Foot and Ankle Surgery xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Foot and Ankle Surgery

journal homepage: www.elsevier.com/locate/fas

Posterolateral plate fixation with Talarlock® is more stable than screw fixation in ankle arthrodesis in a biomechanical cadaver study

N. Gutteck, Ass. Prof.[a,*], H. Martin, Dr. Ing., Ass. Prof.[b], T. Hanke, Dipl. Ing.[c], J.B. Matthies, M.Sc.[b], A. Heilmann, Prof., Chief of the Department[c], H. Kielstein, Prof., Chief of the Department[d], G. Gradl, Prof., Chief of the Department[e], K.S. Delank, Prof., Chief of the Department[a], D. Wohlrab, Prof.[a]

[a] Department for Orthopaedics and Traumatology, Martin Luther University, Halle Wittenberg, Ernst-Grube Str. 40, 06120 Halle, Germany
[b] Department of Medical Biotechnology, University of Rostock, F.-Barnewitz-Str. 4, 18119 Rostock, Germany
[c] Fraunhofer IWM Halle, Walter-Hülse-Straße 1, 06120 Halle, Germany
[d] Department for Anatomy and Cell Biology, Martin Luther University, Halle Wittenberg, Große Steinstraße 52, 06108 Halle, Germany
[e] Department for Orthopaedics and Traumatology, Hospital Harlaching, Sanatoriumsplatz 2, 81545 München, Germany

ARTICLE INFO

Article history:
Received 14 August 2016
Received in revised form 27 November 2016
Accepted 3 February 2017
Available online xxx

Keywords:
Ankle arthrodesis
Ankle deformity
Hindfoot deformity
Plate arthrodesis
Ankle arthritis
Ankle instability

ABSTRACT

Background: A number of studies report on limitations of the screw arthrodesis in severe malalignment of the hindfoot, neuropathic deformity, poor bone quality and osteoporosis.
Methods: Fourteen anatomically correct polyurethane foam models of the right leg (Sawbones Europe, Malmö, Sweden) and eighteen fresh-frozen human lower leg specimens (9 pairs) were used for the comparative biomechanical testing.
Results: The statistical analysis of the stiffness of the fixation developed a significant difference in favor of the plate in all test directions.
Conclusions: The excellent biomechanical results are very promising and we hope for a reduction of the pseudarthrosis rate and shorten the postoperative treatment phase.

1. Introduction

Despite the promising results of ankle joint arthroplasty, the arthrodesis of the ankle remains an established procedure. Various methods for internal osteosynthesis, with numerous modifications, have been described [1–6]. The number of surgical techniques available with variable outcomes and divergent complication rates demonstrate, that an universal method is not yet established [1–6].

The screw arthrodesis is the most commonly used technique [1,2,5,7–10]. Different techniques with two–five screws are described in the literature with different outcomes in biomechanical studies. Mueckley et al. showed a similar stiffness of three-screw arthrodesis — used in this study — compared to the arthrodesis with a compression nail [10]. A number of authors maintain that screw arthrodesis provides insufficient rigidity and primary stability in severe misalignment of the ankle joint, poor bone quality and osteoporosis [11,12]. A superiority of the plate fixation compared to the screw or nail fixation has been shown in former biomechanical studies [13,14]. Thus, the application of ventral plate fixation for ankle arthrodesis with double plate systems and additional lag screws became popular [6,14–17]. However, the limitation of the ventral plate osteosynthesis is the morbidity due to the extended anterior approach. In some cases only one plate can be positioned because of lack of space, so that additional screws or thinner plates have to be used. No significant advantages for the postoperative treatment are reported in the literature. The authors recommend the immobilization of the lower leg in a plaster for eight weeks [17]. A review of the literature failed to show up any further biomechanical analyses of the posterolateral plate arthrodesis. The objective of this work was a comparative study of the biomechanical properties of the posterolateral Talarlock®-plate (Intercus GmbH, Zu den Pfarreichen 5, 07422 Bad Blankenburg, Germany) fixation with the three-screw fixation. A higher stability of the plate arthrodesis was supposed in this study.

* Corresponding author.
E-mail address: natalia.gutteck@uk-halle.de (N. Gutteck).

http://dx.doi.org/10.1016/j.fas.2017.02.005
1268-7731/

2. Methods

Fourteen anatomically correct polyurethane foam models of the right leg (Sawbones Europe, Malmö, Sweden) were used for biomechanical testing in a pilot study. Seven of them were allocated to the screw osteosynthesis and seven to the plate osteosynthesis. Eighteen fresh-frozen human lower leg specimens (9 pairs) were used for the comparative biomechanical testing. Nine of them were allocated to the screw osteosynthesis and nine to the plate osteosynthesis. The allocation of the extremity of a body donor to the group of screw and plate osteosynthesis was randomized, so that the specimens were compared within the same donor. The synthetic bone specimens were used — because of unlimited availability and few production-related variations in material quality — to establish the test program in preparation for tests with cadaver specimens.

Specimens were extracted immediately post mortem at the anatomical institute of Martin Luther University Halle-Wittenberg. All donors agreed to the use of their body or parts of it for research. The mean age of the body donors was 76.6 (61–95) years. Six of them were female and 3 male. The number of specimens was determined by a statistician in a previously performed power analysis. To avoid the variability within the specimens due to the preparation the distal syndesmosis complex, the membrana interossea, the joint capsule, the deltoid ligaments, the lateral ligaments and the joint surfaces were left in place [13,18,19]. The ankle was set in a neutral position with 0° of flexion, 5° valgus and 5° of external rotation. The tibia and fibula was cut to a length of 200 mm. Bone cement (Demotec 95, Demotec Demel eK, Nidderau, Germany) was used for potting the specimens. It was strictly to ensure, that neither the implant nor the joint itself were affected by the bone cement. A single orthopedic foot and ankle surgeon (1) performed the fixation following the instructions of the manufacture. All implants were inserted once for each specimen. The fibula was not screwed due to the comparability of both fixations [20]. The both ventral screws in the screw osteosynthesis were placed two to three centimeters from the tibial joint surface into the medial and lateral posterior talar dome. Posterior screw was placed behind the malleolus medialis into the head of the talus. Solid 6.5 mm cancellous screws were used for the fixation (Fig. 1A, B). The Talarlock®-plate (Intercus GmbH, Zu den Pfarreichen 5, 07422 Bad Blankenburg, Germany) was prefered for the posterolateral ankle fixation. After the two proximal tibial locking screws were placed, the proximal 6.5 mm lag screw was positioned over the talar neck into the talar head. Next, the distal 6,5 mm lag screw was inserted into the talar neck. At least, both distal locking screws were inserted into the talar head (Fig. 2A, B). A servo-hydraulic testing machine type MTS (MTS load cell 100 kN) was used for the biomechanical measurements (MTS headquarters, 14000 Technology Drive, Eden Prairie, United States 55344). The channels force, distance and time were registered. The lever arm was set by 60 mm. Test setting was tested for suitability prior to the cadaver experiments under a static load in the testing machine. Testing was

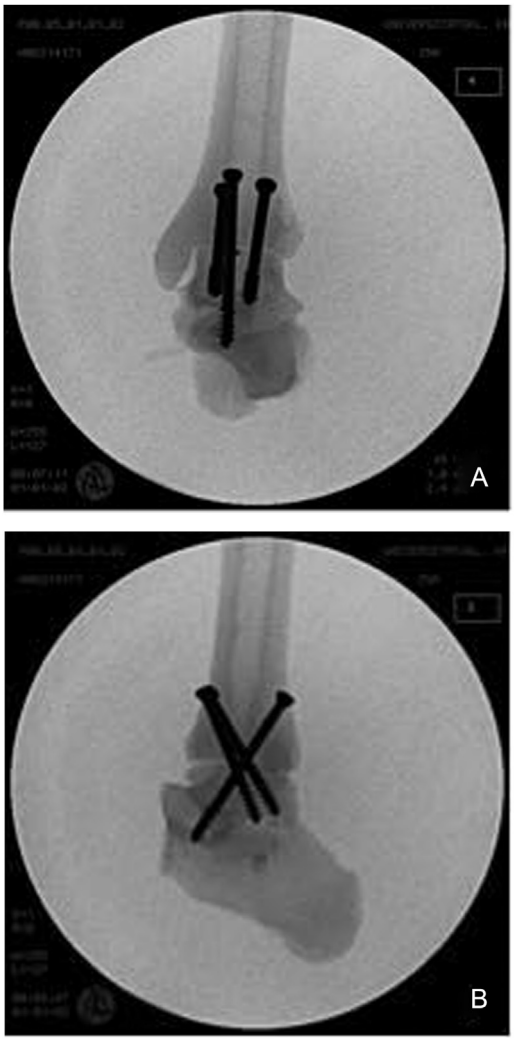

Fig. 1. Fluoroscopy of the specimen with screw arthrodesis in the anteroposterior (a) and lateral (b) projection.

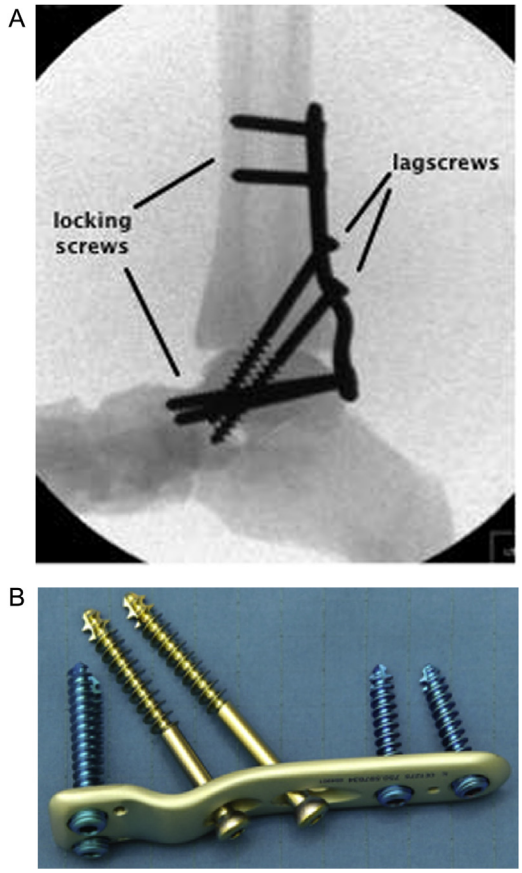

Fig. 2. (A) Fluoroscopy of the specimen with Talarlock® plate in the lateral projection (B) Talarlock® plate.

Please cite this article in press as: N. Gutteck, et al., Posterolateral plate fixation with Talarlock® is more stable than screw fixation in ankle arthrodesis in a biomechanical cadaver study, Foot Ankle Surg (2017), http://dx.doi.org/10.1016/j.fas.2017.02.005