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REVIEWARTICALE

THE IMPORTANCE OF TIMING OF SURGERY IN CLOSED ANKLE FRACTURE – A LITERATURE REVIEW

Feby Andika Firdausi[1,2,*], Komang Agung Irianto Suryaningrat[3,4], Budi Utomo[5]

[1]Orthopaedic and Traumatology Department, Faculty of Medicine, Airlangga University, Surabaya, Indonesia
[2]Orthopaedic and Traumatology Department, Dr. Soetomo General Hospital, Surabaya, Indonesia
[3]Department of Public Health and Preventive Medicine, Faculty of Medicine, Airlangga University, Surabaya, Indonesia
***Corresponding Author:** Feby Andika Firdausi Orthopaedic and Traumatology Department, Faculty of Medicine, Airlangga University, Surabaya, Indonesia Orthopaedic and Traumatology Department, Dr. Soetomo General Hospital, Surabaya, Indonesia E-mail: febyandikaf@gmail.com Tel.: +62 85645113938
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ABSTRACT

Background: Ankle fractures are the second most common lower limb injury and remain a challenge for healthcare professionals due to minimal soft tissue coverage and the high potential for significant swelling. This swelling can compromise terminal vasculature in the superficial layers, reducing the tissue's reparative capacity. In closed ankle fractures, determining the appropriate timing of surgery for displaced fractures is crucial. Operating too soon increases the risk of wound healing complications, whereas delaying too long may hinder optimal anatomical reduction. Current recommendations, such as the AO/ASIF guidelines, suggest surgery within 6–8 hours of injury or delaying for 4–6 days in cases with significant edema or fracture blisters. However, these guidelines are largely based on expert opinion, and there is no definitive consensus on the optimal timing.

Objectives: To evaluate the optimal timing of surgery for closed ankle fractures and its impact on postoperative outcomes, including wound healing, systemic complications, and long-term ankle function.

Results: Existing literature indicates that both early and delayed surgeries carry risks. Early intervention may increase wound-related complications, while excessive delay may impair anatomical reduction and functional outcomes. No universally accepted cut-off point between early and delayed surgery has been established, and most evidence is based on small-scale or observational studies.

Conclusion: Determining the ideal timing for surgical intervention in closed ankle fractures is critical for minimizing complications and optimizing outcomes. High-quality, large-scale studies are needed to establish evidence-based guidelines that clearly define the threshold between early and delayed surgery.

Keywords*:* timing of surgery, closed ankle fracture, complication

INTRODUCTION

Ankle fractures are the second most common lower limb injury, with an annual incidence of around 187 cases per 100,000 population[1]. They occur most frequently in adults of working age, though the incidence is rising among elderly women[2]. Several classification systems exist for ankle fractures, with the Lauge-Hansen (LH) system being among the most widely used and accepted in clinical practice. This system classifies injuries based on the mechanism of trauma and the anatomic sequence of structural involvement—supination injuries typically progress from lateral to medial, whereas pronation injuries progress from medial to lateral[3].

Stable, low-severity ankle fractures can be treated conservatively with splint or cast immobilization, while unstable or more severe fractures generally require surgical intervention. The standard surgical approach is open reduction and internal fixation (ORIF), which has been shown to achieve good clinical results, including in geriatric patients[4-7].

In cases of open fractures, high-velocity open injuries, and polytrauma, immediate external fixation is often employed to enhance fracture stability, minimize further soft tissue and bone damage, and facilitate soft

tissue assessment prior to definitive internal fixation[8].In contrast, there is no established protocol for the optimal timing of internal fixation in closed ankle fractures. Following trauma, significant swelling of the surrounding soft tissue can compromise terminal vasculature in superficial layers, thereby reducing the tissue's reparative capacity. This post-traumatic oedema may necessitate delaying surgical intervention to allow for soft tissue recovery. However, excessive delay may lead to prolonged hospitalization, loss of initial fracture reduction, formation of obstructive bony callus, or soft tissue contracture [9,10]. The decision on surgical timing is currently left to the surgeon's judgment, highlighting the need for a clearer understanding of how timing influences patient outcomes[11].

Timing of Surgery in Closed Ankle Fracture

The timing of surgery for closed ankle fractures remains a subject of debate in many trauma units. Currently, there is no conclusive, evidence-based recommendation regarding the optimal timing of surgery for closed ankle fractures, and the decision must therefore be made on a case-by-case basis[12]. Conventional teaching suggests adopting either an early or a delayed approach to avoid excessive swelling and subsequent soft tissue complications[13]. Although no large-scale studies have established definitive guidelines, many surgeons follow the AO/ASIF recommendations, performing immediate surgery within 6–8 hours or delaying intervention for a minimum of 5–7 days with temporary plaster cast immobilization[14]. A recent guideline issued by the United Kingdom's National Institute for Health and Care Excellence (NICE) aimed to determine the optimal timing for planned surgical intervention in ankle fractures[15].

Surgery performed too soon after the injury may heighten the risk of wound-healing complications due to pronounced swelling, whereas delaying surgery for too long can make achieving accurate anatomical reduction more challenging[16]. Nine cohort studies comparing surgery within 24–48 hours to later intervention indicated that early surgery may shorten inpatient stays and reduce rates of wound infection and venous thromboembolism. Despite the very low quality of evidence, the guideline development group advised performing ankle fracture surgery ideally on the day of injury, and no later than the following day, to limit short-term complications[17]. Nevertheless, the literature remains inconsistent, with some studies associating surgical delay with higher rates of postoperative soft tissue complications—such as wound edge necrosis, blistering, and infection—while others report no significant difference between early and delayed interventions [17-21].

Complication

Complications associated with both nonoperative and operative approaches are key factors in treatment decisions. For certain fracture types, such as stable un-displaced injuries, nonoperative management is often the most suitable option, as surgical intervention in these cases may subject patients to unnecessary risks and is considered overtreatment [22-24].

Complications of nonoperative management

Nonoperative management carries potential complications, including malunion, nonunion, pain, functional loss, muscle atrophy, cartilage degeneration, joint stiffness or swelling, deep vein thrombosis (DVT), and pulmonary embolism (PE). Follow-up durations in the studies reviewed ranged from 20 weeks to an average of 7 years[25]. Secondary displacement—often necessitating surgery—may occur after swelling subsides or in cases with inherently unstable fracture patterns, as reported in 4 of 38 patients in one study[26].

Complications of operative management

Operative treatment of closed ankle fracture also carries some potential complication. Other reported complications include inadequate primary osteosynthesis, soft tissue necrosis, infection, osteitis, deep vein thrombosis (DVT), delayed or non-union, secondary displacement, refracture, stiffness, muscle atrophy, tendon insufficiency, sensory deficits, tarsal tunnel syndrome, and complex regional pain syndrome type [27,28]. The primary outcome measures for assessing the success of operative treatment should include pain, ankle functional outcomes, and the occurrence of major adverse events, the latter defined as complications requiring secondary intervention[29]. Preventive strategies include administering prophylactic antibiotics at anesthesia induction, achieving anatomical reduction with stable fixation, preserving soft tissue integrity by minimizing periosteal stripping, assessing VTE risk with appropriate management, and initiating early ankle mobilization. Successful anatomical reduction of ankle fractures requires thorough understanding of normal anatomy, with emphasis on maintaining fibular length, alignment, and rotation, as well as restoring the syndesmosis. Intraoperative radiographs should be critically evaluated for fibular length using the tibiofibular line (a line drawn from the distal fibular tubercle toward the tibia should intersect the tibial plafond on a mortise view) and the circle sign (an unbroken circle formed between the lateral recess of the fibula and the lateral process of the talus on the mortise view)[30,31].

Wound Complication and Infection

Early complications of closed ankle fractures are often related to the surrounding soft tissue envelope due to anatomical factors, as both malleoli are covered only by subcutaneous tissue. Wound complications following open reduction and internal fixation (ORIF) of ankle fractures have been reported in 1.4% to 18.8% of cases [32]. In fracture-dislocation cases, significant wound complications may develop even before any intervention. Prompt reduction of the dislocation in the emergency department can reduce the risk of further damage; therefore, it is recommended to perform reduction even before obtaining an initial radiograph. Soft tissue care during manipulation and reduction in the emergency department is equally important. If there are concerns in either regard, early orthopedic involvement is advised. When definitive management must be delayed due to excessive swelling, the fracture position should be closely monitored both clinically and radiographically[31].

Blister formation is believed to result from increased interstitial pressure due to post-traumatic edema, which reduces cohesion between epidermal cells and facilitates fluid accumulation within a blister cavity. This process is considered a cleavage injury occurring at the dermo-epidermal junction. Anatomical regions such as the ankle, where the skin is tightly adherent and lacks substantial muscle coverage, are particularly susceptible. The reported incidence of fracture blisters in ankle fractures is 6.6%. These blisters have important implications for both nonoperative and operative management. Although there is no universally accepted guideline for managing closed ankle fractures in the presence of blisters, Uebbing et al. recommended leaving the blisters intact and allowing them to heal before proceeding with surgical intervention[33].

Figure 1. The presence of blisters in a closed ankle fracture indicates poor soft tissue condition, which increases the risk of wound-related and infectious complications

Infection is a recognized complication of operative management in ankle fractures, with reported deep infection rates ranging from 1% to 8% [34-36]. Prevention remains a key consideration, and antibiotic prophylaxis should follow the local policy of the hospital and region. Infections in operated closed ankle fractures, particularly in compromised hosts such a diabetes patient or alcoholism, can be limb-threatening[37-38]. In cases where infection develops in the presence of metalwork, surgical debridement and microbiological cultures are recommended. If the implant remains stable and the fracture is unhealed (presentation within 10 weeks of the index surgery), the metalwork is typically retained, and culture-specific antibiotic suppression is initiated. Final debridement and implant removal are performed once fracture union is achieved[35].

Systemic Complication

Systemic complications following surgery can be devastating, with venous thromboembolism (VTE)—manifesting as pulmonary embolism (PE) or deep vein thrombosis (DVT)—representing a potentially life-threatening event. In patients with leg injuries immobilized in a plaster cast or brace for at least one week without prophylaxis, the incidence of VTE has been reported to range from 4.3% to 40% 3[9]. Although the exact incidence in ankle fractures is unclear, trauma database analyses have estimated rates of 0.28% for DVT and 0.21% for PE, respectively[40]. In contrast, Naumann et al. reported higher rates, with DVT occurring in 1.59% and PE in 0.88% of patients following closed ankle fracture surgery[41]. Established risk factors include a prior history of DVT, prolonged immobilization, non–weight-bearing status, body mass index >30 kg/m², pregnancy, use of oral contraceptives, age >60 years, active malignancy, recent hospital admission, and above-knee plaster application[42,41].

Late Complication

Post-traumatic osteoarthritis (PTOA) is a major late complication of ankle fractures, whether treated conservatively or surgically. Its incidence has been reported to be as high as 70%, with rotational ankle fractures being the most common cause[43]. PTOA typically develops when normal joint anatomy is not restored, most often due to malunion or nonunion, and is the leading indication for ankle arthrodesis. In cases of significant displacement, anatomical reduction-more reliably

achieved through surgical intervention-plays a crucial role in reducing the long-term risk of PTOA[43].

A key factor contributing to PTOA is valgus deformity with fibular shortening, typically resulting from fibular malunion[44]. The average latency from injury to end-stage ankle osteoarthritis has been estimated at 20.9 years[43]. Ligamentous injury is another important predisposing factor, with athletes sustaining lateral ankle sprains being particularly susceptible. Given the high incidence of ankle fracture in younger patients, the need for ankle arthrodesis in middle age is a realistic outcome of PTOA. The pathway to arthrodesis is often marked by chronic pain and functional impairment, both of which significantly impact quality of life and overall morbidity[45].

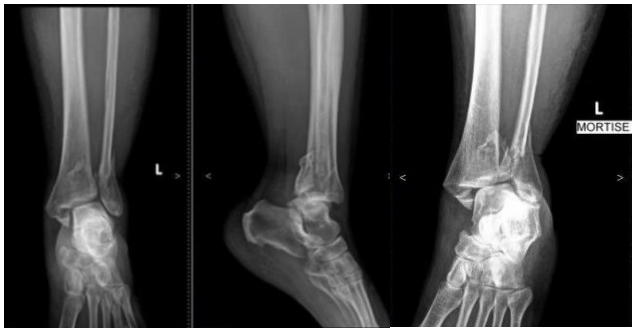

Figure 2. X-ray showing an ankle fracture-dislocation with a tri malleolar fracture. Delayed surgery can make anatomical reduction more difficult due to joint stiffness. Achieving accurate reduction is crucial, as inadequate alignment greatly increases the risk of post-traumatic osteoarthritis (PTOA) and can significantly impair ankle function.

In ankle fractures, syndesmotic disruption may occur and, if left untreated, can lead to persistent instability. When present, syndesmotic disruption is typically managed with fixation using one or more screws or a Tightrope device. Whether syndesmotic screws should be routinely removed remains a subject of debate, as leaving them in place for an extended period may contribute to joint stiffness[31].

Comorbidities

Perioperative comorbidities that can increase the risk of complications in surgical treatment of closed ankle fractures can be divided into two main categories: patient-related (host) factors and fracture-related factors.

- **Host factors** include medical conditions such as diabetes mellitus (DM), peripheral vascular disease (PVD), HIV/AIDS, inflammatory diseases, obesity, history of cigarette smoking, use of corticosteroids or other medications that impair wound healing, and prior surgery involving the injured ankle[46].

- **Fracture and injury-related factors** include the mechanism of injury, time from injury to surgery, fracture type (unimalleolar, bimalleolar, trimalleolar), presence of ankle dislocation or syndesmotic injury, and whether the injury is part of a polytrauma [32].

Diabetes mellitus is a well-recognized risk factor for infection, with reported infection rates after ORIF of ankle fractures reaching as high as 60% in diabetic patients[35]. Untreated infections in this group can lead to amputation in up to 42% of cases and mortality in 11%. The most common causative organism is *Staphylococcus aureus* (65%). Managing ankle fractures in diabetic patients is particularly challenging due to these high complication rates[35].

Two important predictors of poor outcome in diabetics are peripheral neuropathy and absent pedal pulses preoperatively. Neuroarthropathy is a significant risk factor for a broad range of complications[47]. In addition to acute postoperative issues, diabetics are at risk for delayed complications such as loss of fracture reduction, implant failure, nonunion, post-traumatic arthrosis, and Charcot arthropathy[48].

Length of Stay

The timing of surgery in closed ankle fractures can influence the total length of hospital stay (LOS) and overall inpatient costs, which may place a financial burden on healthcare systems. Several studies have shown that delaying surgery is associated with an increase in both total LOS and postoperative LOS. [49-50]. However, some studies show that it may affect total LOS, but not affecting postoperative LOS[12,51].

Post Operative Ankle Function

Postoperative ankle function can be assessed through the evaluation of dorsiflexion and plantarflexion, as well as by using validated functional scoring systems, both subjective and objective, such as the Olerud–

Molander Ankle Score (OMAS), Lower Extremity Functional Scale (LEFS), Self-Reported Foot and Ankle Score (SEFAS), or the American Orthopaedic Foot & Ankle Society (AOFAS) score [12,52,53]. Studies have shown that among these functional scoring systems, the SEFAS is specifically designed for a range of foot disorders, including ankle fractures, and demonstrates the best measurement properties[54].

DISCUSSION

The optimal timing of surgery for closed ankle fractures remains a matter of debate. Conventional teaching, including AO/ASIF guidelines, recommends either performing surgery within 6–8 hours of injury or delaying intervention for 4–6 days in the presence of significant edema or fracture blisters[14]. Determining the optimal timing for surgery in closed ankle fractures is crucial, as it can influence the risk of complications. These may include early complications, such as wound problems and infections; systemic complications, which can be life-threatening; and late complications, which may impair long-term ankle function. While some studies have shown that surgical timing affects the length of hospital stay, others have found no significant association [12,49-51].

It is important to establish a clear cut-off between early and delayed surgery for closed ankle fractures. According to the AO, two studies have evaluated outcomes in patients operated on before and after 8 hours from injury.

One study reported a higher rate of wound complications and infections in the early surgery group (< 8 hours: 26.3% vs > 8 hours: 19.8%)[12]. In contrast, another study found the opposite trend, with lower complication rates when surgery was performed early (< 8 hours: 3.8% vs > 8 hours: 11.9%)[21].

When using a cut-off of 4–6 days, eight studies are available for analysis. Two of these studies used a cut-off at 4 days. One study reported a higher complication rate in the delayed surgery group (< 4 days: 17.9% vs > 4 days: 39.5%) [55], whereas the other study showed the opposite trend (< 4 days: 12.8% vs > 4 days: 5.7%)[11].

For a 5-day cut-off, three studies are available. All three demonstrated that early surgery (before 5 days) was associated with a lower complication rate. The first study reported complication rates of < 5 days: 6.7% vs > 5 days: 11.3%[18]. The second study showed < 5 days: 15.3% vs > 5 days: 30%[56], and the third reported < 5 days: 12% vs > 5 days: 32%[57].

For a 6-day cut-off, three studies were identified. One study found no significant difference in total complication rates between early and delayed surgery (< 6 days: 22% vs > 6 days: 21.19%)[12]. However, two other studies showed a clear benefit for early surgery, with complication rates of < 6 days: 3.6% vs > 6 days: 20.7%, and < 6 days: 2% vs > 6 days: 13.1%, respectively [10, 21].

Table 1. Summary of timing of surgery in complication rate based on AO/ASIF model

Cut-off Time	No of Study	Study Findings	Trend
8 hours	2	Naumann 2017: < 8 h: 26.3% vs > 8 h: 19.8% (higher complication in early group) Saithna 2009: < 8 h: 3.8% vs > 8 h: 11.9% (lower complication in early group)	Mixed
4 days	2	Carragee 1991: < 4 d: 17.9% vs > 4 d: 39.5% (early better) Hawkins 2023: < 4 d: 12.8% vs > 4 d: 5.7% (late better)	Mixed
5 days	3	Konrath 1995: < 5 d: 6.7% vs > 5 d: 11.3% Breederveld 1988: < 5 d: 15.3% vs > 5 d: 30% Gupta 2018: < 5 d: 12% vs > 5 d: 32%	All early better
6 days	3	Naumann 2017: < 6 d: 22% vs > 6 d: 21.19% (no difference) Saithna 2009: < 6 d: 3.6% vs > 6 d: 20.7% (early better) Schepers 2013: < 6 d: 2% vs > 6 d: 13.1% (early better)	Mostly early better

CONCLUSION

The optimal timing of surgery for closed ankle fractures requires a clearly defined cut-off to determine whether early or delayed intervention yields better outcomes. Current evidence, including studies utilizing the AO classification cut-offs, remains limited, making it difficult to establish a universally accepted threshold. While most studies suggest that early surgery is associated with lower complication rates, some report contrasting results. A larger body of high-quality evidence is therefore needed to determine the most appropriate timing. Conducting a systematic review and meta-analysis could provide stronger evidence to guide clinical decision-making, minimize postoperative complications, and improve the management approach for closed ankle fractures.

DECLARATIONS

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Informed Consent Not applicable.

REFERENCES

[1] Y. Kamhieh, D. Leivadiotou, and D. Manoukian, “Operative Fixation of Ankle Fractures: The Effect of Time to Surgery on Length of Stay and Soft Tissue Complication Rates,” *J. Trauma Treat.*, vol. 04, no. 03, pp. 3–5, 2014, doi: 10.4172/2167-1222.1000261.

[2] C. T. Hasselman, M. T. Vogt, K. L. Stone, J. A. Cauley, and S. F. Conti, “Foot and Ankle Fractures in Elderly White Women : Incidence and Risk Factors,” *JBJS*, vol. 85, no. 5, 2003, [Online]. Available: https://journals.lww.com/jbjsjournal/fulltext/2003/05000/foot_and_ankle_fractures_in_elderly_white_women___.8.aspx.

[3] J. P. Tartaglione, A. J. Rosenbaum, M. Abousayed, and J. A. DiPreta, “Classifications in Brief: Lauge-Hansen Classification of Ankle Fractures,” *Clin. Orthop. Relat. Res.*, vol. 473, no. 10, pp. 3323–3328, 2015, doi: 10.1007/s11999-015-4306-x.

[4] D. A. Porter, B. D. May, and T. Berney, “Functional outcome after operative treatment for ankle fractures in young athletes: A retrospective case series,” *Foot Ankle Int.*, vol. 29, no. 9, pp. 887–894, 2008, doi: 10.3113/FAI.2008.0887.

[5] N. B. Dodson, A. J. Ross, R. W. Mendicino, and A. R. Catanzariti, “Factors Affecting Healing of Ankle Fractures,” *J. Foot Ankle Surg.*, vol. 52, no. 1, pp. 2–5, 2013, doi: 10.1053/j.jfas.2012.10.013.

[6] A. J. Pagliaro, J. D. Michelson, and M. S. Mizel, “Results of operative fixation of unstable ankle fractures in geriatric patients,” *Foot Ankle Int.*, vol. 22, no. 5, pp. 399–402, 2001, doi: 10.1177/107110070102200507.

[7] K. J. Koval, W. Zhou, M. J. Sparks, R. V. Cantu, P. Hecht, and J. Lurie, “Complications after ankle fracture in elderly patients,” *Foot Ankle Int.*, vol. 28, no. 12, pp. 1249–1255, 2007, doi: 10.3113/FAI.2007.1249.

[8] J. Manway and P. Highlander, “Open Fractures of the Foot and Ankle: An Evidence-Based Review,” *Foot Ankle Spec.*, vol. 8, no. 1, pp. 59–64, 2015, doi: 10.1177/1938640014557072.

[9] R. A. Singh, R. Trickett, and P. Hodgson, “Early versus late surgery for closed ankle fractures,” *J. Orthop. Surg.*, vol. 23, no. 3, pp. 341–344, 2015, doi: 10.1177/230949901502300317.

[10] T. Schepers, M. R. De Vries, E. M. M. Van Lieshout, and M. Van der Elst, “The timing of ankle fracture surgery and the effect on infectious complications; a case series and systematic review of the literature.,” *Int. Orthop.*, vol. 37, no. 3, pp. 489–494, 2013, doi: 10.1007/s00264-012-1753-9.

[11] T. Hawkins *et al.*, “The Impact of Surgical Timing After Ankle Fracture on Clinical and Long-Term Patient Reported Outcomes Tag edEn,” vol. 62, pp. 701–706, 2023.

[12] M. G. Naumann, U. Sigurdsen, S. E. Utvåg, and K. Stavem, “Associations of timing of surgery with postoperative length of stay, complications, and functional outcomes 3–6 years after operative fixation of closed ankle fractures,” *Injury*, vol. 48, no. 7, pp. 1662–1669, 2017, doi: 10.1016/j.injury.2017.03.039.

[13] L. Solomon, D. Warwick, and S. Nayagam, *Apley and Solomon’s System of Orthopaedics and Trauma*, 10th ed., vol., no. 8. 2015.

[14] M. E. Müller, M. Allgöwer, and H. Willeneger, *Manual of INTERNAL FIXATION*. Berlin, 1992.

[15] The National Institute for Health and Care Excellence (NICE), “Fractures (non-complex): assessment and management Fractures: diagnosis,

management and follow-up of fractures," *NICE Guidel. NG38*, no. February, 2016, [Online]. Available: https://www.nice.org.uk/guidance/ng38.

[16] D. Tantigate *et al.*, "Timing of Open Reduction and Internal Fixation of Ankle Fractures," *Foot Ankle Spec.*, vol. 12, no. 5, pp. 401–408, 2019, doi: 10.1177/1938640018810419.

[17] B. E. Carragee J, Csongradi J, "Complications Treatment in Ankle the Operative of Fractures," *J Bone Jt. Surg [Br]*, vol. 73, no. B, pp. 79–82, 1991.

[18] G. Konrath, D. Karges, J. T. Watson, B. R. Moed, and K. Cramer, "early vs delayed treatment severe ankle fracture.pdf." 1995.

[19] P. Höiness, L. Engebretsen, and K. Strömsöe, "Soft tissue problems in ankle fractures treated surgically A prospective study of 154 consecutive closed ankle fractures," vol. 34, pp. 928–931, 2003.

[20] P. Høiness and K. Strømsøe, "The influence of the timing of surgery on soft tissue complications and hospital stay. A review of 84 closed ankle fractures.," *Ann. Chir. Gynaecol.*, vol. 89, no. 1, pp. 6–9, 2000.

[21] A. Saithna, W. Moody, E. Jenkinson, B. Almazedi, and I. Sargeant, "The influence of timing of surgery on soft tissue complications in closed ankle fractures," *Eur. J. Orthop. Surg. Traumatol.*, vol. 19, no. 7, pp. 481–484, 2009, doi: 10.1007/s00590-009-0455-5.

[22] M. Bauer, B. Bergstrom, A. Hemborg, and J. Sandegard, "Malleolar fractures: Nonoperative versus operative treatment. A controlled study," *Clin. Orthop. Relat. Res.*, vol. NO. 199, pp. 17–27, 1985.

[23] D. Herscovici, J. M. Scaduto, and A. Infante, "Conservative treatment of isolated fractures of the medial malleolus," *J. Bone Jt. Surg. - Ser. B*, vol. 89, no. 1, pp. 89–93, 2007, doi: 10.1302/0301-620X.89B1.18349.

[24] K. D. Kristensen and T. Hansen, "Closed treatment of ankle fractures: Stage II supination-eversion fractures followed for 20 years," *Acta Orthop.*, vol. 56, no. 2, pp. 107–109, 1985, doi: 10.3109/17453678508994330.

[25] D. Christian CMA, "Surgical versus conservative interventions for treating ankle fractures in adults," *Cochrane Database Syst. Rev.*, vol. 29, no. 2, pp. 138–139, 2014, doi: 10.1016/j.jopan.2013.12.001.

[26] A. Dietrich, H. Lill, T. Engel, M. Schönfelder, and C. Josten, "Conservative functional treatment of ankle fractures," *Arch. Orthop. Trauma Surg.*, vol. 122, no. 3, pp. 165–168, 2002, doi: 10.1007/s004020100342.

[27] N. F. SooHoo, L. Krenek, M. J. Eagan, B. Gurbani, C. Y. Ko, and D. S. Zingmond, "Complication rates following open reduction and internal fixation of ankle fractures," *J. Bone Jt. Surg. - Ser. A*, vol. 91, no. 5, pp. 1042–1049, 2009, doi: 10.2106/JBJS.H.00653.

[28] M. Stanton-Hicks, W. Jänig, S. Hassenbusch, J. D. Haddox, R. Boas, and P. Wilson, "Reflex sympathetic dystrophy: changing concepts and taxonomy," *Pain*, vol. 63, no. 1, pp. 127–133, 1995, doi: 10.1016/0304-3959(95)00110-E.

[29] C. Olerud and H. Molander, "A scoring scale for symptom evaluation after ankle fracture," *Arch. Orthop. Trauma. Surg.*, vol. 103, no. 3, pp. 190–194, 1984, doi: 10.1007/BF00435553.

[30] D. J. Herscovici, J. O. Anglen, M. Archdeacon, L. Cannada, and J. M. Scaduto, "Avoiding Complications in the Treatment of Pronation-External Rotation Ankle Fractures, Syndesmotic Injuries, and Talar Neck Fractures," *JBJS*, vol. 90, no. 4, 2008, [Online]. Available: https://journals.lww.com/jbjsjournal/fulltext/2008/04000/avoiding_complications_in_the_treatment_of.28.aspx.

[31] S. Mehta, K. Rees, L. Cutler, and J. Mangwani, "Understanding risks and complications in the management of ankle fractures," *Indian J. Orthop.*, vol. 48, no. 5, pp. 445–452, 2014, doi: 10.4103/0019-5413.139829.

[32] A. G. Miller, A. Margules, and S. M. Raikin, "Risk factors for wound complications after ankle fracture surgery," *J. Bone Jt. Surg. - Ser. A*, vol. 94, no. 22, pp. 2047–2052, 2012, doi: 10.2106/JBJS.K.01088.

[33] C. M. M. Uebbing, M. M. Walsh, J. B. M. Miller, M. M. Abraham, and C. Arnold, "Fracture Blisters," *J. Gen. Intern. Med.*, vol. 37, no. 11, p. 2866, 2022, doi: 10.1007/s11606-022-07568-4.

[34] U. Lindsjö, "Operative treatment of ankle fracture-dislocations. A follow-up study of 306/321 consecutive cases.," *Clin. Orthop. Relat. Res.*, no. 199, pp. 28–38, Oct. 1985.

[35] C. G. Zalavras, T. Christensen, N. Rigopoulos, P. Holtom, and M. J. Patzakis, "Infection following operative treatment of ankle fractures," *Clin. Orthop. Relat. Res.*, vol. 467, no. 7, pp. 1715–1720, 2009, doi: 10.1007/s11999-009-0743-8.

[36] K. H. Mak, K. M. Chan, and P. C. Leung, "Ankle fracture treated w i t h the AO principle experience w i t h 11 6 cases," *Injury*, vol. 16, pp. 265–272, 1985.

[37] C. Bibbo, S. S. Lin, H. A. Beam, and F. F. Behrens, "Complications of Ankle Fractures in Diabetic Patients Orthopedic Clinics of North America," vol. 32, no. 1, pp. 113–133, 2001.

[38] H. Tonnesen, A. Pedersen, M. R. Jensen, A. Moller, and J. C. Madsen, "Ankle fractures and alcoholism. The influence of alcoholism on morbidity after malleolar fractures," *J. Bone Jt. Surg. - Ser. B*, vol. 73, no. 3, pp. 511–513, 1991, doi: 10.1302/0301-620x.73b3.1670461.

[39] M. Testroote, W. A. Stigter, L. Janssen, and H. M. Janzing, "Low molecular weight heparin for prevention of venous thromboembolism in patients with lower-limb immobilization," *Cochrane Database Syst. Rev.*, vol. 2017, no. 8, 2017, doi: 10.1002/14651858.CD006681.pub4.

[40] N. Shibuya, C. H. Frost, J. D. Campbell, M. L. Davis, and D. C. Jupiter, "Incidence of Acute Deep Vein Thrombosis and Pulmonary Embolism in Foot and Ankle Trauma: Analysis of the National Trauma Data Bank," *J. Foot Ankle Surg.*, vol. 51, no. 1, pp. 63–68, 2012, doi: 10.1053/j.jfas.2011.10.017.

[41] L. J. Lapidus *et al.*, "Prolonged thromboprophylaxis with Dalteparin during immobilization after ankle fracture surgery: A randomized placebo-controlled, double-blind study," *Acta Orthop.*, vol. 78, no. 4, pp. 528–535, 2007, doi: 10.1080/17453670710014185.

[42] J. Hill and T. Treasure, "Reducing the risk of venous thromboembolism (deep vein thrombosis and pulmonary embolism) in patients admitted to hospital: Summary of the NICE guideline," *Heart*, vol. 96, no. 11, pp. 879–882, 2010, doi: 10.1136/hrt.2010.198275.

[43] M. Horisberger, V. Valderrabano, and B. Hintermann, "Posttraumatic ankle osteoarthritis after ankle-related fractures," *J. Orthop. Trauma*, vol. 23, no. 1, pp. 60–67, 2009, doi: 10.1097/BOT.0b013e31818915d9.

[44] R. K. Marti, E. L. F. B. Raaymakers, and P. A. Nolte, "Malunited ankle fractures. The late results of reconstruction," *J. Bone Jt. Surg. - Ser. B*, vol. 72, no. 4, pp. 709–713, 1990, doi: 10.1302/0301-620x.72b4.2116416.

[45] V. Valderrabano, B. Hintermann, M. Horisberger, and S. F. Tak, "Ligamentous posttraumatic ankle osteoarthritis," *Am. J. Sports Med.*, vol. 34, no. 4, pp. 612–620, 2006, doi: 10.1177/0363546505281813.

[46] M. G. Franz *et al.*, "Guidelines to aid healing of acute wounds by decreasing impediments of healing," *Wound Repair Regen.*, vol. 16, no. 6, pp. 723–748, 2008, doi: 10.1111/j.1524-475X.2008.00427.x.

[47] W. Costigan, D. B. Thordarson, and U. K. Debnath, "Operative management of ankle fractures in patients with diabetes mellitus," *Foot Ankle Int.*, 28, 1, 32–37, 2007, doi: 10.3113/FAI.2007.0006.

48.K. B. Jones, K. A. Maiers-Yelden, J. L. Marsh, M. B. Zimmerman, M. Estin, and C. L. Saltzman, "Ankle fractures in patients with diabetes mellitus," *J. Bone Jt. Surg. - Ser. B*, vol. 87, no. 4, pp. 489–495, 2005, doi: 10.1302/0301-620X.87B4.15724.

[49] D. Manoukian, D. Leivadiotou, and W. Williams, "Is early operative fixation of unstable ankle fractures cost effective? Comparison of the cost of early versus late surgery," *Eur. J. Orthop. Surg. Traumatol.*, vol. 23, no. 7, pp. 835–837, 2013, doi: 10.1007/s00590-012-1059-z.

[50] P. Pietzik, I. Qureshi, J. Langdon, S. Molloy, and M. Solan, "Cost benefit with early operative fixation of unstable ankle fractures," *Ann. R. Coll. Surg. Engl.*, vol. 88, no. 4, pp. 405–407, 2006, doi: 10.1308/003588406X106504.

[51] K. Pilskog *et al.*, "Association of Delayed Surgery for Ankle Fractures and Patient-Reported Outcomes," *Foot Ankle Int.*, vol. 43, no. 6, pp. 762–771, 2022, doi: 10.1177/10711007211070540.

[52] T. Sugino *et al.*, "The Wait Time for Surgery Following Injury Affects Functional Outcomes and Complications After an Ankle Fracture: A Propensity Score–Matched Multicenter Study, the TRON Study," *Foot Ankle Spec.*, vol. 17, no. 6, pp. 592–597, 2024, doi: 10.1177/19386400231164211.

[53] K. Tada *et al.*, "A comparative study on Early versus Delayed Operative Treatment of Closed Ankle fracture in Adults," *IOSR J. Dent. Med. Sci. e-ISSN*, vol. 18, no. 12, pp. 59–71, 2019, doi: 10.9790/0853-1812035971.

[54] A. M. Garratt, M. G. Naumann, U. Sigurdsen, S. E. Utvåg, and K. Stavem, "Evaluation of three patient reported outcome measures following operative fixation of closed ankle fractures," *BMC Musculoskelet. Disord.*, vol. 19, no. 1, pp. 1–9, 2018, doi: 10.1186/s12891-018-2051-5.

[55] E. J. Carragee, J. J. Csongradi, and E. E. Bleck, "Early complications in the operative treatment of ankle fractures. Influence of delay before operation," *J. Bone Jt. Surg. - Ser. B*, vol. 73, no. 1, pp. 79–82, 1991, doi: 10.1302/0301-620x.73b1.1991782.

[56] R. S. Breederveld, J. van Straaten, P. Patka, and J. C. van Mourik, "Immediate or delayed operative treatment of fractures of the ankle," *Injury*, vol. 19, no. 6, pp. 436–438, 1988, doi: 10.1016/0020-1383(88)90142-8.

[57] S. Gupta, O. Singh, M. A. ud din Darokhan, A. Sen, and S. S. Charak, "The timing of ankle fracture surgery and its effect on complications and hostpital stay- A prospective study in a tertiary centre," *JK Sci.*, vol. 20, no. 4, pp. 189–194, 2018.