



Complication assessment and prevention strategies using midfoot fusion bolt for medial column stabilization in Charcot's osteoarthropathy[☆]

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HIGHLIGHTS

- Postoperative complications using midfoot fusion bolt are high, but can be controlled in general.
- A fully load-bearing and stable foot was obtained, despite osseous consolidation was not detected in all of these cases.
- Bolt dislocation was seen frequently but was mainly associated with occurred bone healing.
- Preoperative increased Hba1c value and presence of preoperative ulcer was associated wound infection.

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ABSTRACT

In Charcot's osteoarthropathy stabilization of the medial column of the foot was introduced in order to establish a stable foot and reduce the risk for amputation. This study was performed to analyze postoperative complications, define risk factors for those and develop strategies for prevention. Since bolt dislocation takes place frequently, it was aimed to predict an appropriate time point for bolt removal under the condition that osseous healing has occurred.

Fourteen consecutive patients with neuroosteoarthropathy of the foot and arch collapse were treated with open reduction and stabilization using midfoot fusion bolt and lateral lag screws. Age, gender, presence of preoperative osteomyelitis or ulcer, number of complications and operative revisions, Hba1c value, consolidation of arthrodesis, presence of a load-bearing foot and period to bolt dislocation was assessed.

The mean follow-up was 21.4 ± 14.6 (mean \pm SDM) months, 64% of patients suffered from diabetes with a preoperative Hba1c of 8.5 ± 2.4 . The mean number of revisions per foot was 3.6 ± 4.1 . Bolt dislocation was seen in 57% of the patients following 11.3 ± 8.5 months; in 75% of these patients bony healing occurred before dislocation. There was a significant association between preoperative increased Hba1c value, presence of preoperative ulcer and wound infection. Healing of arthrodesis was demonstrated in 57% and a permanent weight-bearing foot without recurrent ulcer was achieved in 79%.

The early and late postoperative complications could be controlled in general. A fully load-bearing and stable foot was obtained, despite osseous consolidation was not detected in all of these cases. Once a stable foot has established early removal of fusion bolt should be considered. To decrease the risk of infection Hba1c should be adjusted and ulcers should be treated before the operation.

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1. Introduction

Neuroosteoarthropathy of the foot is caused by peripheral neuropathy and is mainly attributed to diabetes mellitus or alcoholism nowadays. It results in a collapse of the longitudinal arch and breakdown of the foot leading to recurrent ulcers. Since conservative treatment of the instable foot often does not result in a weight-bearing extremity, operative correction and internal fixation of the neuropathic foot were introduced. Recently, first results using a midfoot fusion bolt to stabilize the medial foot column were reported [1]. This technique is promising but some corresponding studies show a high rate of complications; despite the benefit of this technique is under discussion.

Some authors report a moderate rate of bone healing following implantation of midfoot fusion bolt suggesting a poor stabilization of arthrodesis [2] due to the use of fusion bolt in stand-alone technique. In contrast, Sammarco *et al.* obtained osseous consolidation in more than 70% of patients using an intramedullary beaming technique similar to the midfoot fusion bolt except that the lateral column is stabilized by an additional intramedullary rod [3]. Soft tissue infections are observed in more than 13–80% of the patients and major amputations in 25% [4,5,1,6]. Around 30% of the patients obtained a dislocation of the midfoot fusion bolt leading to destruction of its entry point – the first metatarsophalangeal joint – and in some cases to corresponding infection [1,3,5,7].

Several authors tried to identify risk factors for complications in general following operative treatment with fusion bolt arthrodesis [5,8]. Pinzur *et al.* defined those complication related factors including large bone deformity, long standing ulcer, overlying infected bone, regional osteopenia, obesity or immunocompromising illness [8]. It seems to be crucial to further undergo complication analysis to detect risk factors for distinct frequent complications as infection or bolt dislocation to develop prevention measures.

The goal of the present study was to select the most frequent complications of a cohort of consecutive patients undergoing fusion bolt arthrodesis, identify risk factors of these special complications and work out possibilities for prevention. It was hypothesized that preoperative ulcer and increased HbA1c values are conditions increasing the risk for soft tissue infections. It was questioned if bolt dislocation and breakage were rather linked to postoperative osseous healing or pseudarthrosis. To prevent uncontrolled dislocation and to secure a permanent stable and realigned foot, an optimal time window for scheduled removal of midfoot fusion bolt was identified.

2. Patients and methods

Between April 2011 and September 2015, 14 consecutive patients were admitted to the hospital with Charcot neuroarthropathy-associated midfoot collapse. All feet were graded to Eichenholtz Stage III or at least to late Stage II. Acute neuropathic feet due to Eichenholtz Stage I were excluded from the study and conducted to conservative treatment with total contact casting. Preoperative weight-bearing radiographs including Salzmann-View for determining rear foot axis and 99mTc-MDP SPECT/CT were performed. Preoperative levels of HbA1c, CRP and white blood cell count were recorded. Patients presented with a high degree of instability and a non-plantigrade foot position with either ulceration (n=8) or manifest callosity on locations of bony prominence (n=2) or were free of ulcer (n=4). Patients received verbal and written information on the investigation procedure and the aims of the study. All patients signed a consent form. The study was approved by the local ethics committee. The parameters age, birthdate, sex, affected side, previous diseases, HbA1c value, presence of ulcer, postoperative complications and any revision

surgeries were documented. Indication for operation was decided due to a non-plantigrade foot alignment, a high degree of instability in clinical examination and radiographs, clinical manifest or impeding plantar ulcer related to deformity or failed conservative treatment.

Patients were prepared for operation, staged according to the ASA classification [9,10] and an open reduction and stabilisation of the medial column with the midfoot fusion bolt and of the lateral column with large diameter screws were planned.

2.1. Surgical procedure

A dorsomedial approach was used to reduce the medial metatarsocuneiform, medial naviculocuneiform and talonavicular joints and temporary fixed with 2.5 mm K-wires. All avital bony and fibrous tissue was carefully resected, tricortical bone blocks were harvested from the ipsilateral iliac crest and the defects were replenished with the spongy bone blocks or flakes. Then, dorsomedial arthrotomy of the first metatarsophalangeal joint was performed; a guide wire was introduced into the first metatarsal and driven to the talus in a retrograde fashion. Following radiographic control and reaming an intramedullary placement of a 6.5-mm diameter solid bolt (Midfoot Fusion Bolt, Synthes, Zuchwil, Switzerland) was inserted and fixed into the talus. If needed, the lateral tarsometatarsal joint was reduced via a dorsolateral approach. In any case, the lateral column was stabilized with large diameter screws (7.0 mm) from the third and/or fourth metatarsal, beyond the calcaneocuboidal joint into the calcaneus to increase midfoot stability. If no sufficient stability was achieved with one lateral screw a second screws were inserted. If an ankle equinus was present the Achilles tendon was lengthened with a Z-plasty.

For postoperative care patients were requested to wear a non-weight bearing cast for the first 12 weeks, followed by gradual progression to full weight bearing according to the radiographic findings of osseous consolidation.

2.2. Clinical assessment

During the follow-up complications like deep infection, bolt breakage, bolt dislocation and recurrent ulcer were recorded. The number of revision surgery and the time point of bolt dislocation and breakage were documented. At the last follow-up visit the type of foot gear, the use of auxiliary means (e.g. cane), the stability of the foot and the preservation of the longitudinal arch were recorded.

2.3. Radiologic assessment

All patients underwent pre- and postoperative radiographic imaging at 2 days, 6 weeks, 12 weeks, 16 weeks, 6 month, 12 month, 18 month and 24 month after the procedure. Weight bearing radiographs were taken preoperatively and during the follow-up after detection of osseous consolidation. Elsewhere, non-weight bearing X-rays were performed. The talar–first metatarsal angle was measured on the lateral radiographs to control the restoration of the longitudinal arch. Further, healing of arthrodesis sites was assessed.

2.4. Statistics

For statistically significant side-to-side differences the non-parametric Wilcoxon signed rank test was applied. For a significant association between two variables Chi-square testing was performed. The level of significance was set at 5% ($p=0.05$).

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