

Ankle fractures in the elderly: Do we have new concepts?

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- The relevance of geriatric ankle fractures is continuously increasing.
- Treatment of these patients remains challenging and requires adapted diagnostic and therapeutic strategies, as compliance to partial weight bearing is difficult to maintain compared to younger patients.
- In addition, in the elderly even low impact injuries may lead to severe soft tissue trauma, influencing timing and operative strategies.
- Recently, the direct posterolateral approach and plate fixation techniques, angular stable implants as well as intramedullary nailing of the distal fibula have been found to improve stategical concepts.
- This article aims to provide a comprehensive overview of the diagnostic and recent aspects with respect to how this difficult entity of injuries should be approached.

Keywords

- ▶ ankle
- ▶ fracture
- ▶ elderly

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Epidemiology

Ankle fractures are very common, with an annual incidence of 74 per 100 000 people and a mean age of 56 years in Germany (1). Interestingly, 60% of the fractures occur in women with an increase of the incidence between the age of 40 and 70 years (1). With the demographic changes, the relevance of ankle fractures particularly in the elderly will increase. However, there are several differences regarding the diagnostics, fracture pattern and the treatment strategies when comparing the elderly population to younger patients.

Pre-existing conditions

Elderly people suffer more frequently from comorbidities, which will affect the incidence and outcome of ankle fractures. Female gender, high BMI, diabetes, polymedication as well as drug abuse and smoking have been determined as independent risk factors for sustaining an ankle fracture (2, 3). In contrast to other fractures, for example proximal femur or vertebral body, a clear causality between osteoporosis and ankle fractures has so far not been proven (4). However, there seems to be a positive correlation between bone mineral density and ankle fractures of the elderly (5, 6). Furthermore, in the geriatric population, changes of the neurovascular status as well as wound healing disorders, skin necrosis and implant failure occur frequently (7). Therefore, the treatment of these

fractures remains a challenge, requiring soft tissue-related and treatment strategies.

Trauma mechanism

In the elderly, low-energy trauma is more dominant (8, 9). Still, the fracture pattern seems to be more complex, compared to younger patients, presenting areas with multifragmentary and comminuted pathologies (7, 8). Unstable pronation–abduction injuries (stage III), according to Lauge–Hansen classification, are more common in people older than 60 years (10). These fractures frequently compromise the medial soft tissue envelope, which increases the severity (7).

Diagnostics

The radiographic assessment regularly includes a conventional x-ray of the ankle joint in two planes. As the complex fracture patterns in the elderly may predominate and as x-ray lacks sensitivity in the detection of multifragmentary fibular fractures or bony avulsions of the anterior inferior tibiofibular ligament (11), a preoperative CT scan is therefore recommended.

Furthermore, up to 25% of the posterior malleolus fractures are missed by conventional plain radiographs (11).

Besides the radiologic diagnostics, the evaluation of the soft tissue coverage and pre-existing conditions is not only crucial but affects the timing of as well as the definitive

treatment decision. Peripheral artery disease (PAD) is a common and underestimated comorbidity. Therefore, a regular diagnostic algorithm, including the ankle–brachial index, a duplex sonography and – depending on the findings – a CT angiography, is recommended. The standardized diagnostic optimization of the vascular supply in patients with PAD was able to reduce the complication rate in geriatric ankle fractures significantly (12).

Treatment options

The general consideration of treating an ankle fracture in the elderly conservatively or operatively still remains a subject of debate. Fracture dislocations must be reduced and constrained immediately. Here, transfixation with an external fixator becomes increasingly the treatment of choice. It protects the compromised soft tissue, reduces pain and offers stability as well as immediate access to the soft tissue (7). At the moment, these recommendations are not yet state of the art, due to the necessity of an additional operation. However, it opens a window to find the best team, to evaluate preoperative planning as well as to assess the patient's compliance with the postoperative course.

'Stable' ankle fractures may be defined as an isolated fibula fracture with a medial clear space of <4 mm in the mortise view. To detect instability, additional weightbearing x-rays and a GravityView can be performed (7). Stable fractures can be treated conservatively with either a closed contact plaster or a walker for 6–8 weeks.

Besides the fracture pattern, the treatment especially in the geriatric population significantly is affected by the soft tissue status and the pre-existing conditions. The primary goal of an anatomic reconstruction of the articular surface, reduction of the distal fibula and stable retention should carefully be balanced with the status of the patient in general and the soft tissue in particular. A conservative regimen leads to a higher amount of malunions and non-unions of up to 73%, whereas open reduction and internal fixation (ORIF) provides a consolidation rate up to 100% (13, 14). However, the complication rate after surgery in the elderly people is up to 22% (14, 15, 16, 17). Major complications include delayed wound healing, superficial and deep wound infections, malunions and skin necrosis, requiring revision surgery in 11% of patients over 60 years and with an in-hospital mortality rate of 3% (15, 17). The 30-day mortality rate raises up to 5.4% in patients older than 80 years after ORIF (18). Complex bony injuries such as open fractures and more complex bimalleolar and trimalleolar fractures, age, female sex and comorbidities like diabetes, smoking, dementia, osteoporosis and PAD further increase the risk of a peri- or postoperative complications (15, 19, 20).

Regarding the functional outcome, a current systematic review and meta-analysis including eight prospective randomized controlled studies and 1237 patients provides equal results for conservative and surgical treatment in ankle fractures (21). A randomized controlled trial comparing closed contact casting to ORIF in unstable ankle fractures in 593 patients over 60 years describes a similar Olerud and Molander ankle score (OMAS), quality of life, pain, ankle motion, mobility and patient satisfaction after 6 months. However, 19% of the patients in the casting group were converted to surgery due to loss of reduction (22). Consequently, the decision of either conservative or operative handling remains an individual decision. The treatment aims to achieve a stable union and preserve quality of life, rather than achieving anatomical reduction (23). To achieve this, there are several new techniques for geriatric ankle surgery, which are described.

Posterior malleolus fractures

Pronation–abduction injuries regularly lead to a bony avulsion of the posterior syndesmosis – the posterior malleolus (PM). Because of a consecutive instability of the ankle joint, reduction and fixation of the PM is recommended in order to restore the stability of the mortise for PM fractures involving the tibial incisura (24, 25). A historical – size based – indication for operative management of the PM fragment, for example 25% of the articular surface, is now replaced by a morphology-adapted approach. Here the biomechanical aspect of the unstable syndesmosis is the key (25, 26). A direct posterolateral approach clearly increases stability as well as the quality of reduction, compared to an indirect anterior–posterior screw placement (27). Additionally, the stabilization of the PM reduces the risk of complications and enhances the functional outcome compared to an AP lag screw (28, 29). In addition, the need of implantation of a transsyndesmotomic fixation is far lower after ORIF (30). Further benefits of the direct posterolateral approach are the improved soft tissue coverage of the implant and the option of a posterior plate osteosynthesis of the distal fibula with a sufficient peroneal tendon soft tissue coverage (7). The possibility of implanting a lag screw through the plate across the fracture and the placement of longer, bicortical screws in the distal fragment of the distal fibula fracture (dorsal antiglide plate) increase the biomechanical stability compared to a standard lateral plate fixation (31) (Figs. 1 and 2).

Angular-stable locking plates

Locking plates were designed predominantly for the elderly population, as they enhance the stability and reduce wound healing problems (32, 33, 34). However, a meta-analysis of biomechanical studies showed

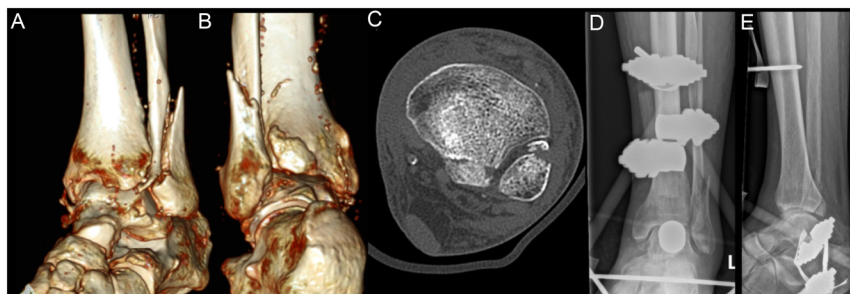


Figure 1
Male patient, 86 years suffering an unstable trimalleolar ankle fracture after a fall at home. (A, B) 3D CT images. (C) Axial CT image. (D, E) X-rays after transfixation with external fixator.



Figure 2
ORIF with three-hole one-third tubular plate for PM fixation, ORIF fibula with 2.7 mm lag screw + 3.5 mm LCP, ORIF Mall. medialis with hook plate LCP. (A) Retention of external fixator for soft tissue consolidation after ORIF. (B, C) X-rays after removal of external fixator 1 week after ORIF. (C) Soft tissue condition during ORIF.

no superiority of lateral locking plates compared to conventional lateral plates but an equal stability also in weak bone, indicating a beneficial effect in osteoporotic bone (35). A posterior polyaxial locking plate showed biomechanically no difference to a non-locking posterior plate (36) (Figs. 3, 4 and 5).

Intramedullary fibula nail

The minimal invasive implantation of intramedullary nails (INs) for unstable distal fibula fractures minimizes the soft tissue damage during the fibula osteosynthesis. However, these new implants might lack the reliability of

anatomic reconstruction. Previous studies revealed not only fewer complications of INs compared to standard plate osteosynthesis but also an equal functional outcome (37, 38). Intramedullary nailing bears the advantage of immediate full weightbearing and provides the same biomechanical stability compared to a lag screw in combination with a locking plate (39, 40). A systematic review with 627 patients treated with a locked IN stated a consolidation rate of 98% with an infection rate of 1% and skin necrosis in 0.6% (41). A recent meta-analysis consisting of four randomized controlled trials with 359 patients comparing IN to ORIF demonstrated fewer wound-related complications and a better functional short-term

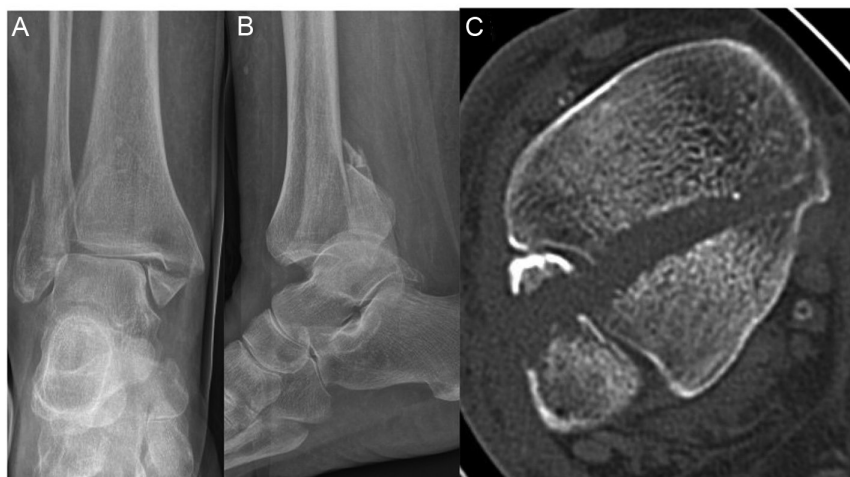


Figure 3
Female patient, 86 years, suffering from diabetes and who had a fall at home. Highly unstable trimalleolar ankle fracture. (A, B) Conventional AP and lateral x-ray with ankle dislocation. (C) Axial CT image with large posterior malleolus fracture (Bartonicek IV).

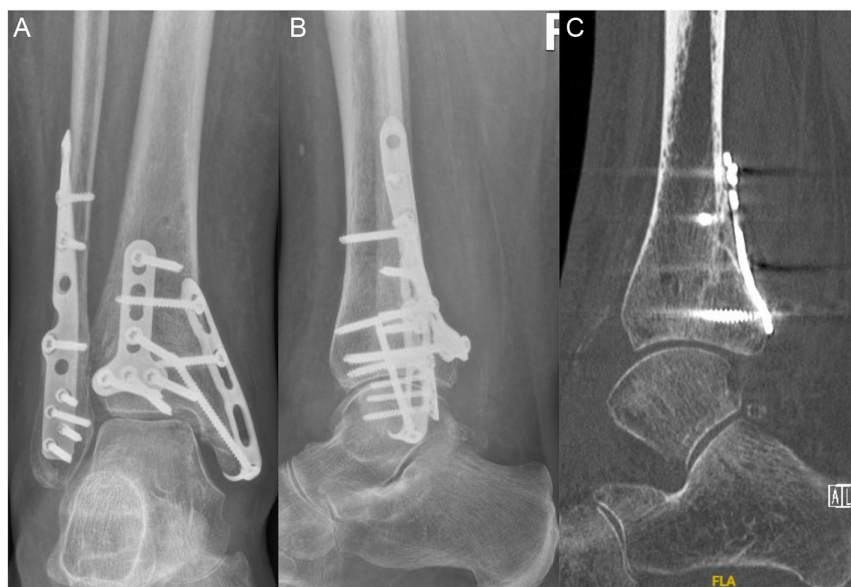


Figure 4

(A, B) X-ray 3 months after ORIF of PM with 3.5 mm T-Plate, ORIF fibula with anatomical 3.0/3.5 mm posterolateral plate, ORIF malleolus medialis with 2.7 mm hook plate LCP. (C) Sagittal CT image showing consolidation of PM fracture.

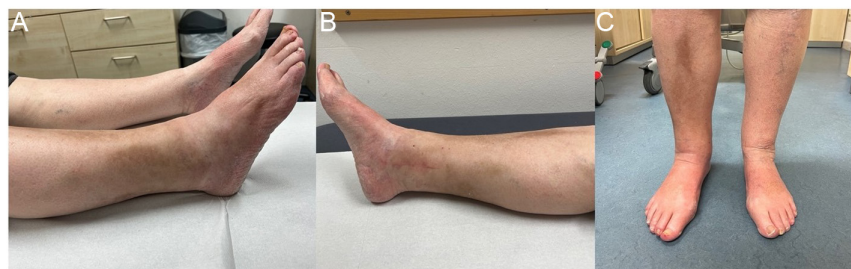


Figure 5

Soft tissue 3 months after ORIF of complex trimalleolar ankle fracture (see Figs. 3 and 4). Full weightbearing.

3-month-follow-up for the IN group but no significant differences regarding the overall complications, midterm functional outcome and quality of reduction (42).

Primary hindfoot arthrodesis

In elderly patients suffering an unstable ankle fracture with severe soft tissue impairment or relevant comorbidities such as diabetes mellitus, an open reduction and internal fixation might be an unsafe option. These patients are often incapable of partial weightbearing and therefore require a treatment option allowing full weightbearing. A primary arthrodesis of the hindfoot including the ankle and subtalar joint (tibiototalcalcaneal arthrodesis (TTC)) might be a safe option for geriatric patients with a consolidation rate of up to 95% and the advantage of allowing immediate full weightbearing (43) and a minimal invasive technique with a hindfoot nail. Furthermore, an atypical, closed reduction and insertion of the nail without an open removal of the cartilage is recommended by some authors, as soft tissue-related complications are minimized by this technique (44). We personally do not have any experience with this modified technique. Recently, a prospective randomized controlled study including 87 patients demonstrated an equal

functional outcome of the TTC arthrodesis compared to ORIF, whereas the revision rate seems to be significantly lower (TTC 3% vs ORIF 14%) (45). A systematic review and meta-analysis by Lu *et al.* revealed high complication rates after TTC arthrodesis with 10% superficial infection, 8% deep infection, 11% implant failure, 11% malunion and 27% all-cause mortality in a high-risk patient cohort with a mean age of 78 years and a diabetes mellitus prevalence rate of 42% (46). These disappointing reports must be seen in relation to the severity of complex bi- or trimalleolar fractures (Figs 6 and 7).

Further options

In cases of a geriatric comminuted distal fibula fracture, some authors propose double plating of the distal fibula in a dorsal and lateral position (47, 48). Compared to an angular stable locking plate, conventional double plating reaches an equal biomechanical stability (49). The incidence of implant irritation seems not to be increased (50).

Tibia-pro-fibula screws, inserted through a fibula plate into the tibia, are another option to strengthen the osteosynthesis in ankle fractures with an increased biomechanical stability compared to locking plates and

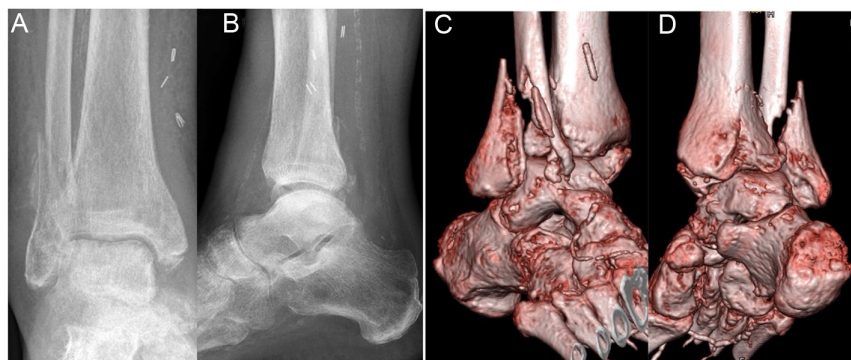


Figure 6

Male patient, 79 years, who had a fall during stay in cardiology (revision of pacemaker). Complex trimalleolar ankle fracture with multifragmentary fibula fracture, posterior malleolus fracture (Bartonicek II) and multifragmentary malleolus medialis fracture. Comorbidities: coronary heart disease with bypass operation 5 years before. (A, B) Plain radiographs after closed reduction. (C, D) 3D CT scan images.



Figure 7

Hindfoot arthrodesis with HAN – nail and removal of cartilage in ankle and subtalar joint. (A, B) Plain radiographs 1 year after surgery. (C, D) Clinical images 1 year after surgery with full weightbearing, good soft tissue condition and no pain.

even lower complication and revision rates compared to intramedullary nailing (51, 52).

Intramedullary (cannulated) partially or fully threaded screws for distal fibula fractures might be an additional option, which allow a minimal invasive implantation with a short skin incision 1–2 cm distal to the fibula tip but bear the disadvantage of a reduced control of reduction (53).

Medial malleolus fractures

Geriatric medial malleolar fractures are often more complex due to a comminuted fracture pattern, decreased bone quality, a high grade of instability and decreased patient compliance. A more rigid and stable fixation compared to the classic fixation with two lag screws might be required. An option to increase the stability is a bicortical placement of the lag screw into the lateral tibial cortex, providing a better biomechanical, radiographic and clinical outcome compared to the monocortical placement (54). However, in cases of a more vertical fracture line or a comminuted fracture, a screw placement can be impossible. Hence, a plate osteosynthesis might be required. A hook plate LCP

osteosynthesis not only increased stability but also decreased complication and revision rates compared to screw osteosynthesis in elderly people (55, 56).

Postoperative considerations

The primary goal in the treatment of geriatric ankle fractures remains the achievement of a stable union and the conservation of the quality of life. Regular clinical and radiological follow-ups to detect and treat complications are recommended. An adequate blood sugar concentration in patients with diabetes mellitus (HbA1c <6.5%) increases the radiological and functional outcome and decreases the complication rate in ankle fractures (57, 58).

In cases of unstable ankle fractures, postoperative restricted load for 6–8 weeks might be desirable. However, partial weightbearing can be very challenging or even impossible for elderly people. Casts or walker orthosis may reduce the peak pressure with loading (59), while early physiotherapy is recommended (7). Recently, a systematic review found that early permissive weightbearing might not only be safe but even beneficial to elderly people above 80 years for both operatively and conservatively treated unstable ankle fractures (60).

ICMJE conflict of interest statement

The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of the research reported.

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