Total Talar replacements, short-medium term case series, South Africa, 2019

by

Michael James Abramson

Master of Medicine (MMed)

(ABRMIC010)

This study is a partial fulfilment of the requirements for the degree

Master of Medicine in Orthopaedic Surgery

University of Cape Town

Supervisor:

Prof Graham McCollum

Division of Orthopaedic Surgery

Groote Schuur Hospital

Department of Orthopaedic Surgery

Ga.mccollum@uct.ac.za

August 2021

Declaration: Student

I, Michael James Abramson, hereby declare that the work on which this thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university. I authorise the University to reproduce this work for the purpose of research, either the whole or any portion of the contents, in any manner whatsoever. I further declare the following:

1. I know that plagiarism is a serious form of academic dishonesty.
2. I have read the document about avoiding plagiarism, am familiar with its contents and have avoided all forms of plagiarism mentioned there.
3. Where I have used the words of others, I have indicated this by the use of quotation marks.
4. I have referenced all quotations and properly acknowledged other ideas borrowed from others.
5. I have not and shall not allow others to plagiarise my work.
6. I declare that this is my own work.
7. I am attaching the summary of the Turnitin match overview

Signature: Signed by candidate **Date:** 2022-01-10

Declaration: Supervisor

This study was conducted from March 2019 to October 2019 under the supervision of Professor Graham McCollum, Department of Orthopaedic Surgery, University of Cape Town.

As the candidates Supervisor, I have approved this dissertation for submission.

Signature: Signed by candidate **Date:** 2021-08-25

Abstract

Background: There are few surgical options available to manage complex talar pathology that result in predictably acceptable functional and patient satisfaction scores. Recently, the total talar replacement has gained popularity as a viable option. This study presents the clinical outcomes of the first case series of total talar replacements in South Africa.

Methodology: A retrospective review of prospectively collected data of eight consecutive patients who underwent a total talus replacement between July 2014 and August 2018 was performed. The American Orthopaedic Foot and Ankle Hindfoot Score (AOFAS) was used to assess clinical functional outcome and the Short Form-36 satisfaction index (SF-36) was used to assess patient satisfaction. Patient demographics as well as data on pathology, range of motion, gait analysis and radiological outcomes were included.

Results: The average age was 46 years (range, 23 to 71). Pathologies included trauma, avascular necrosis and tumours. Average followup time was 23 months (range, 12 to 49). The mean AOFAS score was 79.25 (range, 69 to 88) and the mean SF36 was 83.25. (range, 60 to 93). No complications or revision surgeries have been performed to date. Seven patients demonstrated a mildly abnormal gait pattern with one in the moderate category. One patient showed radiological changes of minor tibial wear, however this was the patient with the longest followup time (49 months) and he remained symptom free.

Conclusion: Total talar replacements are a viable surgical option in appropriately selected patients with end stage talar pathology in the short to medium term, without compromising future salvage options.

Acknowledgements

I would like to thank my supervisor, Professor Graham McCollum, and all the co-authors for their guidance and patience throughout this process. Secondly, I would like to thank Dr Frederick Louw for proof-reading my work and providing invaluable insight prior to its acceptance in the Journal of Foot and Ankle Surgery.

List of tables and figures

Abbreviations

3D - Three dimensional

HREC - Human Research Ethical Committee

CT – Computer tomography

LRS – Limb Reconstruction System

LRQA – Lloyds Register Quality Assurance

PART A: MANUSCRIPT IN ARTICLE FORMAT

TOTAL TALAR REPLACEMENTS

SHORT-MEDIUM TERM CASE SERIES, SOUTH AFRICA, 2019

Michael Abramson[1], Thomas Hilton[2], Keith Hosking [3], Neil Campbell[4], Roopam Dey[5] Graham McCollum[6]

[1] MBChB (UCT), Groote Schuur hospital, Cape Town, South Africa

[2]FCS Ortho (SA), MMED (UCT). Head of Sarcoma and Joint Reconstruction Unit, Groote Schuur hospital, Cape Town, South Africa

[3]FCS Ortho (SA), MMED (UCT). Vincent Pallotti, Life Orthopaedic Hospital, Cape Town, South Africa

[4] MSc Med (Biomedical engineering), South Africa

[5]PhD, Division of Biomechanical Engineering, University of Cape Town, South Africa

[6]FCS Orth (SA), MMED (UCT). Head of foot and ankle division, Groote Schuur hospital, South Africa

Affiliations:
None

Correspondence:
Michael James Abramson
Department of Orthopaedic Surgery
Groote Schuur Hospital
Observatory, Cape Town, 7925, South Africa.
Email: michaeljames1984@gmail.com

Keywords
Additive manufacturing, avascular necrosis, custom implants, total talar replacement

Abstract

Background: There are few surgical options available to manage complex talar pathology that result in predictably acceptable functional and patient satisfaction scores. Recently, the total talar replacement has gained popularity as a viable option. This study presents the clinical outcomes of the first case series of total talar replacements in South Africa.

Methodology: A retrospective review of prospectively collected data of eight consecutive patients who underwent a total talus replacement between July 2014 and August 2018 was performed. The American Orthopaedic Foot and Ankle Hindfoot Score (AOFAS) was used to assess clinical functional outcome and the Short Form-36 satisfaction index (SF-36) was used to assess patient satisfaction. Patient demographics as well as data on pathology, range of motion, gait analysis and radiological outcomes were included.

Results: The average age was 46 years (range, 23 to 71). Pathologies included trauma, avascular necrosis and tumours. Average followup time was 23 months (range, 12 to 49). The mean AOFAS score was 79.25 (range, 69 to 88) and the mean SF36 was 83.25. (range, 60 to 93). No complications or revision surgeries have been performed to date. Seven patients demonstrated a mildly abnormal gait pattern with one in the moderate category. One patient showed radiological changes of minor tibial wear, however this was the patient with the longest followup time (49 months) and he remained symptom free.

Conclusion: Total talar replacements are a viable surgical option in appropriately selected patients with end stage talar pathology in the short to medium term, without compromising future salvage options.

Introduction

Additive manufacturing to produce medical devices is gaining traction, and no more so than in the use of total talar replacements (TTR) to treat complex talar pathologies. Complex talar trauma and its main sequelae, avascular necrosis (AVN), along with primary sarcomas of the talus, pose unique management challenges, and often result in considerable disability despite appropriate treatment.(1,2)

The talus is the second most commonly injured of the tarsal bones, accounting for nearly 1% of all fractures in the body.(3) Talus trauma is usually the result of a high-energy insult, and as such tends to occur in the young and high demand population group.(4,5) These patients historically have poor satisfaction scores with arthrodesis, which is the current gold standard for the treatment of complex talar pathology.(6) This paper looks to provide another option to arthrodesis, whereby replacing the entire talus and thus maintaining kinematics in the ankle, will result in better patient function and satisfaction for appropriately selected complex talar trauma.

Trauma accounts for approximately 75% of cases of talar AVN.(7) Talar AVN can result in collapse of the talar dome which in turn alters the kinematics of the ankle and subtalar joints. This leads to degenerative changes resulting in ankle pain and stiffness.(8)

The surgical options to treat a collapsed talus include various methods of hindfoot arthrodesis or in extreme cases amputation.(9) TTR is an innovative surgical

alternative, albeit one with limited published data for the treatment of complex talus trauma.(10) Furthermore, should TTR fail, an arthrodesis is still an available option.

This paper assesses the feasibility of talar replacements as an intermediary treatment option for end-stage talar pathology. The primary outcome measure was a functional clinical outcome score in the short and medium term, with secondary outcome measures including range of motion, gait analysis, patient satisfaction, radiological sequele and complication rates.

Methods

A retrospective review of prospectively collected data included eight consecutive patients who underwent a TTR between July 2014 to April 2018. The inclusion criteria are listed in table 2. Patients that demonstrated significant ankle or subtalar joint arthritis were excluded. In these patients a hindfoot arthrodesis was performed.

Prospective data collection was done by way of clinical consultations during the latest routine follow-up visits. Follow-up assessments were conducted at two weeks, six weeks, three, six and 12 months, after which the patients were brought back annually. The American orthopedic foot and ankle society (AOFAS- hindfoot) score was used to assess clinical function (11,12) and the Short Format 36 (SF36) scoring sheet was utilized to quantify patient satisfaction at one of these consultations. All the patients were clinically assessed for gait abnormalities and their sagittal (ankle) range of motion (ROM) was measured using a goniometer. Subtalar (coronal) ROM was assessed by using their contralateral subtalar joint as a reference point and grading any loss as mild (75% to 100%), moderate (25% to 75%) or severe (less than 25%). All the assessments were performed by orthopedic surgeons sub-specialized in foot and ankle surgery. Standard radiographic follow-up was performed at six, 12 and 24

weeks and then annually. Full ethics approval from UCT, HREC #447/2018 was obtained for this study.

Preoperative Planning

Informed consent for surgery was obtained preoperatively on all patients. This was after extensive counseling and discussion with the patients regarding all surgical and non-surgical options as well as potential complications.

The implants were manufactured by a local biomedical engineering company, LRS. They are ISO 13485 certified for the management of medical devices through the LRQA of London. A CT scan with 1mm cuts was performed of the contralateral talus, to mirror the affected side, and converted into computer aided design (CAD) format for all but two cases. In the first of these exceptions, the affected talus contained a giant cell tumor which did not alter its overall anatomy and its diagnostic imaging was used to render the prosthesis. In the second case the mirrored contralateral talus was used but the talar dome reduced in size to prevent overstuffing of the joint due to significant pre-existing AVN collapse of the talar dome.

Electron beam melting and titanium 3D printing was used to manufacture all but one implant, which was made using a 5-axis milling machine (Fig 1). The implants were reduced in size by 2.5% to ensure a more atraumatic insertion and better protection of the soft tissues and articular cartilage of the surrounding bones. This technique of deliberately under-sizing the implant has been previously cited in the literature.(13) The implant was finished with a ceramic surface treatment to create a more wear resistant titanium oxide surface layer “(Fig 2.)”.

Operative Technique

The patient was positioned supine and an above knee tourniquet was utilized for the duration of the procedure. The first three surgeries utilized a dual approach, before

changing to a single anterior approach as per the standard surgical technique described by Hoppenfeld for the remaining five patients “(Fig 3)”. The procedure can easily be performed using this approach, which offers excellent access, while minimizing trauma to the soft tissue envelope of the ankle.

Once soft tissue dissection was complete, a small amount of anterior tibia was removed if additional exposure was required. The talus was then removed, either shelled out completely, or split with an osteotome and removed piecemeal. This followed careful inspection of the defect to ensure complete removal of residual bone or soft tissue that may hinder the insertion of the implant. The implant was then inserted. If any difficulty with insertion was encountered, a repeat inspection of the defect was performed, and any offending soft tissue was released. An image intensifier was used to assess the fit of the implant after insertion, and to insure there was no subluxation of the implant through a dynamic range of motion. Another benefit of using the anterior approach is that should revision or salvage procedures be required in the future; this incision can be utilized again.

Post-operatively, all patients were protected in a back-slab splint for two weeks, after which partial weightbearing for six weeks in a foamwalker boot was allowed. All patients were also advised to continue outpatient physiotherapy to aid rehabilitation, but no specific protocol was followed.

Results:

There were four females and four males in the study, with an average age of 46.1 (range, 23 to 71) years. The mean follow-up was 23.1 (range, 12 to 49) months. Basic demographic information shown in table 3. Two patients were operated on for

complex, un-reconstructable trauma, four for post-traumatic AVN with symptomatic collapse, and two for primary bone neoplasms “(Fig. 4)”.

Seven patients achieved an AOFAS category greater than 30 degrees of plantar flexion and one patient scored in the 15 to 29 degrees category. Dorsiflexion results included one patient achieving neutral dorsiflexion, four in the 5 to 9 degrees category and three greater than 10 degrees category. Seven patients were scored as having moderate restriction in their subtalar joint range of motion (25% to 75% of normal) compared to their unaffected side, and one scored in the mild category (75% to 100%). The average AOFAS score was 79.25, with five patients achieving a good result, defined as a score between 80 to 90 out of 100. Two patients recorded a satisfactory result between 70 to 80 and one poor result of less than 70. The average SF36 score was 83.25, with only two patients failing to achieve a score above 80%. There were no postoperative complications recorded in this series, however, three patients demonstrated fixed hindfoot varus, the same number reported exertional posterolateral ankle discomfort, and all but one showed some degree of subtalar ROM deficit and minor gait abnormalities. One patient showed radiological changes of minor tibial wear at 49 months postoperatively. He remained symptom free at the time of the radiological finding. See table 4 for summary of results.

Discussion:

The advent of 3D printing has allowed the total talus replacement to become a more feasible surgical option.(14) Its complex anatomy and intricate relationship to several surrounding bones and joints involved in gait kinematics suggests the need for an anatomical implant to achieve the best clinical outcomes.

The goals of the ideal hindfoot surgery are: a plantigrade, stable and pain free foot, the maintenance of hindfoot mobility as much as possible and a cosmetically near normal looking foot. The current gold-standard for end-stage talus pathology treatment is a hindfoot arthrodesis. Issues commonly reported with these surgeries include loss of leg length, widening of the ankle mortise, loss of hindfoot motion and high complications rates, particularly non-union, infection and amputation.(15)

The Blair fusion, originally described in 1943, was the first operation that recognized the importance of preserving a degree of hindfoot mobility. While several authors have published improved union rates using modifications of the original technique, good long-term clinical outcomes scores are lacking.(16)

Talar arthroplasty as a concept was first described in the 1970's, and in 1997, the landmark paper by Harnroongrog et al showed satisfactory results from a 5 to 15-year follow-up of 16 patients using a cemented stainless steel talar body implant.(17) A 2014 follow-up paper by the same authors showed promising results, reporting a mean AOFAS score of greater than 75 from a 36-year follow-up study.(18) This paper highlighted the importance of surgical technique and patient selection as key components in outcome. The latter proving applicable in our series, as poor clinical and satisfaction scores were reported by our patient with pre-existing subtalar arthritis. Tanaka et al highlighted in their small series of talar body replacements, the ease of the operation and preservation of hindfoot motion as a notable advantage of talar arthroplasty.(19)

Taniguchi et al concluded their work comparing three generations of implants by recommending the TTR as a useful procedure for AVN of the talus, noting the relatively short period of restricted weightbearing, rapid pain relief, preservation of limb length and the favorable congruency of the implant in the maintenance of a stable,

functional ankle joint as benefits of the surgery.(20) Previous case reports have all shown encouraging early results following TTR's following both idiopathic and complex talar trauma to the talus.(21)

Potential complications of this surgery include dislocation of the implant, peri-talar instability, implant migration, osteoarthritis of surrounding bone surfaces and anterior instability.(21) We only encountered subtalar arthritis in one case of our series (Fig 5). Although we are concerned about this finding, the patient remains clinically asymptomatic after 49 months, and we are monitoring his progress closely.

Our clinical assessment did find hindfoot varus on weightbearing in three of our patients. We hypothesize that this is likely because we undersized the implants by 2.5% to prevent overstuffing, which may have altered the kinematics and mobility of the subtalar joint. Upsizing line to line to address this is issue something we will have to consider going forward. Intermittent exertional posterolateral foot pain was a concern in nearly half of our series, most likely from the restricted subtalar joint, and a moderate loss of subtalar ROM was found in all but one of our patients. The small numbers, and varied pathologies in this case series limit any meaningful conclusions pertaining to these findings, in particular whether there may be any aspects to the surgery or postoperative rehabilitation that can be improved on to reduce these occurrences in the future. All but one patient encouragingly reported being able to perform their activities of daily living (ADL's) with minimal to no pain or limitation. The one patient reporting difficulty in some ADL's (patient #2) was also the only person who failed to score more than 70 for the AOFAS-hindfoot. Retrospective review of patient #2's preoperative CT-scan showed more significant subtalar damage from screw penetration than we first appreciated and highlights the importance of pre-

operatively assessing the integrity of the posterior facet of the calcaneus. This finding preoperatively may have excluded her from a TTR in favor of an arthrodesis.

Our mean SF36 score of 83.25 was encouraging, yet two patients failed to score above 80%. Patient #2, which in all likelihood was linked to her poor functional outcome, and (patient #8), who attributed his poor score in the role-limitation due to physical health component, as well as the emotional well-being and social functioning questions of the SF36 score to the loss of his job following his accident.

Future of the TTR

There is ongoing work looking into the production of generic talar implants, with the aim of improving accessibility and reducing cost of the implant.(4) Long-term studies are needed to assess how a generic implant will perform against a custom fitted one. Further research looking at the optimal material for the implant, chiefly with respect to its wear properties, manufacturing capabilities, as well as long-term follow-up clinical outcome studies of the current series are needed before we will fully appreciate the capabilities and limitations of the TTR.

Limitations

We wish to acknowledge several limitations to our research. Firstly, our small sample size, and retrospective nature of the study design. Secondly the fact that the operative technique was changed over the course of the series may be a potential source of outcome bias. Lastly and most critically, the fact that we do not have any preoperative clinical or satisfaction scores to compare with the ones we achieved postoperatively. It is worth noting however that most of the patients in our study were unable to walk prior to surgery, and that encouragingly, all our patients reported that they would have the surgery again given the same choice today.

Conclusion:

The talus replacement is a relatively simple operation to perform, which can produce rapid pain relief, while maintaining ankle range of motion, limb length and foot cosmesis. The results of our study, which showed good clinical outcome scores using the AOFAS and excellent satisfaction scores (SF36) over a mean of just under 24 months, in conjunction with a nearly 90% rate of a normal gait pattern and no postoperative complications, have demonstrated that the TTR is a feasible surgical option in the short to mid-term, in appropriately selected patients, for a variety of complex talus pathologies.

Tables and figures:

"**Table 1"** Inclusion criteria for this study (N=8)

No	Criteria
1	Age above 18 years
2	Complex talar pathology not amenable to reconstruction
3	Failed reconstruction
4	Arthrodesis declined
5	Minimum follow-up of 1 year

"**Table 2"** Showing basic demographic information and average time of follow up

Demographics	
Total Patients	08
Age, y, mean ± SD (range)	46.2 ± 15.8 (23 – 62)
Gender, % female	50
Postoperative follow-up, m, mean ± SD (range)	23.1 ± 11.6 (12 – 49)

“**Table 3”** Results showing age, months since surgery, AOFAS scores, SF36, Hindfoot position (varus/neutral/valgus), Posterolateral (P/L) ankle pain, and sub-talar loss in ROM. (Abbreviations - Obv: Obvious; Mod: Moderate; SD: standard deviation: AVN: Avascular necrosis; GCT: Giant cell tumor; ROM: range of motion) (N = 8)

Patient	Age (years)	Pathology	Time Since Surgery (Months)	AOFAS	SF36	Gait	Varus	P/L Ankle Pain	ST Loss of ROM
1	31	GCT	49	80	89	Mild	Yes	No	Mod
2	71	AVN	33	69	60	Mild	Neutral	No	Mod
3	59	Trauma	23	71	92	Obv	Neutral	Yes	Mod
4	62	AVN	21	85	93	Mild	Yes	No	Mod
5	48	Trauma	18	78	93	Mild	Yes	Yes	Mod
6	42	GCT	17	82	82	Mild	Valgus	No	Mod
7	33	AVN	12	81	82	Mild	Neutral	Yes	Mild
8	23	AVN	10	88	75	Mild	Neutral	No	Mod
Mean ± SD	46.1 ± 15.8		22.9 ± 11.9	79.3 ± 6.1	83.3 ±10.7	NA	NA	NA	NA

Figure 1: A digital recreation of the milling machine used to make our custom-made talus implants

Figure 2 Example of a 3D printed total talar implant, after undergoing its titanium oxide surface treatment

Figure 3: Example of the skin incision for the anterior approach to the talus

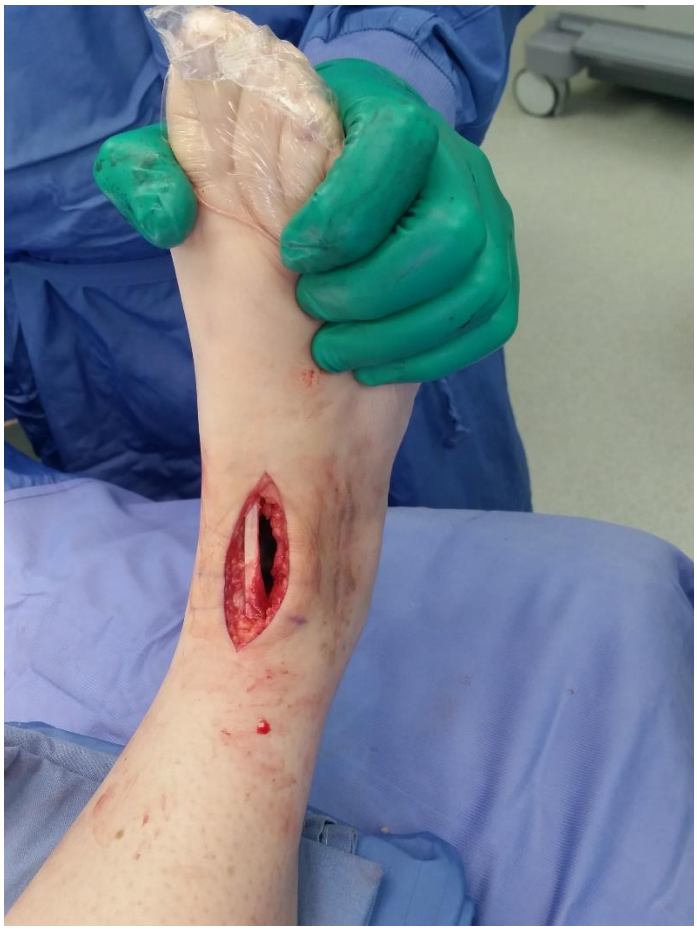


Figure 4: A sagittal cut of the first patients CT, demonstating a giant cell tumour. The tibiotalar and subtalar joints are well preserved, allowing for a TTR to be considered

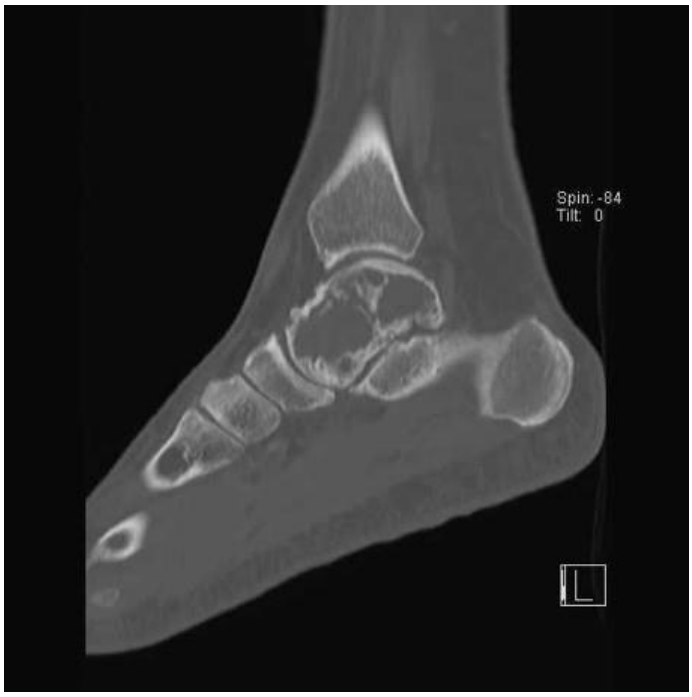
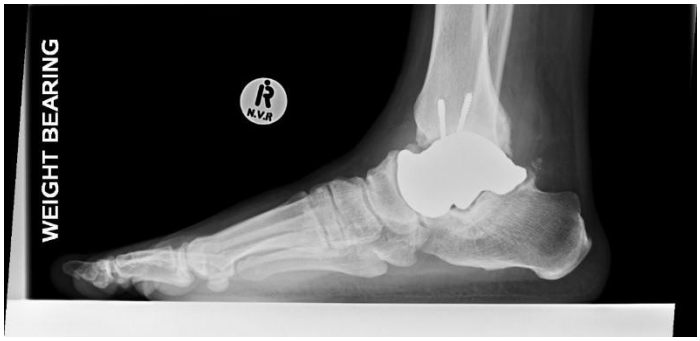


Figure 5: Lateral x-ray of the first patients TTR 49 months postoperatively. Posterior tibial wear and osteophyte formation can be seen



References:

1. Thordarson DB. Talus fractures. *Fuss und Sprunggelenk*. 2007;5(2):104-113. doi:10.1007/s10302-007-0282-0

2. Taniguchi A, Takakura Y, Sugimoto K, et al. The use of a ceramic talar body prosthesis in patients with aseptic necrosis of the talus. *J Bone Jt Surg - Ser B*. 2012;94 B(11):1529-1533. doi:10.1302/0301-620X.94B11.29543

3. Islam K, Dobbe A, Duke K, et al. Three-dimensional geometric analysis of the talus for designing talar prosthetics. *Proc Inst Mech Eng Part H J Eng Med*. 2014;228(4):371-378. doi:10.1177/0954411914527741

4. Trovato AN, Bornes TD, El-Rich M, Dhillon SS, Adeeb S, Jomha NM. Analysis of a generic talar prosthetic with a biological talus: A cadaver study. *J Orthop*. 2018;15(1):230-235. doi:10.1016/j.jor.2018.01.015
5. Trovato A, El-Rich M, Adeeb S, Dhillon S, Jomha N. Geometric analysis of the talus and development of a generic talar prosthetic. *Foot Ankle Surg*. 2017;23(2):89-94. doi:10.1016/j.fas.2016.12.002
6. Myerson MS, Alvarez RG, Lam PWC. Tibiocalcaneal arthrodesis for the management of severe ankle and hindfoot deformities. *Foot Ankle Int*. 2000;21(8):643-650. doi:10.1177/107110070002100803
7. Haskell A. Natural History of Avascular Necrosis in the Talus: When to Operate. *Foot Ankle Clin*. 2019;24(1):35-45. doi:10.1016/j.fcl.2018.09.002
8. Adelaar RS, Madrian JR. Avascular necrosis of the talus. *Orthop Clin North Am*. 2004;35(3):383-395. doi:10.1016/j.ocl.2004.02.010
9. Shakked RJ, Tejwani NC. Surgical treatment of talus fractures. *Orthop Clin North Am*. 2013;44(4):521-528. doi:10.1016/j.ocl.2013.06.007
10. Takakura Y, Tanaka Y, Kumai T, Sugimoto K, Ohgushi H. Ankle arthroplasty using three generations of metal and ceramic prostheses. In: *Clinical Orthopaedics and Related Research*. Lippincott Williams and Wilkins; 2004:130-136. doi:10.1097/01.blo.0000131246.79993.ec
11. Kitaoka HB, Alexander IJ, Adelaar RS, Nunley JA, Myerson MS, Sanders M. Clinical Rating Systems for the Ankle-Hindfoot, Midfoot, Hallux, and Lesser Toes. *Foot Ankle Int*. 1994;15(7):349-353. doi:10.1177/107110079401500701
12. Ibrahim T, Beiri A, Azzabi M, Best AJ, Taylor GJ, Menon DK. Reliability and Validity of the Subjective Component of the American Orthopaedic Foot and Ankle Society Clinical Rating Scales. *J Foot Ankle Surg*. 2007;46(2):65-74.

doi:10.1053/j.jfas.2006.12.002

13. Ruatti S, Corbet C, Boudissa M, et al. Total Talar Prosthesis Replacement after Talar Extrusion. *J Foot Ankle Surg*. 2017;56(4):905-909. doi:10.1053/j.jfas.2017.04.005
14. Kelly BE, Bhattacharya I, Heidari H, Shusteff M, Spadaccini CM, Taylor HK. *Volumetric Additive Manufacturing via Tomographic Reconstruction*. http://science.sciencemag.org/. Accessed April 18, 2020.
15. Acosta R, Ushiba J, Cracchiolo A. The results of a primary and staged pantalar arthrodesis and tibiotalocalcaneal arthrodesis in adult patients. *Foot Ankle Int*. 2000;21(3):182-194. doi:10.1177/107110070002100302
16. Van Bergeyk A, Stotler W, Beals T, Manoli A. Functional outcome after modified blair tibiotalar arthrodesis for talar osteonecrosis. *Foot Ankle Int*. 2003;24(10):765-770. doi:10.1177/107110070302401005
17. Harnroongroj T, Vanadurongwan V. The talar body prosthesis. *J Bone Jt Surg - Ser A*. 1997;79(9):1313-1322. doi:10.2106/00004623-199709000-00005
18. Harnroongroj T, Harnroongroj T. The talar body prosthesis: Results at ten to thirty-six years of follow-up. *J Bone Jt Surg - Am Vol*. 2014;96(14):1211-1218. doi:10.2106/JBJS.M.00377
19. Tanaka Y, Takakura Y, Kadono K, et al. Alumina ceramic talar body prosthesis for idiopathic aseptic necrosis of the talus. In: *Key Engineering Materials*. Vol 240-242. ; 2003:805-808. doi:10.4028/www.scientific.net/kem.240-242.805
20. Taniguchi A, Tanaka Y. An Alumina Ceramic Total Talar Prosthesis for Avascular Necrosis of the Talus. *Foot Ankle Clin*. 2019;24(1):163-171. doi:10.1016/j.fcl.2018.10.004
21. Ando Y, Yasui T, Isawa K, Tanaka S, Tanaka Y, Takakura Y. Total Talar

Replacement for Idiopathic Necrosis of the Talus: A Case Report. *J Foot Ankle Surg*. 2016;55(6):1292-1296. doi:10.1053/j.jfas.2015.07.015

Appendix: AOFAS hindfoot score and SF36 score

Hindfoot Surgery Assessment Form

(Pages 1 & 2 to be completed by surgeon. Pages 3-4 & SF36 to be completed by patient. Surgeon to calculate AOS score).

Name:_____ **DOB:**___	**Date of Assessment:**
Sex:____ *Patient Label*	

Height:_____cms **Weight:**_____Kg **Smoker:** □ YES □ NO

Operation Side: □ Left □ Right

Proposed Operation:_____

Pre-operative diagnosis:

□ **Primary OA**	□ **Achilles Tendon Pathology**
□ **Post-traumatic OA**	
□ Date of injury	□ **Peroneal Tendon Pathology**
□ Previous surgery (specify and date)	
□ **Rheumatoid Arthritis**	□ **Other (specify)**

Previous Operations on Foot:

□ Forefoot (specify)
□ Midfoot (specify)
□ Hindfoot/Ankle (specify)

Other Joints involved:

□ Ankle arthrosis	Left	Right
□ Ankle arthrodesis	Left	Right
□ Ankle fusion	Left	Right
□ Midfoot arthrosis	Left	Right
□ Midfoot fusion	Left	Right

□ Hip arthrodesis/arthroplasty Left Right
□ Knee arthrodesis/arthroplasty Left Right
□ Ankle arthrodesis/arthroplasty Left Right

Past Medical History:

□ Steroid treatment	□ Ischaemic Heart Disease / Peripheral
□ Immune suppression	□ Vascular Disease
□ Diabetes	□ COPD
□ DVT	□ Other

OBJECTIVE ASSESSMENT FOR COMPLETION BY SURGEON

Gait abnormality

□ None, slight
□ Obvious
□ Marked

ROM

□ Extension ≥10º	□ Flexion ≥30º
□ Extension 5-9º	□ Flexion 15-29º
□ Extension <5º	□ Flexion <15º

Hindfoot motion (inversion plus eversion)

□ Normal or mild restriction (75%-100% normal)
□ Moderate restriction (25%-74% normal)
□ Marked restriction (less than 25% normal)

Alignment

□ Good, plantigrade foot, ankle-hindfoot well aligned
□ Fair, plantigrade foot, some degree of ankle-hindfoot malalignment observed, no symptoms
□ Poor, nonplantigrade foot, severe malalignment, symptoms

□ Valgus during loading <5º	□ Varus during loading <3º
□ Valgus during loading 5-10º	□ Varus during loading 4-7º
□ Valgus during loading >10º	□ Varus during loading >7º

Function

Able to toe-walk	□ Yes	□ No
Able to heel-walk	□ Yes	□ No
Normal cadance during staircase walking	□ Yes	□ No
Walking aids	□ Yes	□ No
Orthopaedic footwear	□ Yes	□ No
Able to stand on one leg	□ Yes	□ No

SUBJECTIVE ASSESSMENT FOR COMPLETION BY PATIENT

Please tick one square in each of the boxes below that best describes the pain and function relating to your ankle or hindfoot.

Pain (If you have no pain in your ankle or hindfoot tick “None” and proceed to the Function section.)

□ None

or:

□ Mild, occasional
□ Moderate, daily
□ Severe, almost always present

□ Pain only on starting-up
□ Pain only when walking on uneven surfaces
□ Pain occasionally when walking on any surface
□ Pain always when walking
□ Pain at rest or spontaneously

Function

Activity limitations and support requirement (eg walking stick)

□ No limitations, no support
□ No limitation of daily activities, limited recreational activities, no support
□ Limited daily and recreational activities, cane
□ Severe limitation of daily and recreational activities, walker, crutches, wheelchair, brace

Maximum walking distance, blocks (1 block~150 metres)

□ Greater than 6
□ 4-6
□ 1-3
□ Less than 1

Walking surfaces

□ No difficulty on any surface
□ Some difficulty on uneven terrain, stairs, inclines, ladders
□ Severe difficulty on uneven terrain, stairs, inclines, ladders

AOS SCORE

PAIN

The line next to each item represents the amount of pain you typically had in each situation. On the far left is “No pain” and on the far right is “Worst pain imaginable”. Place a mark on the line to indicate how bad your **ankle/hindfoot pain** was in each of the following situations during the **past week**. If you were not involved in one or more of these situations, place an “X” in the column under the heading “N/A”.

How severe was your ankle/hindfoot pain:

				N/A
1	At its worst?	No pain	Worst pain imaginable	
2	Before you get up in the morning?	No pain	Worst pain imaginable	
3	When you walked barefoot?	No pain	Worst pain imaginable	
4	When you stood barefoot?	No pain	Worst pain imaginable	
5	When you walked wearing shoes?	No pain	Worst pain imaginable	
6	When you stood wearing shoes?	No pain	Worst pain imaginable	
7	When you walked wearing shoe inserts or braces?	No pain	Worst pain imaginable	
8	When you stood wearing shoe inserts or braces?	No pain	Worst pain imaginable	
9	At the end of the day?	No pain	Worst pain imaginable	

To be completed by Surgeon _____/ __ = ___%

DISABILITY

The line next to each item represents the amount of difficulty you had in performing an activity. On the far left is “No difficulty” and on the far right is “So difficult unable”. Place a mark on the line to indicate how much difficulty you had performing each activity because of your **ankle/hindfoot** during the **past week**. If you did not perform an activity during the past week, place an “X” in the column under the heading “N/A”.

How much difficulty did you have:

				N/A
1	Walking around the house?	No difficulty	So difficult unable	
2	Walking outside on uneven ground?	No difficulty	So difficult unable	
3	Walking four or more blocks?	No difficulty	So difficult unable	

4	Climbing stairs?	No difficulty		So difficult unable	
5	Descending stairs?	No difficulty		So difficult unable	
6	Standing on tip toes?	No difficulty		So difficult unable	
7	Getting out of a chair?	No difficulty		So difficult unable	
8	Climbing up or down curbs?	No difficulty		So difficult unable	
9	Walking fast or running?	No difficulty		So difficult unable	

To be completed by Surgeon _____/ __ = ___%

SF-36 Health Survey

Check a box for each question.

1. **In general**, would you say your health is

   Excellent ☐ Very good ☐ Good ☐ Fair ☐ Poor ☐

2. **Compared to 1 year ago**, how would your rate your health in general **now**?

   Much better than 1 year ago ☐ Somewhat better than 1 year ago ☐

   About the same ☐ Somewhat worse than 1 year ago ☐

   Much worse than 1 year ago ☐

The following items are about activities you might do during a typical day. Does **your health now limit you** in these activities? If so, how much?	Yes, Limited a Lot	Yes, Limited a Little	No, Not Limited at All
3. **Vigorous activities**, such as running, lifting heavy objects, participating in strenuous sports	☐	☐	☐
4. **Moderate activities**, such as moving a table, mopping the floor, doing yard work, or playing golf	☐	☐	☐
5. Lifting or carrying groceries	☐	☐	☐
6. Climbing **several** flights of stairs	☐	☐	☐
7. Climbing **one** flight of stairs	☐	☐	☐
8. Bending, kneeling, or stooping	☐	☐	☐
9. Walking **more than a mile**	☐	☐	☐
10. Walking **several blocks**	☐	☐	☐
11. Walking **one block**	☐	☐	☐
12. Bathing or dressing yourself	☐	☐	☐

During the **past 4 weeks,** have you had any of the following problems with your work or other regular daily activities **as a result of your physical health?**	Yes	No
13. Cut down the **amount of time** you spent on work or other activities	☐	☐
14. **Accomplished less** than you would like	☐	☐
15. Were limited in the **kind** of work or other activities	☐	☐
16. Had **difficulty** performing the work or other activities (for example, took extra time)	☐	☐

During the **past 4 weeks,** have you had any of the following problems with your work or other regular daily activities **as a result of any emotional problems** (such as feeling depressed or anxious)?	Yes	No

17. Cut down the **amount of time** you spent on work or other activities ☐ ☐

18. **Accomplished less** than you would like ☐ ☐

19. Didn't do work or other activities as **carefully** as usual ☐ ☐

20. During the **past 4 weeks,** to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?

Not at all ☐ Slightly ☐ Moderately ☐ Quite a bit ☐ Extremely ☐

21. How much **bodily** pain have you had during the **past 4 weeks**?

None ☐ Very Mild ☐ Mild ☐ Severe ☐ Very Severe ☐

22. During the **past 4 weeks,** how much did **pain** interfere with your normal work (including both work outside the home and housework)?

Not at all ☐ Slightly ☐ Moderately ☐ Quite a bit ☐ Extremely ☐

Please check one answer for each question that comes closest to how you have felt during the **past 4 weeks**.	All of the time	Most of the time	A Good Bit of the time	Some of the time	A Little of the time	No of t tim
23. Did you feel full of pep?	☐	☐	☐	☐	☐	☐
24. Have you been a very nervous person?	☐	☐	☐	☐	☐	☐
25. Have you felt so down in the dumps that nothing could cheer you up?	☐	☐	☐	☐	☐	☐
26. Have you felt calm and peaceful?	☐	☐	☐	☐	☐	☐
27. Did you have a lot of energy?	☐	☐	☐	☐	☐	☐
28. Have you felt downhearted and blue?	☐	☐	☐	☐	☐	☐
29. Did you feel worn out?	☐	☐	☐	☐	☐	☐
30. Have you been a happy person?	☐	☐	☐	☐	☐	☐
31. Did you feel tired?	☐	☐	☐	☐	☐	☐
32. How much of the time has your **physical health or emotional problems** interfered with your social activities (like visiting with friends, relatives, etc.)?	☐	☐		☐	☐	☐

	Definitely True	Mostly True	Don't Know	Mostly False	Definit Fals
33. I seem to get sick a little easier than other people	☐	☐	☐	☐	☐
34. I am as healthy as anybody I know	☐	☐	☐	☐	☐
35. I expect my health to get worse	☐	☐	☐	☐	☐
36. My health is excellent	☐	☐	☐	☐	☐