

Sanders IV Calcaneus Fracture Treated with Open Reduction and Internal Fixation with a Moldable Plate: A Case Report

Alejandro Gamboa Ramírez¹, Alexis Emir Noguera Echeverría², María Fernanda Ibarra Guerrero³, Mario José Lezama Peniche⁴, Adrian Guillermo Chan Cisneros⁴

¹Trauma and Orthopedics Resident. Clínica Hospital Mérida, ISSSTE. Facultad de Medicina de la Universidad Autónoma de Yucatán.

²Surgery Resident. Clínica Hospital Mérida, ISSSTE. Facultad de Medicina de la Universidad Autónoma de Yucatán.

³Pediatrics Resident. Clínica Hospital Mérida, ISSSTE. Facultad de Medicina de la Universidad Autónoma de Yucatán.

⁴Orthopedist. Clínica Hospital Mérida, ISSSTE.

ABSTRACT

Introduction: Calcaneus fractures are the most common tarsal bone fractures, affecting patients quality of life due to osteoarthritis and a rigid gait. Management must be individualized based on fracture line characteristics, physical activity, and patient life expectancy.

Clinical case: A 70-year-old Mexican woman with a history of osteopenia fell, imaging showed traces of a multi-fragmentary fracture, including involvement of the subtalar joint and widening and displacement of the posterior tuberosity of the calcaneus. Open surgery was scheduled 72 hours later, and the patient underwent early mobilization of the ankle, knee, and hip without support.

Discussion: The calcaneus is an irregular bone that supports 50% of the forces in the foot during ambulation and standing, resulting in significant deficits after an injury. The surgical management of calcaneal fractures has been criticized for its sequelae, poor functional results, and associated risks. The best management for complex calcaneal fractures is open reduction with primary arthrodesis of the subtalar joint, resulting in a rigid, non-painful foot with adequate mobility.

Conclusion: Calcaneal fractures are challenging to manage due to their high complexity and frequency. With advances in preoperative, transoperative, and post-surgical care, traditional methods can be satisfactory. However, infrequency and complexity make it difficult to define specific management definitively.

KEYWORDS: Calcaneus fractures, tarsal bone fractures, osteoarthritis, management, fracture line, osteopenia, multi-fragmentary fracture, calcaneus, open surgery, ankle, knee, hip, injury, surgical management, open reduction, primary arthrodesis

ARTICLE DETAILS

Published On:
30 January 2025

Available on:
<https://ijmscr.org/>

INTRODUCTION

Fractures of the calcaneus represent 2% of all skeletal fractures. However, they are the most common fractures of the tarsal bones. (1, 2)

Due to the anatomical characteristics and biomechanics of this bone, displaced fractures found in the articular territory usually have a high impact on the patient's quality of life, secondary to the loss of anatomy, which leads to osteoarthritis of the subtalar joint, which causes a constant rigid and painful gait. (3, 4)

The advent of computed tomography allowed a greater understanding of the structures and traces involved in these injuries, promoting the development of new techniques and approaches for surgical management with the aim of a better functional result. (5, 6)

Unfortunately, the main systematic reviews focused on the treatment of these fractures have given inconclusive results due to the lack of evidence and its quality, the vast majority accepting that the management of these injuries must be individualized not only for the characteristics of the fracture

Sanders IV Calcaneus Fracture Treated with Open Reduction and Internal Fixation with a Moldable Plate: A Case Report.

line but also to the level of physical activity and life expectancy of the patient. (7, 8, 9, 10)

In this report, we present the case of a 70-year-old patient with a right calcaneal fracture managed surgically with an anatomical calcaneal plate and her evolution 3 years after the injury.

CLINICAL CASE

A 70-year-old female, Mexican, height 1.60 m and weight 70 kg; no chronic diseases or allergies. With a history of osteopenia four years before the injury, falling from a height of approximately 90 cm, with axial load in the right pelvic

extremity that causes pain and functional inability to stand and walk, and with intense pain in the rearfoot on palpation and mobilization.

X-rays of the affected foot were taken in dorso-plantar, lateral, and axial projection showing traces of a multi-fragmentary fracture, with involvement of the subtalar joint, loss of Böhler and Gissane angles, as well as widening and displacement of the posterior tuberosity of the calcaneus (**Image 1-2**). A simple CT scan of the right foot and ankle was also performed, in which the fracture was classified as Sanders IV (**Image 3-6**).

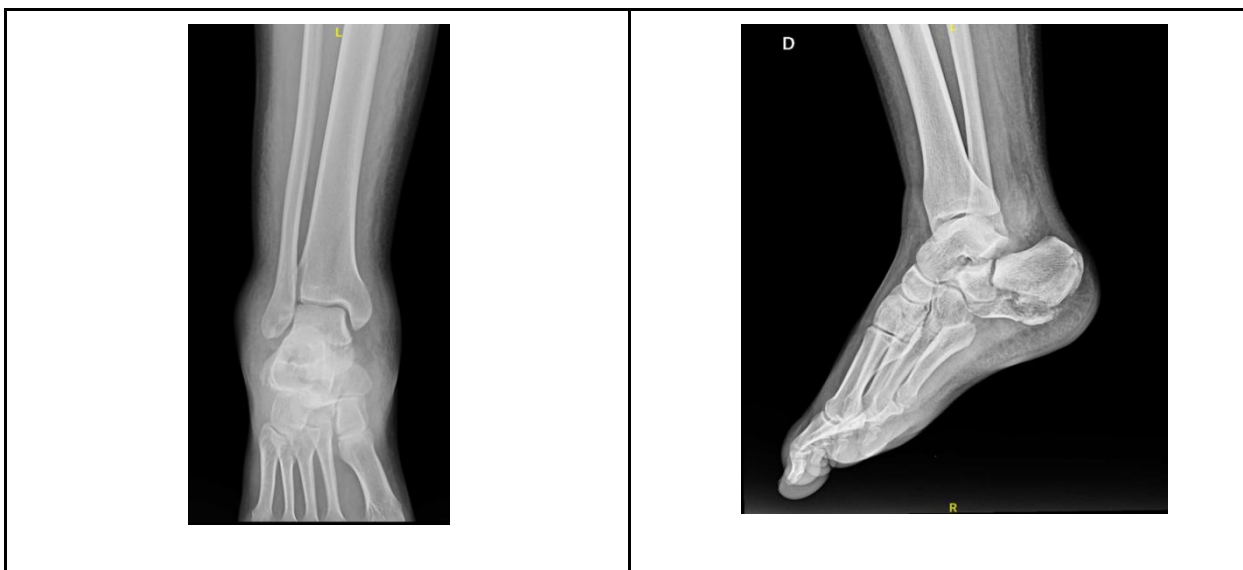


Image 1. AP radiograph of the affected ankle in which widening of the calcaneus image can be observed.

Image 2. Lateral x-ray in which multiple fracture lines can be observed, as well as loss of normal foot angulations.

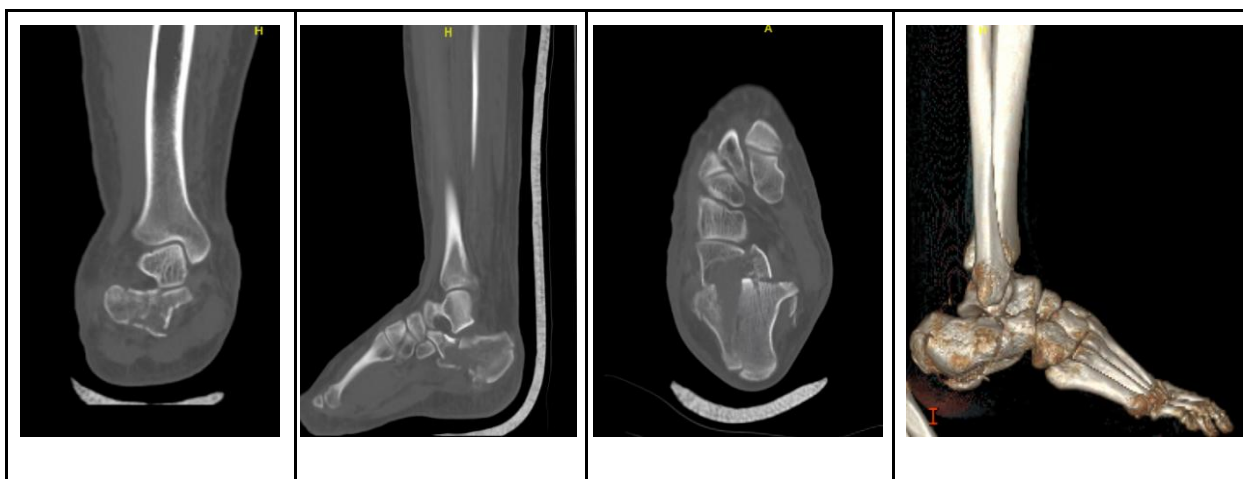


Image 3. Coronal section of CT in which 3 fracture lines are observed affecting the articular area of the calcaneus with the

Image 4. Sagittal section of the CT in which fracture lines are observed affecting the articular area of the calcaneus as well as the

Image 5. Axial section of tomography in which fracture displacement and widening of the calcaneus are observed.

Image 6. 3D reconstruction of tomographic study showing traces of fracture in the body of the calcaneus.

Sanders IV Calcaneus Fracture Treated with Open Reduction and Internal Fixation with a Moldable Plate: A Case Report.

talus.	<i>sustenaculum tali.</i>		
--------	---------------------------	--	--

It was initially managed with an anti-edema bandage, steroid anti-inflammatory, and monitoring of the status of the soft tissues. It was scheduled for open surgery 72 hours later. The surgery was performed through an extended lateral approach, using the posterior surface of the fibula and the

anterior edge of the Achilles tendon as anatomical references for the vertical incision; The horizontal incision used the base of the 5th metatarsal and the skin transition line between the dorsum and the sole as a reference (**Image 7**).



Image 7. Extended lateral approach used to expose the fracture site.



Image 8. Sanders type plate being placed after manual reduction and molding of the plate.

Full-thickness incisions were made to decrease the impact of soft tissue manipulation, taking care to visualize and separate nerve and tendon structures, mainly peroneus longus and sural nerve. An arthrotomy was performed for direct visualization of the sinus tarsi and a reduction maneuver was performed with descent of the posterior tuberosity, compression and slight valgus thereof, performing

provisional fixation with 1.6 mm Kirschner wires, directed at the sustentaculum tali to maintain position, as well as reduction of the anterolateral fragment under direct visualization of the sinus tarsi; the same with provisional fixation with 1.6 mm Kirschner wires. A Sanders-type plate was molded and presented to the shape of the calcaneus and fixed with 4.5 mm cancellous bone screws (**Image 8a-8b**).



Sanders IV Calcaneus Fracture Treated with Open Reduction and Internal Fixation with a Moldable Plate: A Case Report.

<p>Image 8a. Post-surgical lateral radiograph in which partial restitution of foot angles is observed, as well as the location of the placed plate.</p>	<p>Image 8b. Post-surgical axial radiograph of the calcaneus in which partial restoration of the width of the calcaneus is observed, as well as the location of the placed plate.</p>
--	--

Subcutaneous tissues were faced with absorbable sutures and the skin was faced with nylon monofilament sutures. During the immediate postoperative period, early mobilization of the ankle, knee, and hip, without support, was indicated.





Twenty-one days after surgery, the sutures were removed and the use of a Walker boot for ambulation began and continued to be used for 3 months. She began physical rehabilitation 13 weeks after surgery, ambulation with tennis shoes and physiotherapy sessions with electrostimulation, soft tissue massage mobility exercises, and gait re-education with a total of 35 sessions over 6 months.

Four years after surgery, the patient ambulates without assistance, with a gait clearance of 5 cm, adequate step length, and conservation of the three gait rockers.



The patient currently performs physical activity routinely in different disciplines such as Yoga, Tennis, and walking. She reported mild stiffness of the right ankle joint when standing up, and some limitation in maintaining balance in single-leg support on the right pelvic limb.

On physical examination of the ranges of mobility of the right foot: dorsiflexion of 30°, plantar flexion of 15°, and limitation of ankle pivot (5° of inversion and eversion). With a result in functional tests Foot and Ankle Outcome Score (FAOS): 94%, Foot and Ankle Ability Measure (FAAM): 81/84, Foot and Ankle Ability Measure Sport Supplement (FAAM-Sport): 32/32, Foot and Ankle Disability Index (FADI): 102/104, Foot and Ankle Disability Index Sport Supplement (FADI-Sport): 31/37, Lower Extremity Functional Score (LEFS): 77/80, Foot Function Index (FFI): 4/170, American Orthopedic Foot and Ankle Society Score (AOFAS Ankle-Hindfoot): 95/100. Which represents an excellent functional capacity for the foot and ankle, with minimal limitation for day-to-day activities, as well as for sports and recreational activities (**Image 9-15**).

The patient was definitively discharged with adequate clinical evolution and without requiring follow-up or subsequent physical therapy.

			
<p>Image 9. Anterior clinical photograph in which both feet are seen with adequate support.</p>	<p>Image 10. Medial clinical photograph in which the affected foot is observed with adequate support, as well as conservation of the internal arch of the foot.</p>	<p>Image 11. Lateral clinical photograph in which the affected foot is seen with adequate support.</p>	<p>Image 12. Subsequent clinical photograph in which the affected foot is seen with adequate support and a preserved Helbing's line.</p>

Sanders IV Calcaneus Fracture Treated with Open Reduction and Internal Fixation with a Moldable Plate: A Case Report.

		
<p>Image 13. Clinical photograph of the patient in a position that shows limitation of the pivot of the foot.</p>	<p>Image 14. Clinical photograph of the patient with support and dorsiflexion in the affected limb and limitation of the pivot of the foot.</p>	<p>Image 15. Clinical photograph of the patient without support in which a surgical scar with well-defined edges is observed, without erythema, exudate or pressure points under the skin, with an adequate healing and remodeling process of the scar.</p>

DISCUSSION

The cancellous bone is an irregular bone with 7 articular surfaces composed mainly of cancellous bone and a thin cortex with a greater thickness and density in its anterior portion where it articulates with the talus and the cuboid. (1) Likewise, the calcaneus supports 50% of the forces to which the foot is subjected during ambulation and standing. This situation, added to the structural and biomechanical complexity of the hindfoot, usually translates into a significant deficit after an injury. “The man who fractures his calcaneus is finished in terms of his industrial future”, this phrase refers to the average disability time of more than 4 years after the fracture. (2, 4,10)

Since 1930, the surgical management of calcaneal fractures has been described as the worst of both worlds due to the sequelae, poor functional results, and risks associated with surgery. Since 1912 and with subsequent revisions, it was established that the best management for a patient with a complex calcaneal fracture (Sanders IV) is an open reduction with primary arthrodesis of the subtalar joint, thus obtaining a rigid, non-painful foot with adequate foot mobility and the ankle joint; thus, improving results on functional scales, quality of life, convalescence time and avoiding a second surgical procedure. (2)

More recently, closed manipulation and percutaneous fixation have been proposed as management, because severe calcaneal fractures (Sanders IV) represent less than 5% of fractures of this bone and the risk of surgical wound complications is limited. However, more studies are still needed to demonstrate a statistically significant advantage over other treatment options. (11, 12, 13)

Early rehabilitation modalities are a cornerstone for patient recovery and should be supplemented for prolonged periods to obtain better functional results. (14, 15, 16)

Validated functional tests of the foot and ankle are an indispensable tool for adequate monitoring and decision-

making for the approach and treatment of patients with lower extremity injuries. (17, 18, 19, 20, 21, 22, 23, 24, 25)

The patient's case is far from the usual incidence and prevalence groups, being a woman over 65 years of age with a low-energy axial load, since these fractures are usually associated with high-impact events in the male gender and young patients, however, the complexity of the fracture line could be associated mainly with the bone quality of the patient rather than the intensity of the injury. (3)

The diagnosis was made using conventional radiography in 3 positions, anteroposterior, lateral, and axial of the calcaneus, requesting a computed axial tomography for surgical planning. (1, 26)

An open reduction was decided to verify adequate reconstruction since adequate joint reconstruction is associated with better functional results and fewer long-term complications. (27)

Fortunately, the patient presented in the first hours after the accident, this allowed surgery to be performed within the first 72 hours, thanks to the absence of skin lesions in the approach areas.

The use of a moldable stainless steel peripheral plate and cancellous screws was chosen due to the stability they provide to the fracture and a better reconstruction of the articular surface, due to better visualization and manipulation of it. Arthrodesis of the subtalar joint was not performed, since this is associated with an overload of adjacent joints and an acceleration of the osteoarthritis process of the hindfoot. (11, 12, 13)

A late stitch removal was chosen, 21 days after surgery, for adequate recovery of the skin without tension. Although rehabilitation was a prolonged process, its early start allowed recovery in less than 1 year, with functional results after 2 years and with minimal sequelae. (15, 16, 17)

CONCLUSION

Sanders IV Calcaneus Fracture Treated with Open Reduction and Internal Fixation with a Moldable Plate: A Case Report.

Calcaneal fractures continue to be an injury that is difficult to approach and resolve, due to their infrequency and high complexity, which usually lead to severe consequences for the patient and their quality of life. Although a large learning curve may be necessary for their management, they can be managed satisfactorily with relatively traditional methods, helped by advances in preoperative, transoperative, and post-surgical care of the approach area. Considering the relevant biomechanical principles, not only for the anatomical reconstruction of the articular surfaces but also for the adequate stability of the construct subsequently. Unfortunately, this same infrequency and complexity of cases make it difficult to obtain evidence to definitively define specific management, which is why more experimental and comparative studies are needed in the future.

FINANCING

This research has not received any type of funding from public or commercial sector agencies; or for profit.

CONFLICT OF INTERESTS

The authors declare no conflict of interest.

ACKNOWLEDGE

Special acknowledgment to the “Facultad de Medicina de la Universidad Autónoma de Yucatán (UADY)”.

REFERENCES

- I. Maskill, J. D., Bohay, D. R., & Anderson, J. G. (2005). Calcaneus fractures: A review article. *Foot and Ankle Clinics*, 10(3), 463–489. <https://doi.org/10.1016/j.fcl.2005.03.002>
- II. Hernandez, A., Schutte, J., & Dabezies, E. (1986). Calcaneus fracture. *Orthopedics*, 9(3), 444–446. <https://doi.org/10.3928/0147-7447-19860301-19>
- III. Yu, Q., Li, Z., Li, J., Yu, Q., Zhang, L., Liu, D., Zhang, M., & Tang, P. (2022). Calcaneal fracture maps and their determinants. *Journal of Orthopaedic Surgery and Research*, 17(1). <https://doi.org/10.1186/s13018-022-02930-y>
- IV. Walsh, T. P., Vasudeva, V., Sampang, K., & Platt, S. R. (2021). Psychological dysfunction associated with calcaneal fractures. *Injury*, 52(8), 2475–2478. <https://doi.org/10.1016/j.injury.2021.05.013>
- V. Jiménez-Almonte, J. H., King, J. D., Luo, T. D., Aneja, A., & Moghadamian, E. (2019). Classifications in brief: Sanders classification of intraarticular fractures of the calcaneus. *Clinical Orthopaedics and Related Research*, 477(2), 467–471. <https://doi.org/10.1097/corr.0000000000000539>
- VI. Griffin, D., Parsons, N., Shaw, E., Kulikov, Y., Hutchinson, C., Thorogood, M., Lamb, S. E., & for the UK Heel Fracture Trial (UK HeFT) investigators. (2014). Operative versus non-operative treatment for closed, displaced, intra-articular fractures of the calcaneus: randomized controlled trial. *BMJ (Clinical Research Ed.)*, 349(jul24 5), g4483–g4483. <https://doi.org/10.1136/bmj.g4483>
- VII. Scammell, B. E. (2014). Calcaneal fractures. *BMJ (Clinical Research Ed.)*, 349(jul24 11), g4779–g4779. <https://doi.org/10.1136/bmj.g4779>
- VIII. Bába, V., & Kopp, L. (2021). Calcaneal fractures - current trends and pitfalls. *Rozhledy v Chirurgii: Mesicnik Ceskoslovenske Chirurgicke Spolecnosti*, 100(8), 369–375. <https://doi.org/10.33699/PIS.2021.100.8.369-375>
- IX. Schepers, T., van Lieshout, E. M. M., Ginai, A. Z., Mulder, P. G. H., Heetveld, M. J., & Patka, P. (2009). Calcaneal fracture classification: A comparative study. *The Journal of Foot and Ankle Surgery: Official Publication of the American College of Foot and Ankle Surgeons*, 48(2), 156–162. <https://doi.org/10.1053/j.jfas.2008.11.006>
- X. Baertl, S., Alt, V., & Rupp, M. (2021). Surgical enhancement of fracture healing – operative vs. nonoperative treatment. *Injury*, 52, S12–S17. <https://doi.org/10.1016/j.injury.2020.11.049>
- XI. RRoukis, T. S. (2019). Joint-sparing surgical management of sanders IV displaced intra-articular calcaneal fractures. *Clinics in Podiatric Medicine and Surgery*, 36(2), 251–268. <https://doi.org/10.1016/j.cpm.2018.10.007>
- XII. Peng, Y., Wang, J., Feng, B., Li, Y., Zhu, Y., Yuan, W., Teng, L., Zhu, C., Shi, B., & Zhang, L. (2022). Calcaneous interlocking nail treatment for calcaneous fracture: a multiple center retrospective study. *BMC Musculoskeletal Disorders*, 23(1). <https://doi.org/10.1186/s12891-022-05871-z>
- XIII. Stephens, A. R., & Grujic, L. (2020). Post-traumatic hindfoot arthritis. *Journal of Orthopaedic Trauma*, 34(1), S32–S37. <https://doi.org/10.1097/bot.0000000000001695>
- XIV. Chirayath, A., Dhaniwala, N., & Kawde, K. (2024). A comprehensive review on managing fracture calcaneum by surgical and non-surgical modalities. *Cureus*. <https://doi.org/10.7759/cureus.54786>
- XV. Park, E. S., Choi, Y., Lee, J., Park, S.-H., & Lee, H. S. (2021). Calcaneal fracture: results of earlier rehabilitation after open reduction and internal fixation. *Archives of Orthopaedic and Trauma Surgery*, 141(6), 929–936. <https://doi.org/10.1007/s00402-020-03575-4>
- XVI. Albin, S. R., Koppenhaver, S. L., Van Boerum, D. H., McPoil, T. G., Morgan, J., & Fritz, J. M. (2018). Timing of initiating manual therapy and therapeutic exercises in the management of patients after

Sanders IV Calcaneus Fracture Treated with Open Reduction and Internal Fixation with a Moldable Plate: A Case Report.

- hindfoot fractures: a randomized controlled trial. *The Journal of Manual & Manipulative Therapy*, 26(3), 147–156.
<https://doi.org/10.1080/10669817.2018.1432542>
- XVII. Whittaker, G. A., Munteanu, S. E., Roddy, E., & Menz, H. B. (2020). Measures of foot pain, foot function, and general foot health. *Arthritis Care & Research*, 72(S10), 294–320.
<https://doi.org/10.1002/acr.24208>
- XVIII. Larsen, P., Rathleff, M. S., Roos, E. M., & Elsoe, R. (2023). Foot and Ankle Outcome Score (FAOS): Reference values from a national representative sample. *Foot & Ankle Orthopaedics*, 8(4).
<https://doi.org/10.1177/24730114231213369>
- XIX. Martin, R. L., Irrgang, J. J., Burdett, R. G., Conti, S. F., & Van Swearingen, J. M. (2005). Evidence of validity for the foot and Ankle Ability Measure (FAAM). *Foot & Ankle International*, 26(11), 968–983. <https://doi.org/10.1177/107110070502601113>
- XX. Saarinen, A. J., Uimonen, M. M., Suominen, E. N., Sandelin, H., & Repo, J. P. (2022). Structural and construct validity of the foot and ankle ability measure (FAAM) with an emphasis on pain and functionality after foot surgery: A multicenter study. *The Journal of Foot and Ankle Surgery: Official Publication of the American College of Foot and Ankle Surgeons*, 61(4), 872–878.
<https://doi.org/10.1053/j.jfas.2021.12.011>
- XXI. Hale, S. A., & Hertel, J. (2005). Reliability and sensitivity of the Foot and Ankle Disability Index in subjects with chronic ankle instability. *Journal of Athletic Training*, 40(1), 35–40.
- XXII. Choi, H.-S., & Shin, W.-S. (2015). Validity of the lower extremity functional movement screen in patients with chronic ankle instability. *Journal of Physical Therapy Science*, 27(6), 1923–1927.
<https://doi.org/10.1589/jpts.27.1923>
- XXIII. Binkley, J. M., Stratford, P. W., Lott, S. A., & Riddle, D. L. (1999). The Lower Extremity Functional Scale (LEFS): scale development, measurement properties, and clinical application. North American Orthopaedic Rehabilitation Research Network. *Physical Therapy*, 79(4), 371–383.
- XXIV. Budiman-Mak, E., Conrad, K. J., & Roach, K. E. (1991). The foot function index: A measure of foot pain and disability. *Journal of Clinical Epidemiology*, 44(6), 561–570.
[https://doi.org/10.1016/0895-4356\(91\)90220-4](https://doi.org/10.1016/0895-4356(91)90220-4)
- XXV. Kitaoka, H. B., Alexander, I. J., Adelaar, R. S., Nunley, J. A., Myerson, M. S., & Sanders, M. (1994). Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. *Foot & Ankle International*, 15(7), 349–353.
<https://doi.org/10.1177/107110079401500701>
- XXVI. Chirvi, S., Pahapill, N., Yoganandan, N., Curry, W., Stemper, B., Kleinberger, M., & Pintar, F. A. (2022). Calcaneus fracture pattern and severity: Role of local trabecular bone density. *Journal of the Mechanical Behavior of Biomedical Materials*, 134(105332), 105332.
<https://doi.org/10.1016/j.jmbbm.2022.105332>
- XXVII. Clare, M. P., & Crawford, W. S. (2017). Managing complications of calcaneus fractures. *Foot and Ankle Clinics*, 22(1), 105–116.
<https://doi.org/10.1016/j.fcl.2016.09.007>