

General

Complications following surgical treatment of ankle fractures in the elderly: can they be avoided?

Lukas Welzel^{1,2,3}, Mohamed Omar, Prof. Dr. med.², Christian Walter Müller, Priv. - Doz. Dr. med.¹

¹ Department of Orthopedics and Traumatology, Asklepios Klinik Wandsbek, ² Department of Traumatology, Hannover Medical School, ³ Department of Orthopedics and Traumatology, Schön Klinik Neustadt

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Background

Following surgical treatment of ankle fractures, geriatric patients face high complication rates (CR) in literature. Commonly used diagnostic and treatment algorithms fail to consider requirements of ageing patients which increases the risk of postoperative complications.

Objective

Present study critically evaluated surgical management of ankle fractures in patients over 65 years old, with focus on identifying modifiable risk factors and effective comorbidity management strategies.

Methods

We conducted a retrospective single-center study on patients who underwent surgical treatment of an ankle fracture. Based on their age, participants were divided into non-geriatric patients (NGP<65y) and geriatric patients (GP≥65y). We analyzed overall CR and number of minor and major complications in relation to timing of surgery, biological sex, injury pattern, osteosynthesis, pre-existing medical conditions, and postoperative care.

Results

402 patients were included. GP encountered significantly higher overall ($p<0.001$), minor ($p<0.001$) and major ($p=0.003$) complications. They presented more complex, displaced and open fractures. Predominant factor contributing to higher CR in NGP and markedly in GP was concomitant diseases, presenting a strong OR of 19,290 ($p<0.001$) and 17,022 ($p<0.001$). Delaying surgery and managing comorbidities preoperatively had a favorable impact.

Conclusion

We revealed a high significant correlation between pre-existing medical conditions and postoperative results. To ascertain viability of delayed surgery in facilitating additional diagnostics and treatment of comorbidities, further comparative trials with a larger cohort are imperative.

INTRODUCTION

Following surgical treatment of ankle fractures, geriatric patients face high complication rates (CR) up to 30%¹ or even 40%² in literature. Considering epidemiological, demographic trends^{3,4} and functional demands of ageing patients, current – almost standardized - concepts appear to be inadequate and need to be adapted to meet specific needs of geriatric patients.

Since the main treatment goal in GP is fast re-mobilization, conservative treatment is usually reserved for stable, undisplaced fractures or patients who cannot undergo surgery. But due to comorbidities such as diabetes mellitus,⁵ reduced peripheral blood supply,⁶ obesity,⁷ smoking,⁸

polypharmacy⁹ or poor soft tissues,¹⁰ surgical treatment can be challenging.

Reduced bone quality often results in complex fractures following low-energy traumas.¹¹ To avoid long lasting cast immobilization and associated risk for redislocation or skin necrosis,¹² operative treatment is often chosen for better functional results.¹³

This study critically evaluates surgical management of ankle fractures in patients over 65 years old, with focus on identifying modifiable risk factors and effective comorbidity management strategies.

Figure 1. Minor and Major Complications

Minor complications	Major complications
Impairment of Wound Healing	Secondary Dislocation/Implant Failure
Irritation of Tendon	Deep Infection
Delayed Fracture Healing	Pseudarthrosis
Thrombosis	Pulmonary Embolism
	Death

METHODS

ETHICAL CONSIDERATIONS

For this article, none of the authors conducted studies involving human participants or animals in accordance with ethical standards. Retrospective data collection was anonymized. Institutional ethics committee approval has been obtained (protocol No. 9555_BO_K_2021; Hanover Medical School (MHH)).

STUDY DESIGN

In a retrospective single-centre data analysis, patients were evaluated, who underwent surgical treatment of an ankle fracture in a level-II trauma centre in 2015-2021. Pilon- and conservatively treated fractures were excluded.

Based on their age, patients were categorized into 'NGP' (non-geriatric patients; < 65 years at time of surgery) and 'GP' (geriatric patients; ≥65 years).

Complication rates (CR) were classified as 'major complications' (requiring further surgical intervention or leading to patient death) and 'minor complications' (requiring non-invasive treatment) – [Figure 1](#).

CR were calculated for both, GP and NGP groups, considering biological sex, age, timing of surgery (immediate, within 24 hours, or delayed after closed reduction and immobilization), and injury pattern (simple or complex, with associated fractures of the medial malleolus, posterior malleolus, syndesmosis rupture, dislocation or luxation). Risk factors such as concomitant diseases (e.g. diabetes mellitus, peripheral artery disease, chronic venous insufficiency, obesity, osteoporosis, prior history of cancer, alcoholism, heart failure etc.) were identified. We evaluated their influence in postoperative complications and examined type of osteosynthesis employed and the impact of weight-bearing (fully or partially) or non-weight-bearing mobilization on complication rates for NGP and GP patients, along with treatment procedures in postoperative care.

STATISTICS

Microsoft Excel (Microsoft Corporation; Version 2401) and SPSS Statistics (IBM International Business Machines Corporation; Version 29.0.1.0) were used for statistical analysis. Considering data distribution, χ^2 - and Mann-Whitney-U-test was employed for statistics. Logistic regression was

used for regression analysis. Significance level was set to 5% ($\alpha=0.05$).

RESULTS

N=402 patients were included. N=253 (63%) were women, n=149 (37%) men. Mean age at time of surgery was 57,6 years (range 16-92 years).

N=237 (59%) were assigned to NGP-group, comprising n=122 (52%) women and n=115 (48%) men with a mean age of 44,5 years (range 16-64 years) – [Figure 2](#).

N=165 (41%) patients were assigned to GP-group, comprising n=131 (79%) women and n= 34 (21%) men. Mean age was 76,4 years (range 65-92 years) – [Figure 2](#).

Sex ratio was approximately equal (1:1) in NGP, whereas in GP it was about 4:1 in favor of women – [Figure 2](#).

INJURY PATTERN

While ratio of simple versus complex fractures, such as bi- or trimalleolar fractures, was about equal in the NGP group, GP displayed a marked increase in complex, open or dislocated fractures – [Figure 2](#).

SURGICAL STRATEGIES

Surgical procedures performed in GP resulted in an overall CR of 26% (n=42) compared to 8% (n=19; $p<0.001$) observed in NGP. They exhibited higher number of major (n=23; 14%; $p=0.003$) and minor complications (n=19; 12%; $p=0.001$) in comparison to NGP – [Figure 3](#).

Plate osteosynthesis was performed in n=151 (92%) GP using a standard lateral approach and plate positioning. N=128 (85%) received third tubular plates, n=23 (15%) were treated with locking implants. Different types of plates did not demonstrate significant differences in minor ($p=0.673$), major ($p=0.067$), or overall complication rates ($p=0.248$).

A minority of patients underwent other internal osteosynthesis procedures, including intramedullary screws (n=3), fibular nails (n=1), or arthrodesis (n=2). Primary stabilization using an external fixator was performed in n=22 (13%) cases.

RISK FACTORS

Complications in younger patients had various causes. In contrast, high rates in GP were mainly due to displaced fractures and, to a significant extent, comorbidities – [Figure 4](#).

Figure 2. Distribution of age, biological sex, injury pattern and complications in NGP and GP

Total n=402	NGP < 65y.	GP > 65y.	Value p
Number n	237 (59%)	165 (41%)	-
Ø Age	44,5 y.	76,4 y.	-
Range	16 - 64 y.	65 - 92 y.	-
Men	115 (48%)	34 (21%)	-
Female	122 (52%)	131 (79%)	-
Sex ratio	1:1 (m:f)	1:4 (m:f)	-
Simple fracture	120 (51 %)	48 (29 %)	p < 0,001
Complex fracture	117 (49 %)	117 (71 %)	p < 0,001
Open fracture	4 (2%)	11 (7 %)	p = 0,010
Displaced fracture	70 (30 %)	73 (44 %)	p = 0,002
Overall complications	19 (8 %)	42 (26 %)	p < 0,001
Major complications	13 (6 %)	23 (14 %)	p = 0,003
Minor complications	6 (3 %)	19 (12 %)	p < 0,001

Figure 3. Distribution of minor and major complications in NGP and GP

	NGP Number n	GP Number n
Overall CR	19 (8%)	42 (26%)
Minor complications	6	19
Impairment of wound healing	5	17
Irritation of tendon	-	1
Delayed fracture healing	-	1
Thrombosis	1	-
Major complications	13	23
Secondary dislocation	6	9
Deep infection	7	10
Pseudarthrosis	-	1
Pulmonary embolism	-	1
Death	-	2

Figure 4. Risk factors and their impact on complication rate

Risk factor	NGP	GP
Simple/complex fracture	p=0,027	p=0,205
Open fracture	p=0,002	p=0,390
Displaced fracture	p=0,021	p=0,021
Comorbidities	p<0,001	p<0,001
Sex	p=0,394	p=0,772

Regression analysis identified prior diseases as a primary risk factor for major (OR 19,290; 95% CI 7,623-48,818; p<0.001) and minor complications (OR 17,022; 95% CI 5,855-49,489; p<0.001) in NGP and GP. In all GP, prevalence of comorbidities was 32% (n=53), while comorbidities were present in 91% (n=38) of all GP with complications.

With concomitant diseases present, CR was 72% (n=38) compared to 4% (n=4) without (p<0.001). After additional preoperative screening and treatment for pre-existing conditions, which was received by 14 (26%) of comorbid GPs, overall complication rate was 43% (n=6/14), while CR was 82% (n=39) without. There was a statistically significant difference in the occurrence of overall (p=0.005) and minor complications (p=0.029) between those with and without it.

TIMING OF SURGERY

N=31 (19%) geriatric patients underwent surgery on day of trauma and the overall complication rate was 11/31 (36%) including 5/31 major and 6/31 minor complications.

Regression analysis couldn't reveal any disadvantage between timing of surgery and major (OR 0,964; 95% CI 0,870-1,067; p=0,478) or minor complication rate (OR 0,982; 95% CI 0,873-1,104; p=0,757) – **Figure 5**.

In patients suffering from comorbidities, CR was 9/10 (90%) following immediate surgical treatment, while it was 21/31 (68%) with delayed surgical treatment between 3rd and 7th day following trauma ($p=0.136$).

However, delaying surgery to run diagnostic and treatment procedures for comorbidities corresponded with a reduced complication rate of 3/10 (30%; $p=0.004$).

POSTOPERATIVE AFTERCARE

In 99% of patients ($n=164$), rebound air walker was used for postoperative aftercare, including 75% ($n=123$) undergoing at least half- or fully-weight-bearing. 25% ($n=42$) were treated with non-weight-bearing mobilization according to the surgeon's preference. Both groups had comparable overall ($p=0.343$), minor ($p=0.077$) and major ($p=0.659$) complications, with a rate of 24% ($n=29$) in the weight-bearing group and 31% ($n=13$) in the non-weight-bearing group. Most complications during weight-bearing mobilization were $n=9$ impairments of wound healing, $n=9$ cases of deep infections, and $n=5$ secondary dislocations. The number of subsequent surgical interventions was almost identical under non-weight-bearing ($n=6$; 14%) and weight-bearing ($n=16$; 13%; $p=0.833$) mobilization.

DISCUSSION

Following surgical treatment of ankle fractures in the elderly, our data show massively higher overall, minor and major complications than in younger ones. This is congruent with existing international literature and reported outcomes of up to 30%¹ or even 40%² indicating that surgical intervention for ankle fractures presents a high-risk approach for elderly patients. Due to increasing demands of elderly patients, surgical treatment should be performed to achieve the best functional outcomes¹³ and to avoid cast immobilization.¹²

RISK FACTORS

Although postoperative complications display a variety of factors in younger patients, in geriatric ones, in our findings, concomitant diseases, represent the most significant and potent risk factor with a remarkable odds ratio for minor and major complications. Previous studies identified various influential factors, such as multimедication with more than three drugs,⁹ smoking,⁸ diabetes,⁵ reduced blood supply,⁶ advanced age^{6,14} or heart failure,⁶ necessitating individualized perioperative management to prevent predictable complications.

COMORBIDITY STRATEGIES

Given the low percentage of 26% in our data, it appears that the number of comorbid GP receiving additional preoperative diagnostics and therapy for prior conditions is inadequate. Consequent assessment of blood glucose,¹⁵ evaluation of limb blood supply,¹⁶ and at a minimum, additional CT diagnostics are recommended.¹⁷ Aigner et al.¹⁶ recently demanded a standardized pre-operative diagnostic algo-

rithm to minimize complications. Pulse palpation and clinical assessment are naturally required, but due to the large number and varied nature of comorbidities, it is crucial to consider all concurrent medical conditions. Orthogeriatric co-management may be beneficial in improving outcomes¹⁸ by addressing concomitant diseases.

TIMING OF SURGERY

Due to the high incidence of dislocated fractures and compromised soft tissue in elderly patients, immediate definitive surgery may not be feasible. However, delaying surgery may not have negative consequences.¹⁹ Until soft tissue permits surgical intervention, instant reduction and immobilization should be considered as necessary regardless of timing of surgery. Given the risk of loss of reduction with cast immobilization,¹² temporary fixation with an external fixator¹² or K-wire transfixation²⁰ as a temporary hindfoot arthrodesis may be used for primary stabilization. The time delay can be useful to conduct supplementary diagnostics for concomitant diseases.

SURGICAL STRATEGIES

Our data mainly presented one surgical approach to the ankle and plate positioning. It is important to note, that older patients may require more tailored procedures. Considering better soft tissue cover of implants, a posterolateral approach can be used for posterior malleolus fractures^{25,21} as it allows simultaneous access to the fibular fracture, while antiglide plating of distal fibula appears to result in fewer hardware removal and reoperations than lateral plate positioning.^{22,23} Bariteau et al.²⁴ found that locking implants in lateral position provide greater stability in comminuted fractures. However, other authors take a critical view,^{25,26} indicate higher costs and risk of wound complications.²⁷ In particular, a posterolateral approach can be used for posterior malleolus fractures, as it provides simultaneous access to the fibular fracture and better soft tissue coverage of the implants.^{26,27} To increase stability of the osteosynthesis, various treatment options are available, such as the combination of two non-locking plates²⁸ (posterior and lateral), the "K-Wire-Cage" technique²⁹ or the "Tibia-Pro-Fibula" concept.³⁰ In older patients with poor soft tissue conditions, it is recommended to consider less invasive techniques with small skin incisions, such as intramedullary fixation like retrograde percutaneous cannulated screw fixation³¹ of malleolus as well as intramedullary implants like fibular nails³² or Illuminoss.³³ Primary nail arthrodesis with a hindfoot nail can provide favorable outcomes in cases of severely compromised soft tissue and in patients with lower functional demands, allowing for early weight-bearing mobilization.³⁴

LIMITATIONS

The study has some limitations that need to be considered. Firstly, it is retrospective in nature, meaning that only data from patients and complications treated in the same hospital could be collected. The patients were not explicitly

called. Secondly, it is difficult to create a viable and useful strategy for comorbidities, as the percentage of patients receiving additional diagnostics and treatment for concomitant diseases is low. Further trials with larger cohorts are necessary to determine viability, possibly in a prospective manner.

CONCLUSION

Our data clearly demonstrate that surgical treatment of ankle fractures in elderly patients is a challenging task. We have considered both patient-related and non-patient-related conditions during the high-volume data collection process. Our findings highlight the urgent need to identify individual risk factors, such as comorbidities, which are emphasized by a remarkable odds ratio. It is important to optimize any modifiable factor, especially diagnosis and treatment of concomitant diseases before entering the operating room. Considering their impact on postoperative complication rates, orthogeriatric co-assessment, like that

used in management of hip fractures, may be helpful in pre- and post-operative course to manage risk factors. As our findings did not show any negative impact of delayed surgery, in patients with a comorbid high-risk profile immediate definitive surgical intervention should be avoided in favor of prior treatment of comorbidities. Perioperative strategies must consider specific needs of ageing patients. Tailored concepts regarding surgical approach, osteosynthesis procedures, considering any available system, timing of surgery, early weight bearing mobilization and particularly effective comorbidity strategies are warranted. It is imperative to conduct further comparative trials with a larger cohort to find a viable, adapted treatment regimen for handling these frequent but high-risk patients.

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