Talar Fractures

Subjects: Public, Environmental & Occupational Health

Contributor: Babak Saravi

Talar fractures are associated with relatively poor postoperative outcomes, high rates of AVN, and posttraumatic osteoarthritis. Poor outcomes revealed a positive association with fracture severity. Prospective studies investigating predictors for treatment success and/or failure are urgently needed to improve the overall quality of life and function of patients undergoing surgical treatment due to talar fractures.

Keywords: talus ; ankle fractures ; ankle injuries ; osteoarthritis ; osteonecrosis ; systematic review

1. Introduction

Talar fractures account for 0.3% of all fractures and 3.4% of foot fractures [1][2]. The integrity of the talus is crucial to the normal function of the ankle, subtalar, and transverse tarsal joints. Injuries to the head, neck, or body of the talus can disrupt the physiologic movement of these joints, potentially leading to chronic pain, loss of motion, and deformity. Typical findings after incorrectly healed talus fractures are axial deviations, in particular varus malalignment, posttraumatic osteoarthritis of the upper and lower ankle joints, symptomatic pseudarthrosis, impingement of the posterior tibial tendon or tarsal tunnel syndrome due to bony prominences, and, finally, the collapse of the talar body [3]. One of the most common causes of central talar fractures is a fall from a great height [1]. The typical trauma mechanism of talar neck fractures (contributing to more than 50% of all talar fractures) involves forced dorsiflexion of the foot combined with extensive axial forces. Consequently, the neck of the talus is sheared between the anterior edge of the tibia and the sustentaculum tali. In contrast, forced plantar flexion combined with a rotational component at the time of violence is held responsible for talar body fractures (around 20% of all talar injuries) [4]. The rare talar head fractures (less than 10% of all talar fractures) usually occur when the midtarsal (Chopart) joint is involved, and are caused by forced abduction or adduction of the forefoot with simultaneous rotation of the rear foot [5]. Notably, 13–15% of all talar fractures are open fractures [6]. Concomitant injuries are found in nearly half of all talar fractures [4][7]. Severe soft tissue damage occurs in approximately 15% of cases [6]. Additional regional injuries include malleolar fractures (in up to 44% of fracture cases), injuries to the calcaneus (in 11–18% of fracture cases), and concomitant metatarsal fractures (in up to 18% of fracture cases) [8][9].

The talar body is mainly supplied by an anastomosis between the canalis tarsi artery and the sinus tarsi artery. The vessels enter the talar body at the level of the talar neck and run from distal to proximal. If this anastomosis ruptures due to dislocated fractures of the talar neck, the risk of bone necrosis is significantly increased [10]. Additionally, the deltoid branch is discussed as an important vessel that revascularizes the talus from the medial side after fractures and should, therefore, be spared in medial surgical access [10][11][12]. The extensive cartilaginous surface of the talus affects blood supply and leads to a high risk of posttraumatic damage, such as avascular bone necrosis (AVN) and posttraumatic osteoarthritis [11]. AVN is reported to occur in up to 50% of central fractures and dislocations [13]. Although the necrosis rate is reported to vary considerably, there seems to be a correlation with the initial degree of dislocation. AVN is found in 0–24% of Hawkins type I fractures, whereas 33–100% occur in Hawkins type III and IV fractures [11][14]. Non-displaced fractures of the talar body (Marti type II) are associated with AVN in 5–44% of cases, and displaced talar body fractures (Marti types III and IV) can result in AVN in up to 50% of patients [15]. With open fractures, the risk of AVN appears to be increased [16][17].

Available reviews on this topic focused solely on talar neck fractures [18][19][20] or talar head fractures [21]. Considering the variability in the literature and the development of new therapeutic options, an updated comprehensive review focusing on both talar neck and body fractures that summarizes the current status of clinical outcomes of talar fractures is warranted. The inclusion of both conservative and surgical treatments, such as multiplanar external fixation, open articular bony reduction, and internal fixation, as well as non-operative treatments, such as casting, along with the inclusion of all studies regardless of publication year, further allows the evaluation of the outcome of the therapeutical approaches over time, considering that the therapeutical strategies might have changed and will be the fundament of the present review.

The present systematic review with a meta-analysis sought to summarize the available evidence on clinical outcomes and complications following conservative and surgical treatment of talar fractures.

2. Current Insights

The present entry and meta-analysis aimed to investigate the clinical outcomes of talar fractures, with a special focus on success as well as complications. Based on the available evidence, clinical outcomes of talar fractures were dependent on their severity, and were generally unsatisfying. We estimated a success rate of 62% for 987 fractures, regardless of the location and severity of the fracture. In 12 studies including *n* = 377 fractures of the talar neck, the success rate was 60%. Furthermore, the AVN rate was estimated to be 25% for pooled talar fractures, with higher rates (43%) for talar neck fractures than talar neck and body fractures (25%). We also found similar rates of posttraumatic osteoarthritis (43%).

2.1. Pooled Talar Fractures

When pooling all talar fractures (*n* = 987) in the present meta-analysis, a success rate of 62% was found in conjunction with high heterogeneity of I^2 = 91%, questioning the reliability of the results. Comparable studies examining talar fractures are currently scarce. Halvorson et al. (2013) [18] reported a success rate of 56% in 429 talar neck fractures. Sneppen et al. (1977) [22] estimated a 39% success rate for 51 fractures of the talar body. Similarly, Dumont et al. (2007) [23] examined the clinical results of 41 talar fractures, and reported an average success rate of 39%.

2.2. Talar Neck Fractures

Twelve studies were included in the evaluation of the outcome of talar neck fractures. The success rate was 60% for the 377 fractures. Halvorson et al. examined outcomes of talar neck fractures in 2013 [18]. Results from a total of 943 fractures of the talar neck were collected from 21 studies. Similar to the present meta-analysis, not all fractures could be clinically reexamined due to loss to follow-up, and remaining fractures were reexamined using a wide variety of outcome scores. Nonetheless, the authors were able to extract the clinical results of 429/943 fractures, which were examined using the Hawkins score. A success rate (i.e., excellent and good results) of 56% was demonstrated. A total of 87 patients had an excellent result, and 152 revealed good results in the follow-up examination. The results are in accordance with the results provided in the present work.

2.3. Fracture Severity

Several classifications have been established to determine the severity of talar fractures. Outcomes of the 29 included studies were described with eight different score systems: 11 × Hawkins score [4], 6 × AOFAS score [24][25], 1 × Ankle-Hindfoot Scale (AHS) [25][26], 5 × Maryland Score [27], 1 × Foot Function Index (FFI) [25], 1 × Mazur Score [27], 1 × Kiel Foot Score [28], and 1 × score according to Frawley [29]. All mentioned score systems share the following characteristics: they measure the outcome after talar trauma based on the range of motion, strength, functionality, stability, and pain. The Hawkins classification, modified by Canale and Kelly, is most often used for talar neck fractures. However, other classifications (including the Szyszkowitz classification and Marti/Weber) are also commonly found in the literature. A shared feature of these gradings is that they affect the treatment and prognosis of the fractures, as both depend on the severity of the fracture. In all classifications, non-dislocated fractures are considered to result in fewer complications, whereas fractures with complete dislocation or fragmented fractures are more often associated with a complicated course, as demonstrated in the present work.

In 69 fractures classified according to Hawkins 1, a success rate of 65% was found. In contrast, the success rate for nine fractures that fell into the Hawkins 4 classification was 25%. The heterogeneity in this subgroup analysis lies in a range of 0–48%, and can therefore be classified as insignificant to moderate. The estimation results can thus be viewed as relatively consistent. However, the number of fractures in the individual subgroups was inconsistent. In the largest group (Hawkins 2), there were 150 examined fractures. In contrast, only nine fractures were included in the Hawkins 4 fracture group. A similar picture emerges when focusing on the fracture outcomes classified according to Marti/Weber and Szyskowitz. In summary, despite the low number of patients in the individual groups, there is a clear tendency towards higher success rates for simple fractures versus low success rates for complex fractures.

2.4. Complications

All 29 inclusion studies could be included to evaluate the avascular bone necrosis (AVN) rates following talar fractures. An AVN rate of 25% was found in a total of 987 talus fractures, regardless of the severity of the fracture. In the subgroup of fractures of the talar neck (n = 377), the result corresponds to a 43% AVN rate. Fractures of the talar neck and body were examined in nine studies. In this subgroup with *n* = 246 fractures, a necrosis rate of 25% was determined. Although there

was a considerable amount of heterogeneity among these studies, the results obtained largely coincide with those provided by Dodd et al. [19]. They evaluated the data of 26 studies with a total of 980 talar neck fractures, and determined an overall AVN rate of 31%. Similarly, Metzger et al. [11] reported an AVN rate of 37% in 12 studies reporting a total of 589 talar neck fractures.

Information on posttraumatic osteoarthritis was obtained from 17 studies, including 637 fractures that were identified in 43% of all cases, regardless of fracture location and/or severity. Dodd et al. [19] examined degenerative changes in the subtalar joint of 647 talar fractures. They reported a posttraumatic osteoarthritis rate of 49%. This result is in accordance with the results determined in the present work. In contrast, Halvorson et al. [18] reported posttraumatic osteoarthritis rates of 68% in 635 talar neck fractures. The tibiotalar, subtalar, and talonavicular joints were affected. In some cases, multiple joints were involved at the same time. Notably, the subtalar joint was most often affected. Sanders et al. [26] examined 70 fractures of the talar neck in 69 patients and concluded that the initial functional results greatly predicted the follow-up complication rates. The incidence of secondary reconstructive surgery after talar neck fractures increased over time, and was most commonly performed to treat subtalar arthritis or malalignment after inadequate fracture healing. The calculated percentages of patients who needed secondary surgery at one, two, five, and 10 years were 24%, 32%, 38%, and 48%, respectively.

2.5. Strengths and Limitations

The present entry is associated with strengths and limitations. First, the Hawkins classification [4] modified by Canale and Kelly [6] is the most common classification system for talar neck fractures [30][31]. Drummond Filho et al. showed that the inter- and intra-rater reliability of the Hawkins classification was generally satisfactory [32]. However, no reliability studies are currently available for the other classifications considered in the included studies. Another limitation when comparing the included studies was the variety of different outcome scores. We pooled excellent and good results to estimate success rates. Thus, the difference between the scoring systems could be partially counteracted. The two most frequently used outcome scores in the included studies were the Hawkins score and the AOFAS Ankle-Hindfoot score. As far as we know, none of these scoring systems have yet been evaluated with regards to their validity and/or reliability in patients with talar neck fractures. The AOFAS score is one of the most frequently used outcome measures in foot and ankle surgery, although it has not yet been adequately tested regarding validity or reliability. This remains a problem when assessing the outcome of foot and ankle trauma. Overall, comparing patient outcomes is difficult without reliable and standardized outcome measures [19]. Unfortunately, we found no studies comparing the scoring systems mentioned above. An in-depth analysis of the sources of heterogeneity using meta-regression techniques did not allow any meaningful conclusion. According to the Cochrane handbook, this would be defined as heterogeneity that cannot be explained [33]. Therefore, we performed a meta-analysis considering the heterogeneous character of the studies by applying a random effects model, following the recommendations of the Cochrane handbook. A random effects model, in contrast to the fixed effects model, accounts for statistical heterogeneity. The authors assume that the factors of the surgeon and therapy could be the most straightforward explanation, as the publications ranged from 1974–2019, and, in this time frame, the experience of the surgeons and the development of the surgical technique might have a significant influence that, however, cannot be analyzed statistically in the present study.

Furthermore, the included studies of the present work revealed a rather moderate methodological quality, with a mean CMS of 34.3 (range: 19–47). None of the included studies achieved the maximum possible number of points. Most studies reached only a few points in the categories study size, study type, and description of the postoperative rehabilitation protocol. The Coleman Methodology Score was developed by Coleman et al. to assess the methodological quality of clinical studies. Since then, the score has been used in numerous studies dealing with trauma surgery and orthopedics. In this systematic review, we applied the CMS for the first time to evaluate the methodological quality of studies focusing on talar fractures. As most included studies showed a level 4 grade of evidence, selection bias could have been a problem. However, most included studies reported that patients were consecutively included. The selection process and the handling of excluded patients are assessed in the Coleman Methodology Score in part B3. The included studies received an average of 3.5 out of a maximum of 15 possible points. Therefore, selection bias should be considered when interpreting the present results. Comparable systematic reviews on this topic were published between 2013 and 2017, but mainly focused on talar neck fractures [18][19][34]. The majority of the currently available reviews call for an analysis of predictive factor and subgroup evaluations to examine the reason for the high complication rates. The advantage of our initial study protocol compared to the available reviews was the focus on talar fractures generally, and not only talar neck fractures. On the one hand, this broadens understanding and allows comparability of complication rates in different talar regions within one systematic review protocol. On the other hand, we have applied a random effects model while analyzing the studies, which better accounts for the heterogeneous character of the studies compared to the current meta-analysis conducted on talar neck fractures previously [19]. A constant evaluation of the literature on this topic in the

form of a systematic approach is warranted to find new and promising developments and therapeutic advances. Our literature search yielded one recent study performed by Lui et al., which generally showed lower AVN and osteoarthritis rates than those obtained by the pooled prediction in the random effects model [35]. After anatomical reduction, they used two screws and fixed the lateral malleolus with distending wires. This recent reporting indicated that internal fixation of talar fractures with lateral malleolar osteotomy might be associated with satisfying clinical outcomes. Most of the evidence included in the aforementioned systematic reviews was published in the last century, and might not be comparable to the currently performed techniques. Historically, therapy of talar fractures was generally performed more conservatively compared to the current strategies. Thus, prospective studies and literature searches should be performed in regular time intervals so as not to miss any progress on this topic that might be of relevance for the therapy of future affected patients.

2.6. Recommendations

Overall, the current evidence on clinical outcomes following talar fractures must be considered insufficient. To the best of our knowledge, there are no randomized controlled trials on this topic, limited to the current evidence grade. Prospective randomized and nonrandomized studies will be of help to gain more reliable evaluations of outcomes in future. A standardization of talar fracture classifications and scoring systems would improve the comparability of future studies. Large sample-sized prospective studies are warranted to detect further predictive factors influencing the currently unsatisfactory clinical outcome of patients undergoing talar fracture treatment. Specifically, the confounding factors of the surgeon and exact treatment strategy should be considered in future studies. Studies involving multiple surgeons, secondary treatments, and/or multiple treatments bias the result evaluations, and might be the reason for the current heterogeneity in the literature. Considering the remaining high rate of complications despite the development of diagnostics and surgical therapies, delayed surgery and remaining fracture displacements might be the main risk factors for complications. However, current reports do not call for immediate emergent surgical management using open reduction and internal fixation in contrast to historical recommendations [36]. Nevertheless, nonsurgical treatment should only be reserved for nondisplaced fractures. Nearly 95% of the talar neck fractures since 2000 were treated surgically [19]. Notably, the quality of reduction seems to be more important than the timing of reduction [37]. A dual incision technique utilizing anteromedial and anterolateral approaches for talar neck fractures under good visualization and fluoroscopy during reduction helps to prevent rotational and angular malreductions [38]. For treatment of talar neck fractures, there is no clear clinical evidence for superiority between screw fixation alone and screw/plate fixation [38]. However, screw fixation may be advantageous for maintaining the talar neck's crucial blood supply. For talar body fracture treatment, the biplanar chevron technique showed high malunion rates of up to 30% when fixed with two lag screws compared to buttress plates, whereas, for talar head fractures, a dual incision technique with medial-to-lateral screws recessed into the subchondral bone was recently introduced for fixation [39]. The following key points should be considered by orthopedic surgeons and researchers, which might help to decrease the complication rates in the future: (1) standardized treatment algorithms based on high-evidence studies; (2) standardized outcome evaluations of the applied therapies; (3) timely soft tissue coverage and management for open fractures; and (4) the quality of the surgical technique seems to be more important than the time of reduction.

References

1. Kuner, E.H.; Lindenmaier, H.L. Zur Behandlung Der Talusfraktur. Unfallchirurgie 1983, 9, 35–40.
2. Richter, M.; Zech, S. Behandlung der Talusfraktur. OP J. 2007, 23, 104–109.
3. Zwipp, H.; Rammelt, S. Posttraumatische Korrekturoperationen am Fuß. Zent. Chir 2003, 128, 218–226.
4. Hawkins, L.G. Fractures of the Neck of the Talus. J. Bone Jt. Surg. Am. 1970, 52, 991–1002.
5. Zwipp, H. Chirurgie des Fußes; Springer: Vienna, Hungary, 1994; ISBN 978-3-7091-7366-4.
6. Canale, S.T.; Kelly, F.B. Fractures of the Neck of the Talus. Long-Term Evaluation of Seventy-One Cases. J. Bone Jt. Surg. Am. 1978, 60, 143–156.
7. Pennal, G.F. Fractures of the Talus. Clin. Orthop. Relat. Res. 1963, 30, 53–63.
8. Berndt, A.L.; Harty, M. Transchondral Fractures (Osteochondritis Dissecans) of the Talus. J. Bone Jt. Surg. Am. 1959, 41-A, 988–1020.
9. Gregory, P.; DiPasquale, T.; Herscovici, D.; Sanders, R. Ipsilateral Fractures of the Talus and Calcaneus. Foot Ankle Int. 1996, 17, 701–705.
10. Sanders, D.W.; Busam, M.; Hattwick, E.; Edwards, J.R.; McAndrew, M.P.; Johnson, K.D. Functional Outcomes Following Displaced Talar Neck Fractures. J. Orthop. Trauma 2004, 18, 265–270.

11. Metzger, M.J.; Levin, J.S.; Clancy, J.T. Talar Neck Fractures and Rates of Avascular Necrosis. J. Foot Ankle Surg. 1999, 38, 154–162.
12. Rammelt, S.; Zwipp, H. Talar Neck and Body Fractures. Injury 2009, 40, 120–135.
13. Isay, M.; Wolvius, R.; Ochsner, P.E. Long-term results of talus fractures. Z Unf. Versicher. 1992, 85, 12–18.
14. Adelaar, R.S. The Treatment of Complex Fractures of the Talus. Orthop. Clin. N. Am. 1989, 20, 691–707.
15. Tscherne, H. Major Fractures of the Pilon, the Talus, and the Calcaneus Current Concepts of Treatment; Springer: Berlin, Germany, 1993; ISBN 978-3-642-77729-5.
16. Lindvall, E.; Haidukewych, G.; DiPasquale, T.; Herscovici, D.; Sanders, R. Open Reduction and Stable Fixation of Isolated, Displaced Talar Neck and Body Fractures. J. Bone Jt. Surg. Am. 2004, 86, 2229–2234.
17. Vallier, H.A.; Nork, S.E.; Benirschke, S.K.; Sangeorzan, B.J. Surgical Treatment of Talar Body Fractures. J. Bone Jt. Surg. Am. 2004, 86-A Suppl. 1, 180–192.
18. Halvorson, J.J.; Winter, S.B.; Teasdall, R.D.; Scott, A.T. Talar Neck Fractures: A Systematic Review of the Literature. J. Foot Ankle Surg. 2013, 52, 56–61.
19. Dodd, A.; Lefaivre, K.A. Outcomes of Talar Neck Fractures: A Systematic Review and Meta-Analysis. J. Orthop. Trauma 2015, 29, 210–215.
20. Leonetti, D.; Di Matteo, B.; Barca, P.; Cialdella, S.; Traina, F.; Arcidiacono, M.; Kon, E.; Tigani, D. Complications after Displaced Talar Neck Fracture: Results from a Case Series and a Critical Review of Literature. TOORTHJ 2018, 12, 567–575.
21. Ibrahim, M.S.; Jordan, R.; Lotfi, N.; Chapman, A.W.P. Talar Head Fracture: A Case Report, Systematic Review and Suggested Algorithm of Treatment. Foot 2015, 25, 258–264.
22. Sneppen, O.; Christensen, S.B.; Krogsoe, O.; Lorentzen, J. Fracture of the Body of the Talus. Acta Orthop. Scand. 1977, 48, 317–324.
23. Dumont, C.; Fuchs, M.; Burchhardt, H.; Tezval, M.; Wachowski, M.; Stürmer, K. Wie sind die klinischen Ergebnisse operativ behandelter Talusfrakturen? Z Orthop Unf. 2007, 145, 212–220.
24. Kostuj, T.; Schaper, K.; Baums, M.N.; Lieske, S. Eine Validierung des AOFAS-Ankle-Hindfoot-Scale für den deutschen Sprachraum. Fuß Sprunggelenk 2014, 12, 100–106.
25. Madeley, N.J.; Wing, K.J.; Topliss, C.; Penner, M.J.; Glazebrook, M.A.; Younger, A.S. Responsiveness and Validity of the SF-36, Ankle Osteoarthritis Scale, AOFAS Ankle Hindfoot Score, and Foot Function Index in End Stage Ankle Arthritis. Foot Ankle Int. 2012, 33, 57–63.
26. Sanders, R.; Fortin, P.; DiPasquale, T.; Walling, A. Operative Treatment in 120 Displaced Intraarticular Calcaneal Fractures. Results Using a Prognostic Computed Tomography Scan Classification. Clin. Orthop. Relat. Res. 1993, 290, 87–95.
27. Mazur, J.M.; Schwartz, E.; Simon, S.R. Ankle Arthrodesis. Long-Term Follow-up with Gait Analysis. J. Bone Jt. Surg. Am. 1979, 61, 964–975.
28. Besch, L.; Drost, J.; Egbers, H.-J. Die Behandlung der seltenen Talusluxationsfrakturen Analyse von 23 Verletzungen: Analyse von 23 Verletzungen. Unfallchirurg 2002, 105, 595–601.
29. Frawley, P.A.; Hart, J.A.L.; Young, D.A. Treatment Outcome of Major Fractures of the Talus. Foot Ankle Int. 1995, 16, 339–345.
30. Alton, T.; Patton, D.J.; Gee, A.O. Classifications in Brief: The Hawkins Classification for Talus Fractures. Clin. Orthop. Relat. Res. 2015, 473, 3046–3049.
31. Williams, T.; Barba, N.; Noailles, T.; Steiger, V.; Pineau, V.; Carvalhana, G.; Le Jacques, B.; Clave, A.; Huten, D. Total Talar Fracture—Inter-and Intra-Observer Reproducibility of Two Classification Systems (Hawkins and AO) for Central Talar Fractures. Orthop. Traumatol. Surg. Res. 2012, 98, S56-65.
32. Drummond Filho, M.L.; Verzani, M.A.; Rosa, A.F.; Pimenta, C.J.; Grynwald, J.; Cliquet Junior, A. Fractures of the Neck of the Talus: Evaluation of Reproducibility of Hawkins' Classification. Acta Ortop. Bras. 2012, 20, 170–173.
33. Higgins, J.; Green, S. Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0; The Cochrane Collaboration, John Wiley & Sons: Hoboken, NJ, USA, 2011.
34. Jordan, R.K.; Bafna, K.R.; Liu, J.; Ebraheim, N.A. Complications of Talar Neck Fractures by Hawkins Classification: A Systematic Review. J. Foot Ankle Surg. 2017, 56, 817–821.
35. Liu, G.; Ge, J.; Zheng, X.; Wu, C.; Yan, Q.; Yang, H.; Zou, J. Therapeutic Efficacy Analysis of Talar Fracture Internal Fixation with Lateral Malleolar Osteotomy. Med. Sci. Monit. 2019, 25, 3463–3468.

36. Biz, C.; Golin, N.; De Cicco, M.; Maschio, N.; Fantoni, I.; Frizziero, A.; Belluzzi, E.; Ruggieri, P. Long-Term Radiographic and Clinical-Functional Outcomes of Isolated, Displaced, Closed Talar Neck and Body Fractures Treated by ORIF: The Timing of Surgical Management. BMC Musculoskelet. Disord. 2019, 20, 363.
37. Buckwalter, V.J.A.; Westermann, R.; Mooers, B.; Karam, M.; Wolf, B. Timing of Surgical Reduction and Stabilization of Talus Fracture-Dislocations. Am. J. Orthop. 2017, 46, E408–E413.
38. Lee, C.; Brodke, D.; Perdue, P.W.; Patel, T. Talus Fractures: Evaluation and Treatment. J. Am. Acad. Orthop. Surg. 2020, 28, e878–e887.
39. Bull, P.E.; Berlet, G.C.; Canini, C.; Hyer, C.F. Rate of Malunion Following Bi-Plane Chevron Medial Malleolar Osteotomy. Foot Ankle Int. 2016, 37, 620–626.