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Double posterior lateral plating arthrodesis for charcot ankle: A case series

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ABSTRACT

Introduction: Ankle arthrodesis is one of the managements for a significantly unstable Charcot ankle. Some of the methods of internal fixation for ankle arthrodesis include the use of intramedullary nails, screws, and plates. Ankle arthrodesis using intramedullary nails has become more popular. However, studies evaluating the use of plate fixation, particularly double posterior lateral plating, are limited. We report the clinical and radiological outcomes of double posterior lateral plating ankle arthrodesis in three diabetic Charcot ankle patients.

Presentation of case: Three patients, aged 73, 67, and 65 years old, complained of ankle pain and with a history of type 2 diabetes mellitus. The physical examination revealed swelling and erythema without a sign of active infection. The radiological examination showed ankle deformity, and the American Orthopaedic Foot & Ankle Society (AOFAS) Ankle-Hindfoot scores were 5, 10, and 0, respectively. All patients were diagnosed with a diabetic Charcot ankle and underwent ankle arthrodesis using double posterior lateral plating. Four months and six months follow up revealed talus union, improved ankle deformity, and improved AOFAS Ankle-Hindfoot scores to 70, 76, and 73, respectively.

Discussion: Various methods of ankle arthrodesis are retrograde intramedullary nails, screws, and plates. In this report, we opt for plate fixation because it allows for stable internal fixation, adequate compression, high angular stability, and a lower irreversible deformation in osteoporotic bone.

Conclusion: Double posterior lateral plating ankle arthrodesis provided satisfactory clinical and radiological outcomes. This method can be an alternative for patients with Charcot ankle requiring ankle arthrodesis.

1. Introduction

Charcot neuroarthropathy, also known as Charcot joint, is a progressive and destructive joint disorder following trauma to a neuropathic extremity [1,2]. Jean-Martin Charcot first described it in 1868 in patients with tabes dorsalis [3]. The disorder mainly occurs in the foot and ankle joints. The process consists of bone and joint destruction, joint deformity, ulceration, and, if left untreated, may lead to amputation [2,4,5]. The majority of the Charcot joint cases are associated with a neuropathic complication in patients with diabetes. Thus, with the increase in the current incidence of diabetes, the increase of Charcot joint cases is also expected [5–7].

The treatment of Charcot joint is varied and expanding from nonoperative, such as total contact casting, modified shoe, and medication, to operative treatment [4,8,9]. However, when the deformity is severe enough and cannot be modified conservatively, the operative management is necessary. There are some surgical approaches to manage Charcot joint, such as exostectomy, Achilles tendon lengthening, arthrodesis with internal or external fixation, and amputation [10,11].

Arthrodesis is indicated in severe Charcot joint derangement with significant skeletal instability [8,10]. For Charcot ankle arthrodesis, internal fixation is more popular than external fixation in the absence of osteomyelitis, significant bone defect, poor bone quality, and poor soft tissue coverage. Various methods of internal fixation have been evaluated, including retrograde intramedullary nails, screws, and plates [10,12]. Up until now, many surgeons chose retrograde intramedullary nail fixation as the main method of internal fixation. However, limited compression and high nonunion rates have been found with intramedullary nail fixation [13,14]. The use of plate fixation is favorable because of its many options in terms of plate type, number, and placement location. Plates offer stiff constructs, thus facilitating better union

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rates [12]. Nevertheless, there are limited studies on the use of plate fixation, especially double posterior lateral plating, in the ankle arthrodesis for Charcot ankle. Here, we report the improved clinical and radiological outcomes from a series of three patients with diabetic Charcot ankle after ankle arthrodesis using double posterior lateral plating. The work has been reported in line with the PROCESS 2020 criteria [15]. This study also has been registered to research registry with Unique Identifying Number (UIN) of researchregistry6544.

2. Presentation of case

2.1. Case 1

A 73-year-old female came to our outpatient clinic complaining of right ankle pain for two months prior. There has been a general weakness in her body since three years ago and has been getting worse in the last two months. She usually checked her condition to the public health center in the last three years. There was no history of hypertension or trauma, but she was diagnosed with type 2 diabetes mellitus three years ago and routinely taking Metformin 500 mg three times a day. Some members of her family from her father's side also had type 2 diabetes

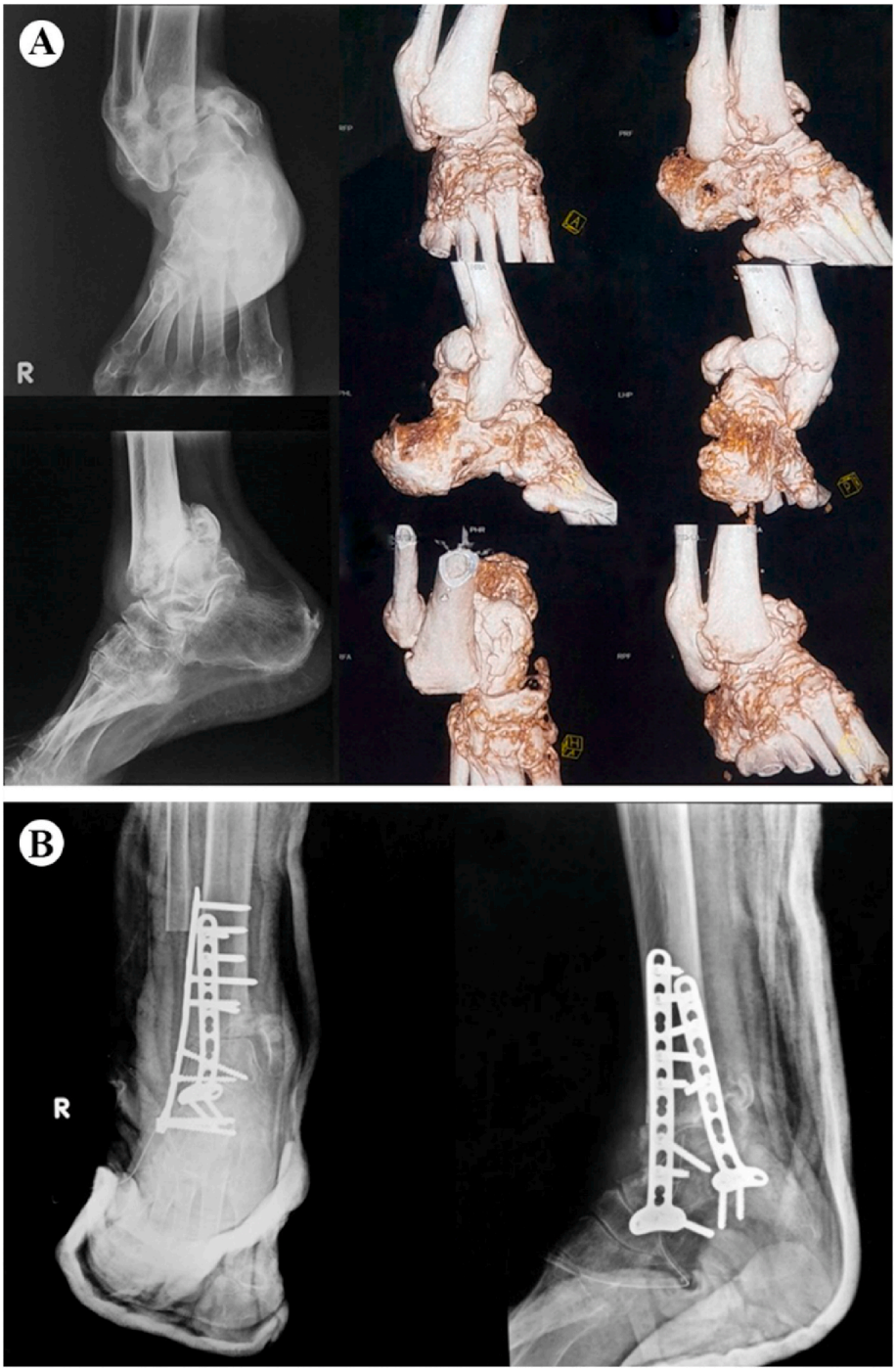

Fig. 1. Preoperative plain radiograph and CT-scan of the right ankle of case 1 showing ankle deformity with Böhler angle 10° and Gissane angle 100° (A) and four months postoperative plain radiograph of case 1 showing the union of the talus, Böhler angle 30°, and Gissane angle 120° (B).

mellitus. She never consulted about her right ankle pain with a physician before.

Physical examination revealed swelling and erythema without the presence of necrotic tissue, slough, pus, gangrene, and tenderness on her right foot. A weak right dorsalis pedis artery pulse was found, while the right tibialis posterior artery pulse was absent. The Ankle Brachial Index was 0.8. The oxygen saturation of the right first to the fifth toe was 93%, 92%, 92%, 91%, and 90%, respectively. There was a limited right ankle's range of motion, and there was an absence of right ankle dorsiflexion and plantarflexion. Plain radiograph and CT-scan of the right foot revealed bone deformity of the ankle with Böhler angle 10° and Gissane angle 100° (Fig. 1A). The clinical status was measured with the American Orthopaedic Foot & Ankle Society (AOFAS) Ankle-Hindfoot score, a standardized scoring system comprised of nine questions and covers three categories (pain, function, and alignment) with a maximum score of 100. The pain category was answered by asking the patient about her level of pain, while the alignment category was answered based on the physician's assessment. Both the patient and the physician completed the function category. The patient's AOFAS Ankle-Hindfoot score was 5 out of 100. She was subsequently diagnosed with diabetic Charcot neuroarthropathy of the ankle or Charcot ankle.

After the diagnosis was established, the improvement of the patient's general condition was initially conducted by joining care with the internal medicine department to control the patient's blood glucose level. Ankle arthrodesis using double posterior lateral plating was subsequently performed. The operator was an orthopaedic surgeon with five years experiences in the field of ankle and foot surgery. The surgery was conducted in an academic general hospital in Malang, East Java, Indonesia. The follow-up was conducted two times, at four and six months after the surgery, in our hospital by performing physical examination and ankle radiograph, measuring the Böhler and Gissane angle, and calculating the AOFAS Ankle-Hindfoot score. At the fourth month follow-up, the ankle showed no sign of infection or inflammation. The radiograph revealed the union of the talus, Böhler angle 30°, and Gissane angle 120° (Fig. 1B). The postoperative AOFAS Ankle-Hindfoot score was 70 out of 100. The patient felt that her ankle pain significantly decreased and her quality of life was getting better. No adverse and unanticipated events were noted. The sixth month follow-up showed no swelling, erythema, necrotic tissue, slough, pus, gangrene, and tenderness on her right foot (Fig. 2A). The radiograph revealed the union of the talus, Böhler angle 30°, and Gissane angle 120° (Fig. 2B), with 70 out of 100 AOFAS Ankle-Hindfoot score.

2.2. Case 2

A 67-year-old male referred to our outpatient clinic from another hospital due to right ankle pain since the previous three months. No treatment has been received yet. The patient has been feeling weak since five months ago, and it has been worse since the last one month. Four months ago, there had been a blister underneath his right fifth toe with 1 cm in diameter. However, the wound has healed at the time of examination because it had been treated at the referring hospital. There was no history of hypertension and trauma, but he was diagnosed with type 2 diabetes mellitus seven years ago. Since then, he has been routinely consuming Glibenclamide. He had a family history of type 2 diabetes mellitus from his mother's side.

Physical examination of the right foot showed swelling, erythema, and necrotic tissue without slough, pus, gangrene, or tenderness. A weak right dorsalis pedis artery pulse and an absent right tibialis posterior artery pulse were found. The Ankle Brachial Index was 0.7. The oxygen saturation of the right first to the fifth toe was 90%, 86%, 80%, 78%, and 90%, respectively. The right ankle's range of motion was limited, and the right ankle dorsiflexion and plantarflexion were absent. Plain radiograph and CT-scan of the right foot showed bone deformity of the

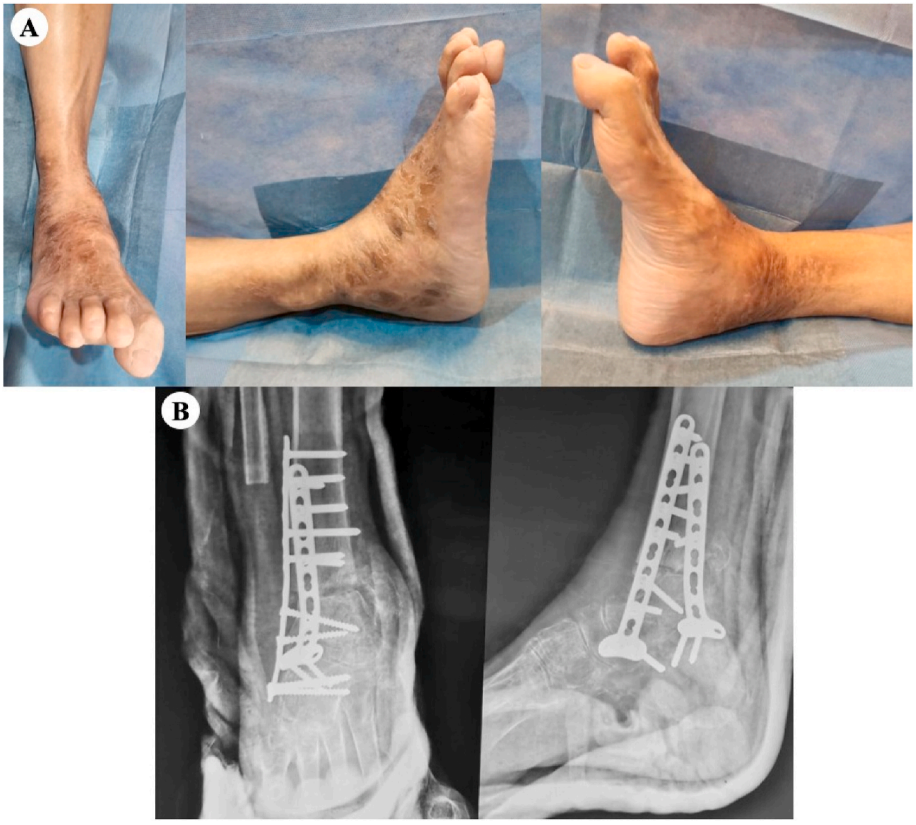

Fig. 2. Six months postoperative clinical picture of case 1 showing no swelling, erythema, necrotic tissue, slough, pus, gangrene, and tenderness (A) and six months postoperative plain radiograph of case 1 showing the union of the talus, Böhler angle 30°, and Gissane angle 120° (B).

ankle with Böhler angle 15° and Gissane angle 150° (Fig. 3A). The preoperative AOFAS Ankle-Hindfoot score was 10 out of 100. The diagnosis of diabetic Charcot ankle was established.

The management of the patient started by improving his general condition, controlling his blood glucose level, and continued by performing ankle arthrodesis using double posterior lateral plating. The operator was an orthopaedic surgeon with five years experiences in the field of ankle and foot surgery. The surgery was conducted in an academic general hospital in Malang, East Java, Indonesia. We planned to conduct the follow-up two times, at four and six months after the surgery, in our hospital by performing physical examination and ankle radiograph, measuring the Böhler and Gissane angle, and calculating the AOFAS Ankle-Hindfoot score. The fourth month physical examination revealed no swelling, erythema, necrotic tissue, slough, pus, gangrene, and tenderness on her right ankle. The radiograph showed the union of the talus, Böhler angle 32°, and Gissane angle 110° (Fig. 3B). The AOFAS Ankle-Hindfoot score was 76 out of 100. The patient stated that he experienced a drastic decrease in his ankle pain and was having a better

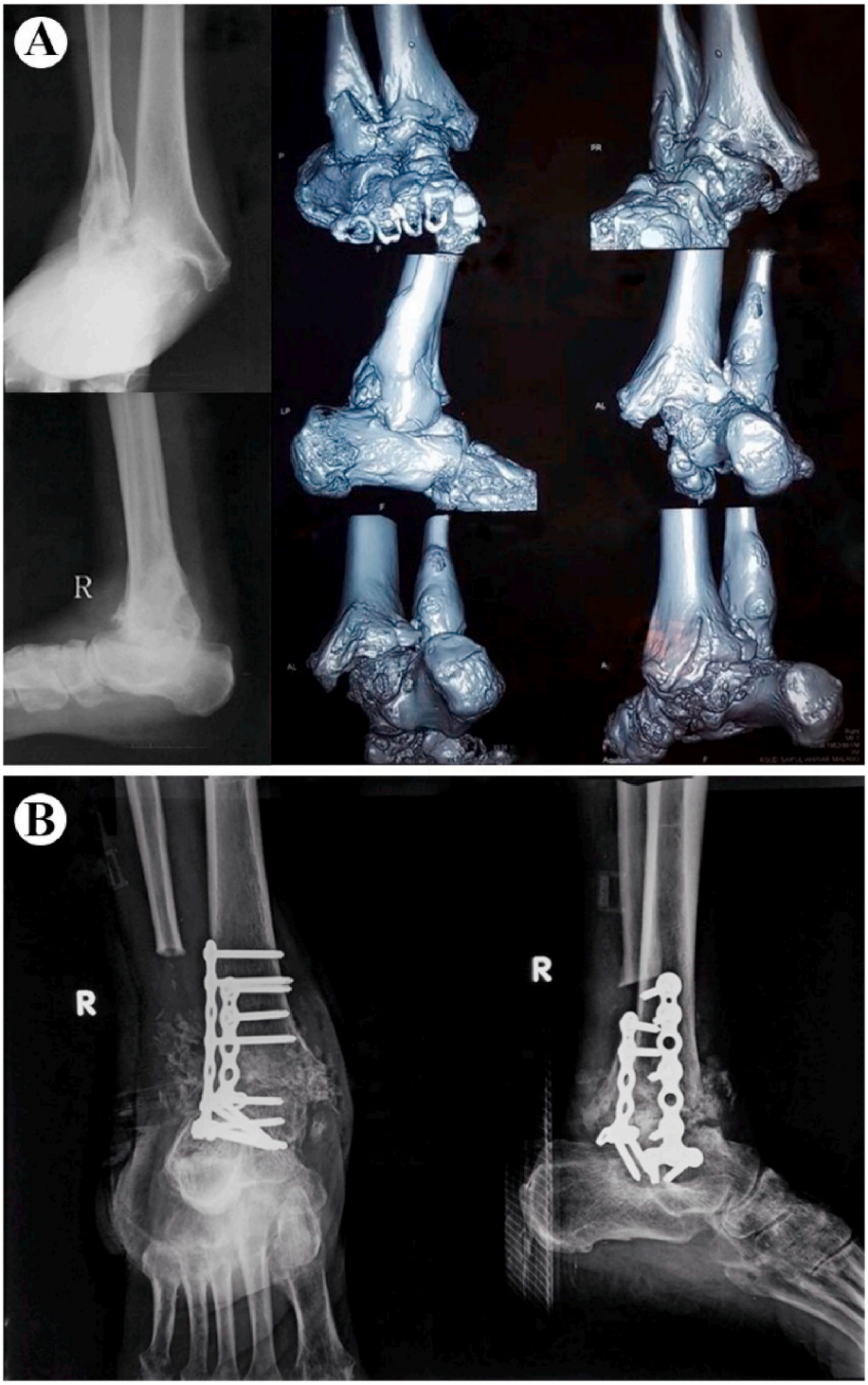

Fig. 3. Preoperative plain radiograph and CT-scan of the right ankle of case 2 showing ankle deformity with Böhler angle 15° and Gissane angle 150° (A) and postoperative plain radiograph of case 2 showing the union of the talus, Böhler angle 32°, and Gissane angle 110° (B).

quality of life. There were no adverse events observed. Unfortunately, the patient was lost to follow up by being unreachable, therefore the sixth month follow up cannot be completed.

2.3. Case 3

A male aged 65 years old came to our outpatient clinic with left ankle pain in the last five months. He experienced weakness throughout his body for four years and has worsened for the last one month. For the last five years, the patient checked his condition to the public health center, but he never consulted about his left ankle pain. He was diagnosed with type 2 diabetes mellitus seven years ago and routinely consuming Metformin 500 mg three times a day. There was no history of hypertension and trauma. Many members of her family from her mother side also had type 2 diabetes mellitus.

Physical examination of the left ankle revealed swelling and erythema without the appearance of necrotic tissue, slough, pus, gangrene, and tenderness (Fig. 4). A weak left dorsalis pedis artery pulse was palpated and left tibialis posterior artery pulse was absent. The Ankle Brachial Index was 0.8. The oxygen saturation of the right first to the fifth toe was 94%, 93%, 92%, 92%, and 90% respectively. A limited left ankle's range of motion and absence of left ankle dorsiflexion and plantarflexion was found. Plain radiograph and CT-scan of the left foot showed bone deformity of the ankle with Böhler angle 150° and Gissane angle 155° (Fig. 5A). The AOFAS Ankle-Hindfoot score was 0 out of 100. The patient was subsequently diagnosed with diabetic Charcot ankle.

After the diagnosis, the patient's general condition was firstly improved by controlling his blood glucose level before ankle arthrodesis using double posterior lateral plating was subsequently performed. The operator was an orthopaedic surgeon with five years experiences in the field of ankle and foot surgery. The surgery was conducted in an academic general hospital in Malang, East Java, Indonesia. We planned to conduct the follow-up two times, at four and six months after the surgery, in our hospital by performing physical examination and ankle radiograph, measuring the Böhler and Gissane angle, and calculating the AOFAS Ankle-Hindfoot score. At the fourth month follow-up, patient's left ankle showed no swelling, erythema, necrotic tissue, slough, pus, gangrene, and tenderness.Plain radiograph and AOFAS Ankle-Hindfoot score were taken and measured. The plain radiograph showed the union of the talus bone, Böhler angle 25°, and Gissane angle 110° (Fig. 5B). The postoperative AOFAS Ankle-Hindfoot score was 73 out of 100. He perceived a decrease in his left ankle pain and an increase in his quality of life. No unanticipated events were observed. However, the sixth month follow up cannot be completed due to loss of contact with the patient.

3. Discussion

Operative treatment for Charcot ankle is frequent. Schneekloth et al. [16] reported 330 (38.4%) Charcot ankle surgeries of 860 procedures for diabetic Charcot neuroarthropathy. Arthrodesis, as one of the management options for Charcot ankle, is indicated when there is a significant skeletal instability [8,17]. Moreover, Charcot ankle is often associated with multiplanar deformities, resulting in sagittal, frontal, and rotational malalignment. Consequently, exostectomy is rarely successful, making arthrodesis as the method of choice in correcting Charcot ankle [18]. The method has been more common with Schneekloth et al. [16] reported 170 tibiotalocalcaneal (TTC) arthrodesis and more than 75 ankle arthrodesis out of 860 diabetic Charcot neuroarthropathy procedures. In this report, ankle arthrodesis was selected because all three cases exhibited unbraceable deformity associated with instability based on the clinical and radiological examination.

We used internal fixation rather than external fixation for all three cases in this report. Indeed, both internal and external fixation for ankle arthrodesis has their advantages and drawbacks. It has been suggested that patients with diabetes are known for their poor wound healing potential and might be benefited from external fixation [19]. External fixation allows limited incisions, weight-bearing, and can be used for a long time until fusion is obtained. Studies have described the use of external fixation with satisfactory results [20–22]. However, external fixation is associated with lower union rates, risk of recurrent deformity, lower outcome measures, poor patient compliance, long period of rehabilitation, and pin track infection [1,10,12,17]. Meanwhile, a systematic review by Lee et al. [23] reported that internal fixation had a lower risk for nonunion, lower ulceration rate, and higher return to functional ambulation than external fixation. Considering the old age of all the patients in this report, which might result in poor compliance, and the inability to withstand the long duration of immobilization and rehabilitation, the use of internal fixation was justified.

Nevertheless, the same study by Lee et al. [23] found that internal fixation is related to a higher rate of complications, such as amputation, deep infection, and wound healing complications. In order to minimalize the drawbacks and reach the optimal results, a principle of fixation popularized by Sammarco [24] has been fundamental. The principle is called "superconstructs" and is defined by four factors: enough bone resection to allow adequate reduction of deformity and reduce soft tissue tension, fixation extension beyond the zone of injury, strongest fixation devices utility that can be tolerated by the soft tissue, and the use of strongest fixation devices that are applied to maximize mechanical function.

After all, the decision of whether to choose internal or external fixation for ankle arthrodesis is mainly based on the surgeon's experience

Fig. 4. The preoperative clinical picture of case 3 showing swelling and erythema without the appearance of necrotic tissue, slough, pus, gangrene, and tenderness.

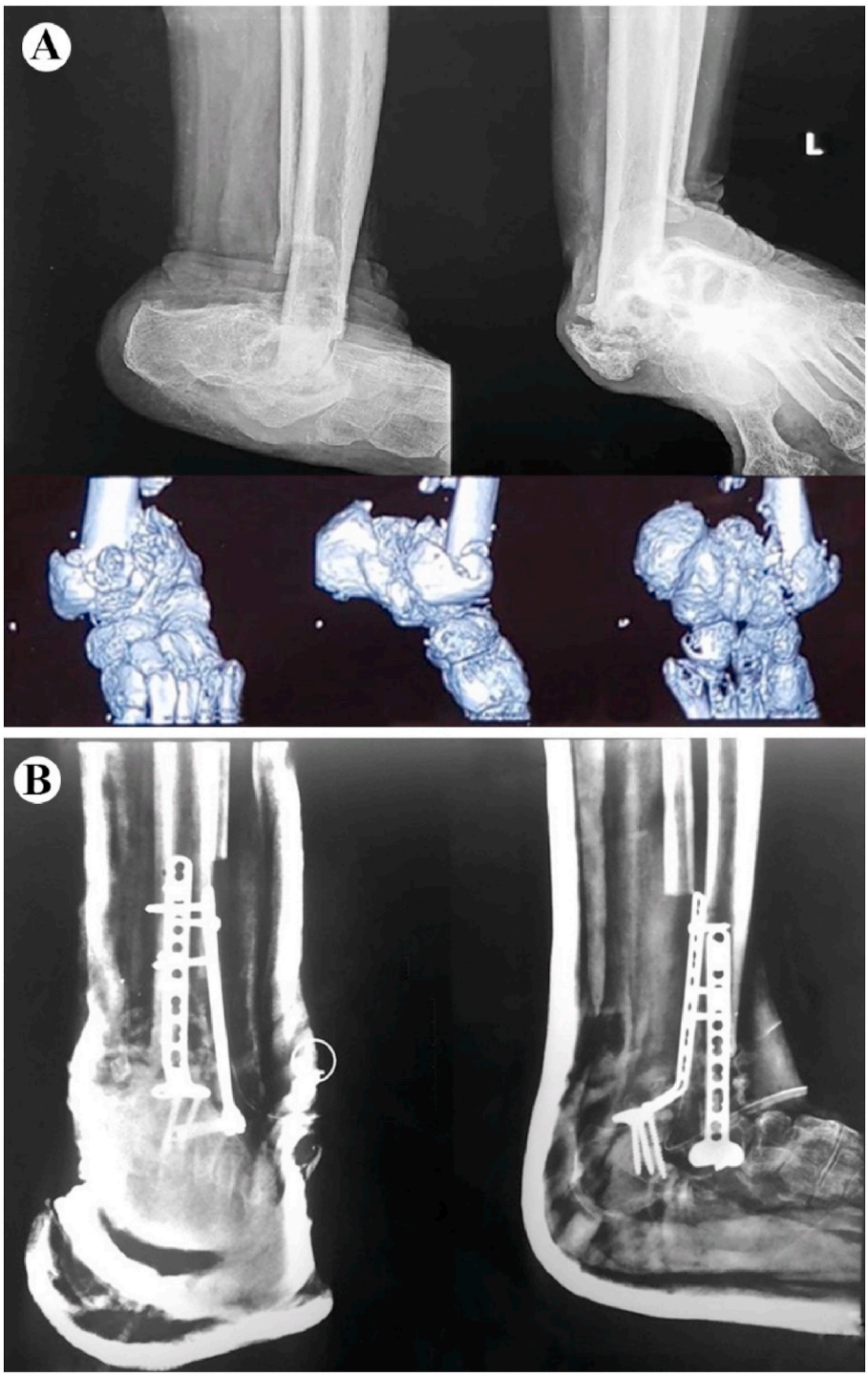

Fig. 5. Preoperative plain radiograph and CT-scan of the left ankle of case 3 showing ankle deformity with Böhler angle 150° and Gissane angle 155° (A) and postoperative plain radiograph of case 3 showing the union of the talus, Böhler angle 25°, and Gissane angle 110° (B).

and factors related to the patient. However, the general rule is to use external fixation for ankle with an active infection, large soft tissue defects, and poor bone quality, and to use internal fixation for ankle without a wound and active infection, and with good bone quality and adequate soft tissue coverage [18]. In our report, all three cases came without the presence of active infection, extensive soft tissue defect, and poor bone quality. The patient from case 2 had a history of a blister on his right fifth toe four months prior, but the wound was healed at the time of examination, and no sign of active infection was present. Therefore, internal fixation was selected for all three cases.

In this study, we report the use of double posterior lateral plating for ankle arthrodesis in all three patients. Generally, many surgeons preferred retrograde intramedullary nailing for internal fixation because of its mechanical advantages [25]. However, the use of intramedullary nail for ankle arthrodesis has some drawbacks, including limited compression, high nonunion rates, and the need for experienced surgeons [13,14]. Moreover, it can stress the neurovascular bundles if not performed in stages [26]. Meanwhile, plate fixation allows for stable internal fixation and adequate compression [27,28]. It also offers high angular stability and a lower irreversible deformation in osteoporotic

bone compared to intramedullary nail fixation [29,30]. Furthermore, it is technically easier to perform than the intramedullary nail. The use of plates for fixation is convenient because it offers many options of type, number, and placement location [12,31]. The simplest type of fixation is the use of screws. Screws are favorable because they are easy to use, ubiquitous, cheap, and have low morbidity. However, they are associated with high nonunion rates, especially in osteoporotic bones [32,33]. Thus, they are usually used as supporting devices, rarely as the sole devices.

We opt for double posterior lateral plating in all of our reported cases because it can improve fixation stability and outcomes. Whereas the use of lateral plate alone has limited ability in controlling sagittal forces, the sole use of the posterior plate does not include the subtalar joint [26]. Thus, combining both placements can result in stiffer constructs and may achieve better union. The improving clinical and radiological outcomes and the absence of adverse events in all three patients in our report described the benefit of this method. The use of an anterior plate is also an option for ankle arthrodesis, but the thin and limited anterior soft tissue coverage discourages the use of this plate. However, to our knowledge, no study systematically compares between different numbers and placement locations of plates for ankle arthrodesis. While some studies reported the satisfying outcomes and advantages of posterior plating for ankle arthrodesis [31,34,35], studies that evaluate the use of double posterior lateral plates are limited.

Charcot neuroarthropathy was found to affect the quality of life of patients [36–38]. A minimum of one operation is indicated in 50% of the patients, and 15% of cases are associated with major amputation [36,39,40]. AOFAS Ankle-Hindfoot score has been widely used as a valid and reliable tool to measure the clinical status of Charcot neuroarthropathy [38]. It is comprised of nine questions that cover three categories which are pain, function, and alignment. The pain category has a maximum score of 40 and consists of one question asking the patient's level of pain. The function category has a maximum score of 50 and consists of seven questions, such as activity limitation, maximum walking distance, walking surfaces, gait abnormality, sagittal motion, hindfoot motion, and ankle-hindfoot stability. The alignment category consists of one question asking the patient's ankle-hindfoot alignment and has a maximum score of 10. Hence, a healthy ankle is specified by a score of 100. In our report, all patients were found to have a drastically improved AOFAS Ankle-Hindfoot score after the surgical intervention indicating an increased clinical status. Case 1, 2, and 3 exhibited an improvement of AOFAS Ankle-Hindfoot score from 5, 10, and 0 to 70, 76, and 73, respectively. In addition, all patients stated that they experience a better quality of life after the surgery.

The radiological improvement, marked by a union of talus and improvement of Bohler and Gisane angle, combined with the increased score of AOFAS Anke-Hindfoot score in all three cases demonstrated a satisfactory result from ankle arthrodesis using a double posterior lateral plating method. We believe that the satisfactory outcomes were due to a precise surgical technique and a strong plates construct. This method provides an alternative option in achieving adequate internal fixation and an improvement in patient's quality of life. Nevertheless, this report is limited by the duration of follow up. The difficulty in keeping in contact with the patients in Indonesia making the follow up was restricted to only four months after the surgery in two patients and six months after the surgery in one patient. We believe a more extended period of follow up will provide more outcome data, hence a better understanding of the effect of our surgery method. An additional limitation of our report is the small population size. A randomized controlled trial study that consists of more subjects will allow for an analytical study, thus providing a better level of evidence.

4. Conclusion

Double posterior lateral plating ankle arthrodesis provided satisfactory clinical and radiological outcomes. We found this plating method useful for achieving strong constructs and stable fixation. This method can be an alternative for patients with Charcot ankle requiring ankle arthrodesis.

Informed consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

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Declaration of competing InterestCOI

None.

Ethical approval

Not applicable.

Author contribution

Ananto Satya Pradana: study concept and design, data collection, supervising.

Krisna Yuarno Phatama: study concept and design, data collection, supervising.

Edi Mustamsir: study concept and design, data collection, supervising.

Ganang Dwi Cahyono: data collection, data analysis, writing the paper.

I Gusti Ngurah Arga Aldrian Oktafandi: data collection, data analysis, writing the paper.

Edi Mustamsir: study concept and design, data collection, supervising.

Registration of research studies

UIN: researchregistry6544.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amsu.2021.102250.

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