Total ankle arthroplasty with total talar prosthesis for talar osteonecrosis with ankle osteoarthritis: A case report

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Introduction

Osteoarthritis (OA) is a leading cause of disability, affecting more than 30 million adults in the United States [1]. For hip and knee OA, high rates of success have been reported for arthroplasty [2-4]. For treatment of severe ankle OA, arthrodesis has been considered a primary procedure [5]. Recently, total ankle arthroplasty (TAA) has been considered a good choice for the treatment of ankle OA [6, 7]. However, treatment of complicated ankle OA such as subtalar OA or severe talar collapse remains challenging. Herein, we reported a novel technique for such complicated pathology as talar necrosis with ankle OA and subtalar OA using TAA with total talar prosthesis (combined TAA) [8].

Report of the case

A 77-year-old woman with left ankle sprain had been treated with a cast for 2 weeks followed by a brace by her orthopedist 5.5 years before. After 3.5 years, she began to experience left ankle pain and was conservatively treated with pain killer alone by another orthopedist. However, because her symptoms continued and worsened, she presented to a general hospital and was diagnosed with talar osteonecrosis. She was admitted to our institution for operative treatment. Her previous medical history only included appendectomy at the age of 30 years. No other remarkable medical, drinking, and smoking history were reported.

Physical examination revealed swelling of her ankle and tenderness both anteriorly and in the tarsal sinus, with worsening during movement. The ankle showed 5 degrees of dorsiflexion, 15 degrees of plantarflexion, 5 degrees of inversion, and 0 degrees of eversion. Neither an anterior drawer test nor subtalar joint instability was noted. The American Orthopaedic Foot and Ankle Society (AOFAS) score was 60 points, with subscores of 20, 35, and 5 points for pain, function, and alignment, respectively.

Radiographs showed joint space narrowing with spur formation and collapse of the talus (Fig. 1). The anteroposterior tibial anterior surface angle (TAS) was 91 degrees, the tibial lateral surface angle (TLS) was 88 degrees, and the tibial medial malleolar angle (TMM) was 23 degrees. Computed tomography (CT) revealed collapse of the talus. Irregularity, spur formation, and joint space narrowing was observed in the talocrural, subtalar, and talonavicular joints. A cyst was also observed in the tibia (Fig. 2). T1-weighted magnetic resonance imaging showed a low-intensity area in the whole talus, indicating severe osteonecrosis (Fig. 3). Therefore, our diagnosis was talar osteonecrosis (stage Ⅳ according to the classification of Ficat and Arlet [9]) with ankle OA (stage Ⅲ according to the classification proposed by Takakura Y et al. [10]), and operative intervention with TAA and total talar replacement was planned.

The patient was placed in the supine position with a thigh tourniquet under general anesthesia. The operation was performed using an anterior approach to the ankle joint. After a longitudinal skin and retinaculum incision, the tibialis anterior was retracted to the medial side and the other muscles to the lateral side. Tibial osseous membrane was peeled, and the talonavicular joint was exposed by removing the joint capsule. Osteotomy of the tibial plafond and medial malleolus was performed using the extramedullary guiding rod placed through the center of the patella (Fig. 4). An alumina ceramic talar prosthesis (Kyocera, Kyoto, Japan) designed using CT images of the healthy side was implanted. The talus was then excised piece-by-piece with a bone saw, followed by excision of all soft tissues, such as talocalcaneal interosseous ligament, both anterior and posterior talofibular ligament, deep layer of the deltoid ligament, and posterior joint capsule at the attached area to the talus. We confirmed that no remaining talus was noted. Additional osteotomy in the convex portion of the tibial component on the proximal side was performed using another tibial cutting guide. We placed the total talar prosthesis and trial tibial component to assess the range of ankle motion. A TNK tibial component (Kyocera) was fixed using calcium phosphate paste, and the marrow fluid collected from the iliac bone was placed on the paste to promote bone growth.

The marrow fluid was additionally injected into the interface of the implant with the bone. AO small cancellous bone screw (DePuy Synthes, West Chester, PA, USA) was inserted through a screw hole. Although the medial malleolus fracture occurred accidentally when impacting the tibial component, probably because of thinner than usual medial malleolus in this osteotomy, we treated it conservatively because the periosteum remained continuous, and no displacement was observed. After repairing the retinaculum, the procedure was completed with skin closure. No special surgical instrument was required for total talar prosthesis. The patient was instructed to not bear weight for 3 weeks with a below-knee cast, followed by weight bearing with a cast for 3 weeks, because of the medial malleolus fracture without displacement detected during the operation. During casting, we encouraged the patient to perform toe exercises. After the cast was removed, the patient restored muscle strength around the ankle joint by returning to her usual activities of daily living. At the most recent follow-up 4 years postoperatively, the patient reported no pain, and no implant failure was found (Fig. 5). The degree of both plantarflexion and dorsiflexion was the same as that before the operation, and the AOFAS score improved to 88 points, with subscores of 40, 38, and 10 points for pain, function, and alignment, respectively. The patient provided consent to publish this case in a journal.

Discussion

Even though the hip and knee are the most commonly studied lower extremity joints [11, 12], ankle OA can also cause functional impairment and decreased quality of life [5]. Saltzman et al. reported that the degree of physical impairment associated with ankle OA is equivalent to that associated with severely disabling medical problems including end-stage kidney disease and congestive heart failure [13]. Therefore, it is essential to develop a reliable treatment method for ankle OA, which has remained challenging, even though total hip and knee arthroplasty have been successful. For treatment of severe ankle OA, arthrodesis had been considered the gold standard [5]. TAA has been reported to be useful for OA as an alternative to arthrodesis, with low complication rates compared to arthrodesis [5, 14], in addition to good clinical results [15, 16]. However, it is often difficult to treat ankle OA combined with subtalar OA, severe talar collapse, or avascular talar necrosis [17, 18]. Such cases have been treated using TAA with subtalar fusion, but there are few reports of long-term follow-up after this procedure [18, 19]. Furthermore, the treatment of avascular talar necrosis itself has been challenging, because of the few available options such as arthrodesis and non-vascularized or vascularized bone-grafting [20-22]. Moreover, such treatments may affect ankle joint function and cause non-union [20, 21, 23]. Manes et al. reported that TAA for talar necrosis resulted in functional improvement and pain relief [24]. Although the clinical results seemed to be satisfactory for short- to mid-term follow-up, some serious complications, such as loosening and subsidence of the prosthesis were found [25-28]. In fact, extensive talar necrosis has been considered as the relative contraindication of TAA because the talar component would more easily subside due to poor bone quality [28, 29]. Here, we expect that we could cope with such complicated pathology as extensive talar necrosis with OA without worrying about talar subsidence by using the total talar prosthesis in this case. To the best of our knowledge, this is the first report using combined TAA procedures for treatment of extensive talar necrosis with ankle OA and subtalar OA. A total talar prosthesis has been developed for use in avascular talar necrosis (Fig. 6) [30]. The prosthesis is designed for each patient using a CT image of the unaffected side, following the procedure proposed by Taniguchi et al. [30]. In brief, relevant dimensions are measured based on the radiographs and CT scans of the healthy side. CT images are taken within 2-mm intervals in the axial and sagittal planes, and a three-dimensional wire model and implant are assembled. A stereolithographic model is then cast, and an alumina ceramic prosthesis is customized. The curvature of the sliding surface is tailored to the tibial component in this procedure. These prostheses are produced in 4 weeks (Fig. 7). The prosthesis can provide appropriate articulation in the talocrural, subtalar, and talonavicular joints in addition to avoid the risk of talar subsidence. Good prosthetic alignment can also be reproduced by proper bone alignment. Harnroongroj et al. reported a stainless steel talar body prosthesis designed using slit scenography [31]. Subsequently, a Japanese orthopedic group developed a custom-made artificial talar body implant made of alumina ceramic and designed with CT; however, some of these resulted in failure due to talar neck loosening or talar head destruction [32]. Therefore, the same group developed a total talar prosthesis to avoid these complications, while providing good clinical function and patient satisfaction [30, 33]. They also reported that alumina ceramic is a suitable material because of the complexity of the talar joint surface in contact with surrounding bone, based on comparative studies showing that alumina ceramic exhibited less wear than 316L stainless steel [30, 34], as well as reports of long-term successful clinical results in hip arthroplasty [35, 36].

One study reported that the average range of motion after TAA ranged from 5 degrees of dorsiflexion to 19 degrees of plantarflexion [6]. In our case, the range of ankle motion recovered to the initial preoperative level, although the results were not as good as in other reports [6, 15, 37]. However, the AOFAS score in our case of combined TAA improved to the average level achieved with TAA alone [15, 37]. When compared to arthrodesis, TAA alone can provide better self-reported results and gait analysis [38-40]. Therefore, the combined TAA will also be expected to yield better functional results compared to arthrodesis. Loosening or sinking of the component was reportedly the main complication leading to revision [5]. Thus far, no complications have been observed in our case, except for an intraoperative medial malleolar fracture, which can be found 4 to 11.4% of cases, according to previous reports [6, 37]. Although such fractures can be fixed with screws or Kirschner wires, we used casting because there was no displacement and union was successful. Additionally, for the fixation of the TNK tibial component with calcium phosphate paste, we followed the temporary cementation technique reported by Bibbo to provide a stable and safe implant interface with native bone [41]. Thus, TAA with total talar prothesis can be useful for treatment of talar necrosis with ankle OA and subtalar OA. However, long-term follow-up is needed to determine the true durability of combined TAA.

References

1. Cisternas MG, Murphy L, Sacks JJ, Solomon DH, Pasta DJ, Helmick CG. Alternative Methods for Defining Osteoarthritis and the Impact on Estimating Prevalence in a US Population-Based Survey. Arthritis Care Res (Hoboken) 2016 May;68(5):574-80.

2. Pollock M, Somerville L, Firth A, Lanting B. Outpatient Total Hip Arthroplasty, Total Knee Arthroplasty, and Unicompartmental Knee Arthroplasty: A Systematic Review of the Literature. JBJS Rev 2016 Dec 27;4(12).

3. Delaunay CP, Putman S, Puliero B, Begin M, Migaud H, Bonnomet F. Cementless Total Hip Arthroplasty With Metasul Bearings Provides Good Results in Active Young Patients: A Concise Followup. Clin Orthop Relat Res 2016 Oct;474(10):2126-33.

4. Chinzei N, Ishida K, Tsumura N, Matsumoto T, Kitagawa A, Iguchi T, Nishida K, Akisue T, Kuroda R, Kurosaka M. Satisfactory results at 8 years mean follow-up after ADVANCE(R) medial-pivot total knee arthroplasty. Knee 2014 Mar;21(2):387-90.

5. Lawton CD, Butler BA, Dekker RG, 2nd, Prescott A, Kadakia AR. Total ankle arthroplasty versus ankle arthrodesis-a comparison of outcomes over the last decade. J Orthop Surg Res 2017 May 18;12(1):76.

6. Kitaoka HB, Patzer GL. Clinical results of the Mayo total ankle arthroplasty.

J Bone Joint Surg Am 1996 Nov;78(11):1658-64.

7. Kamrad I, Carlsson A, Henricson A, Magnusson H, Karlsson MK, Rosengren BE. Good outcome scores and high satisfaction rate after primary total ankle replacement. Acta Orthop 2017 Dec;88(6):675-80.

8. Katsui R, Takakura Y, Komei T, Takakura Y, A. T, Tanaka Y. Results of Combined Total Ankle Arthroplasty with a Total Talar Prosthesis. Nihon Ashi No Geka Gakkai Zasshi (The journal of the Japanese Society for Surgery of the Foot) 2018 August;39(1):38-41 (in Japanese).

9. Mont MA, Schon LC, Hungerford MW, Hungerford DS. Avascular necrosis of the talus treated by core decompression. J Bone Joint Surg Br 1996 Sep;78(5):827-30.

10. Takakura Y, Tanaka Y, Kumai T, Tamai S. Low tibial osteotomy for osteoarthritis of the ankle. Results of a new operation in 18 patients. J Bone Joint Surg Br 1995 Jan;77(1):50-4.

11. Cross M, Smith E, Hoy D, Nolte S, Ackerman I, Fransen M, Bridgett L, Williams S, Guillemin F, Hill CL, Laslett LL, Jones G, Cicuttini F, Osborne R, Vos T, Buchbinder R, Woolf A, March L. The global burden of hip and knee osteoarthritis: estimates from the global burden of disease 2010 study. Ann Rheum Dis 2014 Jul;73(7):1323-30.

12. Wood AM, Brock TM, Heil K, Holmes R, Weusten A. A Review on the Management of Hip and Knee Osteoarthritis. Int J Chronic Dis 2013;2013:845015.

13. Saltzman CL, Zimmerman MB, O'Rourke M, Brown TD, Buckwalter JA, Johnston R. Impact of comorbidities on the measurement of health in patients with ankle osteoarthritis. J Bone Joint Surg Am 2006 Nov;88(11):2366-72.

14. Odum SM, Van Doren BA, Anderson RB, Davis WH. In-Hospital Complications Following Ankle Arthrodesis Versus Ankle Arthroplasty: A Matched Cohort Study. J Bone Joint Surg Am 2017 Sep 6;99(17):1469-75.

15. Nunley JA, Caputo AM, Easley ME, Cook C. Intermediate to long-term outcomes of the STAR Total Ankle Replacement: the patient perspective. J Bone Joint Surg Am 2012 Jan 4;94(1):43-8.

16. Koivu H, Kohonen I, Mattila K, Loyttyniemi E, Tiusanen H. Long-term Results of Scandinavian Total Ankle Replacement. Foot Ankle Int 2017 Jul;38(7):723-31.

17. Tsukamoto S, Tanaka Y, Maegawa N, Shinohara Y, Taniguchi A, Kumai T, Takakura Y. Total talar replacement following collapse of the talar body as a complication of total ankle arthroplasty: a case report. J Bone Joint Surg Am 2010 Sep 1;92(11):2115-20.

18. Devalia KL, Ramaskandhan J, Muthumayandi K, Siddique M. Early results of a novel technique: Hindfoot fusion in talus osteonecrosis prior to ankle arthroplasty: A case series. Foot (Edinb) 2015 Dec;25(4):200-5.

19. Prissel MA, Hyer CF, Berlet GC. A Review of 399 Total Ankle Replacements:

Analysis of Ipsilateral Subtalar Joint Arthrodesis and Associated Talar Component Subsidence. J Foot Ankle Surg 2017 Jan - Feb;56(1):10-4.

20. Gross CE, Sershon RA, Frank JM, Easley ME, Holmes GB, Jr. Treatment of Osteonecrosis of the Talus. JBJS Rev 2016 Jul 12;4(7).

21. Dennison MG, Pool RD, Simonis RB, Singh BS. Tibiocalcaneal fusion for avascular necrosis of the talus. J Bone Joint Surg Br 2001 Mar;83(2):199-203.

22. Rammelt S, Zwipp H. Talar neck and body fractures. Injury 2009 Feb;40(2):120-35.

23. Van Bergeyk A, Stotler W, Beals T, Manoli A, 2nd. Functional outcome after modified Blair tibiotalar arthrodesis for talar osteonecrosis. Foot Ankle Int 2003 Oct;24(10):765-70.

24. Manes HR, Alvarez E, Llevine LS. Preliminary report of total ankle arthroplasty for osteonecrosis of the talus. Clin Orthop Relat Res 1977(127):200-2.

25. Takakura Y, Tanaka Y, Kumai T, Sugimoto K, Ohgushi H. Ankle arthroplasty using three generations of metal and ceramic prostheses. Clin Orthop Relat Res 2004 Jul(424):130-6.

26. Buechel FF, Sr., Buechel FF, Jr., Pappas MJ. Ten-year evaluation of cementless Buechel-Pappas meniscal bearing total ankle replacement. Foot Ankle Int 2003 Jun;24(6):462-72.

27. Buechel FF, Pappas MJ, Iorio LJ. New Jersey low contact stress total ankle

replacement: biomechanical rationale and review of 23 cementless cases. Foot Ankle 1988 Jun;8(6):279-90.

28. Newton SE, 3rd. Total ankle arthroplasty. Clinical study of fifty cases. J Bone Joint Surg Am 1982 Jan;64(1):104-11.

29. Easley ME, Vertullo CJ, Urban WC, Nunley JA. Total ankle arthroplasty. J Am Acad Orthop Surg 2002 May-Jun;10(3):157-67.

30. Taniguchi A, Takakura Y, Tanaka Y, Kurokawa H, Tomiwa K, Matsuda T, Kumai T, Sugimoto K. An Alumina Ceramic Total Talar Prosthesis for Osteonecrosis of the Talus. J Bone Joint Surg Am 2015 Aug 19;97(16):1348-53.

31. Harnroongroj T, Vanadurongwan V. The talar body prosthesis. J Bone Joint Surg Am 1997 Sep;79(9):1313-22.

32. Taniguchi A, Takakura Y, Sugimoto K, Hayashi K, Ouchi K, Kumai T, Tanaka Y. The use of a ceramic talar body prosthesis in patients with aseptic necrosis of the talus. J Bone Joint Surg Br 2012 Nov;94(11):1529-33.

33. 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 Nov - Dec;55(6):1292-6.

34. Yoshinaga K. Replacement of femoral head using endoprosthesis (alumina ceramics vs metal)--an experimental study of canine articular cartilage. Nihon Seikeigeka Gakkai Zasshi (The Journal of the Japanese Orthopaedic Association) 1987

May;61(5):521-30 (in Japanese).

35. Garcia-Rey E, Cruz-Pardos A, Garcia-Cimbrelo E. The evolution of an uncemented acetabular component in alumina-on-alumina total hip arthroplasty has improved clinical outcome: a prospective, comparative five- to 15-year follow-up study. Bone Joint J 2017 Jun;99-B(6):749-58.

36. Toni A, Giardina F, Guerra G, Sudanese A, Montalti M, Stea S, Bordini B. 3rd generation alumina-on-alumina in modular hip prosthesis: 13 to 18 years follow-up results. Hip Int 2017 Feb 21;27(1):8-13.

37. Choi GW, Kim HJ, Yeo ED, Song SY. Comparison of the HINTEGRA and Mobility total ankle replacements. Short- to intermediate-term outcomes. Bone Joint J 2013 Aug;95-B(8):1075-82.

38. Benich MR, Ledoux WR, Orendurff MS, Shofer JB, Hansen ST, Davitt J, Anderson JG, Bohay D, Coetzee JC, Maskill J, Brage M, Houghton M, Sangeorzan BJ. Comparison of Treatment Outcomes of Arthrodesis and Two Generations of Ankle Replacement Implants. J Bone Joint Surg Am 2017 Nov 1;99(21):1792-800.

39. Rouhani H, Favre J, Aminian K, Crevoisier X. Multi-segment foot kinematics after total ankle replacement and ankle arthrodesis during relatively long-distance gait. Gait Posture 2012 Jul;36(3):561-6.

40. Singer S, Klejman S, Pinsker E, Houck J, Daniels T. Ankle arthroplasty and ankle arthrodesis: gait analysis compared with normal controls. J Bone Joint Surg Am

2013 Dec 18;95(24):e191(1-10).

41. Bibbo C. Temporary cementation in total ankle arthroplasty. J Foot Ankle Surg 2013 Sep-Oct;52(5):650-4.

Figure legends

Fig. 1. Radiographic findings

Radiographs showing joint space narrowing with spur formation and collapse of the talus.

Black arrows indicate joint space narrowing. White arrows indicate collapse of the talus. TAS＝tibial anterior surface angle, TLS=tibial lateral surface angle

1A Anteroposterior radiograph

1B Lateral radiograph

Fig. 2. Computed tomography (CT) findings

CT scan showing collapse of the talus (black arrows). Irregularity, spur formation, and joint space narrowing are observed in the talocrural (white arrow a), subtalar (white arrow b), and talonavicular joints (white arrow c).

2A Coronal CT

2B Sagittal CT

Fig. 3. Magnetic Resonance Image (MRI) findings

T1-weighted MRI image showing a low-intensity area in the whole talus, indicating severe osteonecrosis (black arrows).

3A Coronal T1-weighted MRI

3B Sagittal T1-weighted MRI

Fig. 4. Intraoperative findings

After osteotomy of the tibial plafond and medial malleolus, the surface of the collapse of the talus is observed.

Fig. 5. Postoperative radiographic findings immediately after surgery, at the 2-year follow-up postoperatively, and at the most recent follow-up.

No implant failure is found at every time point.

5A Anteroposterior radiograph immediately after surgery

5B Lateral radiograph immediately after surgery.

5C Anteroposterior radiograph at the postoperative 2-year follow-up.

5D Lateral radiograph at the postoperative 2-year follow-up.

5E Anteroposterior radiograph at the most recent follow-up.

5F Lateral radiograph at the most recent follow-up.

Fig. 6. Total talar prosthesis

It is designed for each patient using a CT image of the unaffected side; in addition, the curvature of the sliding surface is tailored to the tibial component.

Fig. 7. Combined TAA

The sliding surface of total talar prosthesis is tailored to the tibial component.

Conflict of interest

All authors declare that there is no conflict of interest concerning this work.

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Figure 1

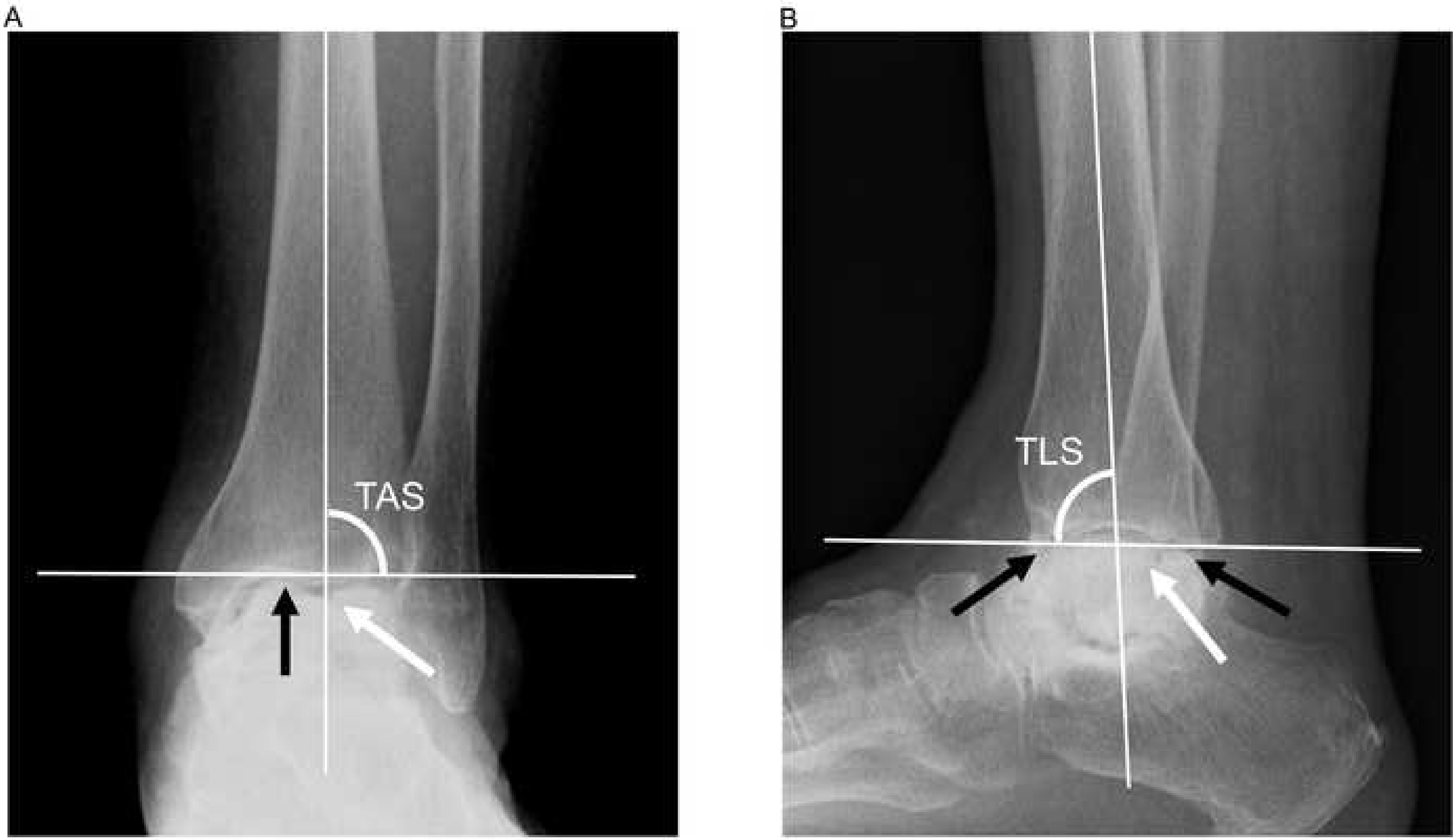

Figure 2

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Figure 3

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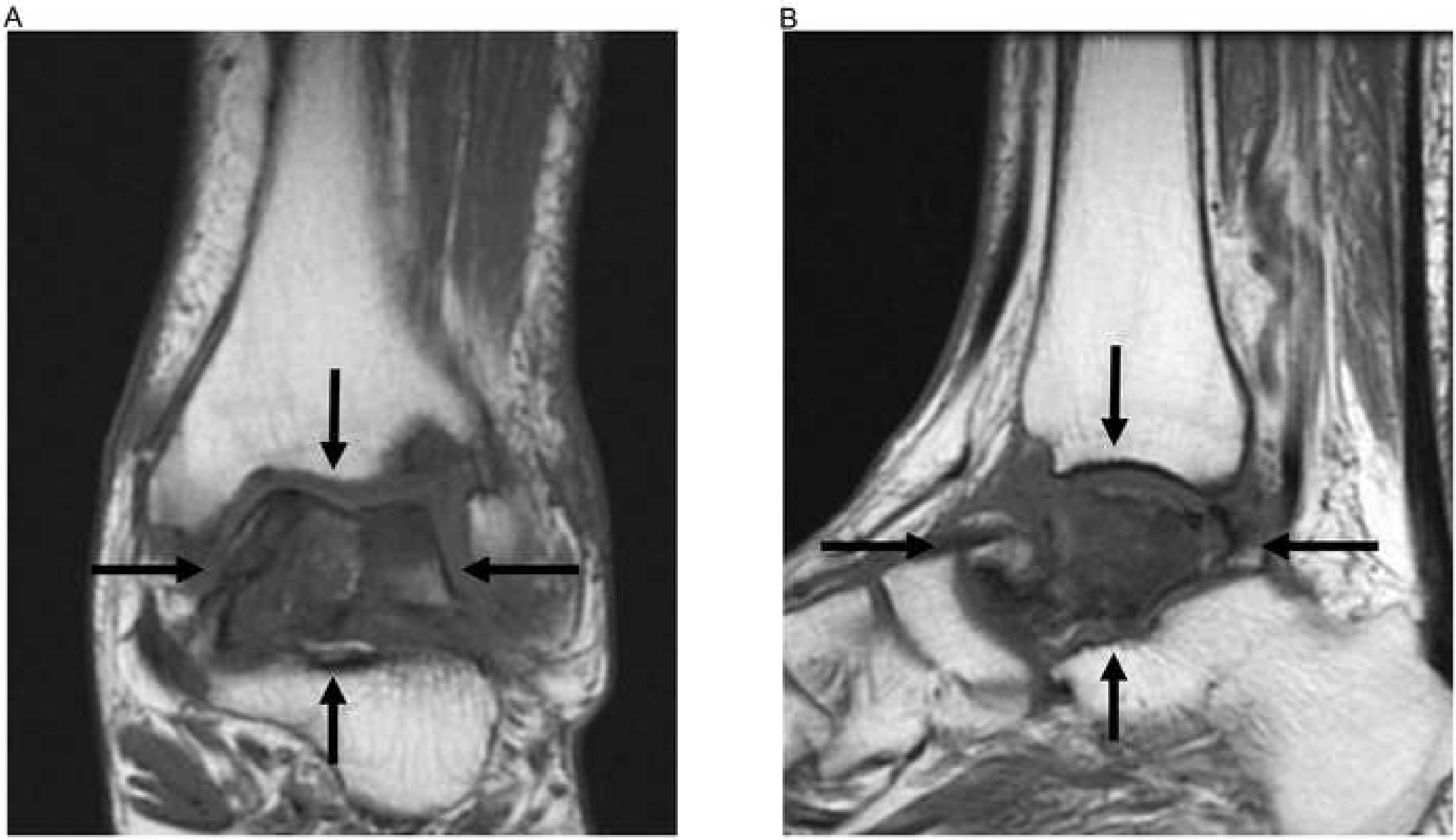

Figure 4

Figure 5A-B

A B

Figure 5C-D

C D

Figure 5E-F

E F

Figure 6

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Figure 7