C, Paireon P, et al. Clinical pathways for fragility fractures of the pelvic ring: personal experience and review of the literature. *J Orthop Sci.* 2015;20(1):1-11.
- Stuby FM, Schäffler A, Haas T, et al. Insuffizienzfrakturen des Beckenrings. *Unfallchirurg.* 2013;116(4):351-366.
- Lau T, Leung F. Occult posterior pelvic ring fractures in elderly patients with osteoporotic pubic rami fractures. *J Orthop Surg (Hong Kong).* 2010;18(2):153-157.
- Tosounidis G, Wirbel R, Culemann U, et al. Fehleinschätzung bei vorderer Beckenringfraktur im höheren Lebensalter. *Unfallchirurg.* 2006;109(8):678-680.
- Böhme J, Höch A, Boldt A, et al. Einfluss der Standard-Computertomografie hinsichtlich Frakturklassifikation und Therapie von Beckenringfrakturen bei Patienten über dem 65. Lebensjahr. *Z Orthop Unfall.* 2012;150(5):477-483.
- Scheyerer MJ, Osterhoff G, Wehrle S, et al. Detection of posterior pelvic injuries in fractures of the pubic rami. *Injury.* 2012;43(8):1326-1329.
- Dechert TA, Duane TM, Frykberg BP, et al. Elderly patients with pelvic fracture: interventions and outcomes. *Am Surg.* 2009;75(4):291-295.
- Koval KJ, Rosenberg AD, Zuckerman JD, et al. Does blood transfusion increase the risk of infection after hip fracture? *J Orthop Trauma.* 1997;11(4):260-265; discussion 265-266.
- Alnaib M, Waters S, Shanshal Y, et al. Combined pubic rami and sacral osteoporotic fractures: a prospective study. *J Orthop Traumatol.* 2012;13(2):97-103.
- Hill RM, Robinson CM, Keating JF. Fractures of the pubic rami. Epidemiology and five-year survival. *J Bone Joint Surg Br.* 2001;83(8):1141-1144.
- Rommens PM, Hofmann A. Comprehensive classification of fragility fractures of the pelvic ring: recommendations for surgical treatment. *Injury.* 2013;44(12):1733-1744.

12. Böhme J, Höch A, Josten C. Osteoporotische Frakturen. *Chirurg.* 2012;83(10):857.
13. Bruce B, Reilly M, Sims S. OTA highlight paper predicting future displacement of nonoperatively managed lateral compression sacral fractures: can it be done? *J Orthop Trauma.* 2011;25(9):523-527.
14. Höch A, Schneider I, Todd J, et al. Lateral compression type B 2-1 pelvic ring fractures in young patients do not require surgery [published online May 2, 2016]. *Eur J Trauma Emerg Surg.* 2016.
15. Beckmann JT, Presson AP, Curtis SH, et al. Operative agreement on lateral compression-1 pelvis fractures. A survey of 111 OTA members. *J Orthop Trauma.* 2014;28(12):681-685.
16. Ellert U, Bellach BM. Der SF-36 im Bundes-Gesundheitssurvey—Beschreibung einer aktuellen Normstichprobe. *Gesundheitswesen.* 1999;61 Spec No: S184-90.
17. Boufous S, Finch C, Lord S, et al. The increasing burden of pelvic fractures in older people, New South Wales, Australia. *Injury.* 2005;36(11):1323-1329.
18. Peters E, Pritzkeleit R, Beske F, et al. Demografischer Wandel und Krankheitshäufigkeiten. *Bundesgesundheitsbl.* 2010;53(5):417-426.
19. Quansah B, Stammers J, Sivapathasuntharam D, et al. Fragility pelvic fractures in the elderly population. *Hard Tissue.* 2013;2(1). Web site. <http://www.oapublishinglondon.com/article/314>.
20. Kannus P, Palvanen M, Niemi S, et al. Epidemiology of osteoporotic pelvic fractures in elderly people in Finland: sharp increase in 1970-1997 and alarming projections for the new millennium. *Osteoporos Int.* 2000;11(5):443-448.
21. Breuil V, Roux CH, Testa J, et al. Outcome of osteoporotic pelvic fractures: an underestimated severity. Survey of 60 cases. *Joint Bone Spine.* 2008;75(5):585-588.
22. Tsiridis E, Upadhyay N, Giannoudis PV. Sacral insufficiency fractures: current concepts of management. *Osteoporos Int.* 2006;17(12):1716-1725.
23. Morris RO, Sonibare A, Green DJ, et al. Closed pelvic fractures: characteristics and outcomes in older patients admitted to medical and geriatric wards. *Postgrad Med J.* 2000;76(900):646-650.
24. Dittmer DK, Teasell R. Complications of immobilization and bed rest. Part 1: Musculoskeletal and cardiovascular complications. *Can Fam Physician.* 1993;39:1428-1432, 1435-1437.
25. Teasell R, Dittmer DK. Complications of immobilization and bed rest. Part 2: Other complications. *Can Fam Physician.* 1993;39:1440-1442, 1445-1446.
26. van Dijk WA, Poeze M, van Helden SH, et al. Ten-year mortality among hospitalised patients with fractures of the pubic rami. *Injury.* 2010;41(4):411-414.
27. Zwingmann J, Südkamp NP, König B, et al. Intra- and postoperative complications of navigated and conventional techniques in percutaneous iliosacral screw fixation after pelvic fractures: results from the German Pelvic Trauma Registry. *Injury.* 2013;44(12):1765-1772.
28. Pavelka T, Salášek M, Weisová D. Komplikace operačního léčení zlomenin pánevního kruhu. *Acta Chir Orthop Traumatol Cech.* 2013;80(3):208-215.
29. Nazrun AS, Tzar MN, Mokhtar SA, et al. A systematic review of the outcomes of osteoporotic fracture patients after hospital discharge: morbidity, subsequent fractures, and mortality. *Ther Clin Risk Manag.* 2014;10:937-948.