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Radiological evaluation of ankle arthrodesis with Ilizarov fixation compared to internal fixation

Piotr Morasiewicz*, Maciej Dejnek, Wiktor Urbański, Szymon Łukasz Dragan, Mirosław Kulej, Szymon Feliks Dragan

Wrocław Medical University, Department and Clinic of Orthopaedic and Traumatologic Surgery, Borowska 213, 50-556 Wrocław, Poland

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ABSTRACT

Introduction: We asked whether the type of ankle joint arthrodesis stabilization will affect: (1) rate of union, (2) rate of adjacted-joint arthritis, (3) malalignment of the ankle joint.
Material and methods: We retrospectively radiological studied 62 patients who underwent ankle arthrodesis with Ilizarov external fixator stabilization (group 1,n = 29) or internal stabilization (group 2, n = 33) from 2006 to 2015. Radiologic outcomes were mesure by: (1) rate of union, (2) rate of adjacent-joint arthritis, (3) malalignment of the ankle joint. The Levene's test,Mann–Whitney *U* test and Students *t*-test were used to the statistical analyses.
Results: Ankle fusion was achieved in 100% of patients treated with external fixation and in 88% with internal stabilization. Desired frontal plane alignment was achieved in 100% of patients with external fixation and 76% with internal stabilization. Desired sagittal plane alignment was achieved in 100% of external fixation and 85% of internal stabilization. A total of 14 (48.3%) patients from group 1 showed a radiographic evidence of pre-existing adjacent-joint OA. The radiographic evidence of pre-existing adjacent-joint OA was also found in 27(81.8%) subjects from group 2. Alterations of adjacent joints were also found on postoperative radiograms of 19 (65.5%) patients subjected to Ilizarov fixation and in all 33 patients from group 2.
Discusion: Ilizarov fixation of ankle arthrodesis is associated with lower prevalence of adjacent-joint OA and ankle joint misalignment,and with higher fusion rates than after internal fixation.Although achieving a complex ankle fusion is generally challenging,radiological outcomes after fixation with the Ilizarov apparatus are better than after internal stabilization.

Introduction

Osteoarthritis and deformities of the ankle joint result in pain and reduced joint function. Ankle arthrodesis is a common and effective treatment of severe osteoarthritis and ankle joint deformities [1–11].

Ankle arthrodesis can be made with external fixators or internal fixation [1–3,8–12]. Authors opinions about the effectiveness of ankle joint arthrodesis with external or internal fixation vary [1–3,8,12]. Ankle arthrodesis with Ilizarov external fixators is better for patients with poor status of the skin and soft tissues, large or multi-planar deformities,inadequate-quality of bone and shortening of the limb [1,2,8,9,12]. Ankle arthrodesis with internal fixation is better for patients with good status of soft tissues and bones, without concomitant limb shortening and deformities [2,3,8].

Ankle arthrodesis alters biomechanics of the musculoskeletal system [13]. According to some authors, this may result in increased risk of adjacent-joint OA [13] However, published opinions on the causative link between ankle arthrodesis and progression to adjacent-joint OA are somehow conflicting [13].

Delayed fusion or non-union is frequent complications of ankle arthrodesis. Depending on the type of fixation and study subjects, non-union rate may reach even up to 50% [1,2,4,5,8].

Correct axis of the lower extremity is important of normal functioning of the musculoskeletal system [2,14–16]. Misalignment of the ankle joint may impair both statics and dynamics of the locomotor system. Post-arthrodesis deformity of the ankle may cause pain, difficulty walking and contribute to more rapid progression of degenerative lesions; therefore, it exerts

* Corresponding author at: Department and Clinic of Orthopaedic and Traumatologic Surgery, Wrocław Medical University, ul. Borowska 213, 50-556 Wrocław, Poland.
E-mail address: morasp@poczta.onet.pl (P. Morasiewicz).

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unfavorable effects on the activities of daily living and treatment outcome [2,5,14–16]. Consequently, appropriate alignment of the joint is an important component of ankle arthrodesis.

An improved understanding of the contributions of type of ankle joint arthrodesis stabilization to the healing of ankle fusions, rate of adjacted-joint arthritis and malalignment of the ankle joint would be valuable to provide information for surgeons'.

We asked whether the type of ankle joint arthrodesis stabilization will affect: (1) rate of union, (2) rate of adjacted-joint arthritis, (3) malalignment of the ankle joint.

Material and methods

We retrospectively radiological studied all 70 patients who underwent ankle arthrodesis with Ilizarov external fixator stabilization (group 1) or internal stabilization with screws (group 2) at our institution from 2006 to 2015.

Indications to ankle arthrodesis included severe primary or secondary (post-traumatic, neurogenic, rheumatoid, congenital) degenerative-deforming changes of the ankle joint.

Patients were subjected to ankle arthrodesis with either external Ilizarov fixation or internal fixation with cannulated screws. Individuals with poor status of soft tissues (necrosis, inflammation, fistulas, trophic changes, scars, vascular lesions, skin lesions, ulcers) and bones (osteoporotic, loss, infections), severe deformities ($>15^{00}$ in one axis or multi-planar deformities) and infection were always qualified for ankle arthrodesis with Ilizarov fixation. Remaining patients were subjected to ankle arthrodesis with either external Ilizarov fixation or internal fixation with cannulated screws. We prefered ankle arthrodesis with internal fixation in patients with good status of soft tissues and bones, deformities $<5^{00}$, without concomitant disease, which prevented immobilization in a plaster cast, and in patients who cooperated with restricted limb weight bearing early after the surgery.

Criteria for inclusion in the study consisted of: performance of ankle arthrodesis with Ilizarov external fixator stabilization or internal stabilization with screws, more than twenty-four months since the conclusion of the treatment; presence of baseline values of etiology of ankle pathology and demographic data in medical records, presence of preoperative and postoperative radiologic data. Exclusion criteria consisted of: lack of ankle arthrodesis with Ilizarov external fixator stabilization or internal stabilization with screws, lack of baseline values of etiology of ankle pathology and demographic data in medical records; lack of preoperative and postoperative radiologic data, follow-up period shorter than twenty-four months, Charcot neuroarthropathy, patients with multiple joint or bilateral ankle injuries and those with associated procedures during the surgical intervention.

Between 2006 and 2015, 70 patients underwent ankle arthrodesis. Of these, 32 were treated with an Ilizarov device, and 38 with internal fixation (screws). In the Ilizarov group, 1 (3%) was lost to followup before 2 years, 1 (3%) were not included because of missing data in patient records, and 1 (3%) was excluded because they had neuropathic arthropathy, bilateral ankle injuries, or had associated ankle procedures at the time of the arthrodesis, leaving a total of 29 or analysis here. Those 29 patients had a mean follow up of 45 months (range, 24–108 months). In the internal fixation group, 3 were lost to followup before 24 months (8%), 1 (3%) was not included because of missing data in patient records, and 1 (3%) was excluded because they had neuropathic arthropathy, bilateral ankle injuries, or had associated ankle procedures at the time of the arthrodesis, leaving a total of 33 for analysis here. Those 33 patients were evaluated at a mean followup of 47 months (range, 24–104 months).

All patients were given perioperative antibiotics and were placed in a supine position, and then a tourniquet was then applied (320 mm Hg). A anterior approach centered over the ankle joint was used for an ankle joint fusion. Ilizarov apparatus (group 1) or Cannulated screws (group 2) were used to achieve compression at the ankle joint. Ilizarov apparatus for ankle arthrodesis consisted of proximal ring fixed to the tibia and fibula with 3 Kirschner wires, distal ring fixed to the tibia and fibula with 2 Kirschner wires, and U-shaped foot ring fixed to the calcaneus with 2 Kirschner wires with olives and fixed to distal part of metatarsal bones with 1 Kirschner wires with olives. All patients in group 1 and in group 2 were operated by three surgeons, everyone did both techniques. Patients from group 1 (Ilizarov stabilzation) start weight bearing in firts postoperative day. The minimum time wearing the Ilizarov fixator was 9 weeks. Patients, after Ilizarov fixator removed transitioned to a walker boot for a minimum of 6 weeks. Postoperatively, patients from group 2 remained nonweight bearing for a minimum of 6 weeks in a cast, followed by protected progressive weight bearing in a controlled ankle motion (CAM)-walker for the next 6 weeks. Usually by 3 months patients made a transition to normal shoe wear.

Radiologic outcomes were mesure by: (1) rate of union, (2) rate of adjacted-joint arthritis, (3) malalignment of the ankle joint, in external fixator stabilization (group 1)or internal stabilization with screws (group 2).

Radiographic union, rate of adjacted-joint arthritis and malalignment of the ankle joint was determined by the A-P and lateral view X-ray of the foot in weight bearing, and the A-P and lateral view X-ray of the ankle joint in weight bearing [1,5,8]. These evaluations were performed based on preoperative radiologic data and at postoperative clinic visits at 2 weeks, 6 weeks, 3 months, 6 months, 12 months, 18 months,2 years, and every year thereafter as required postoperatively.

Union was defined as complete cortical bridging or bridging callus or trebeculation across the ankle joint and loss of lucency between fusion surfaces with no pain and motion when stress was applied to the ankle joint during clinical examination. Nonunion was defined as the lack of bridging callus or trebeculation or large lucency at the tibiotalar interface observed on the radiograph and continued pain and/or motion when stress was applied to the ankle joint [1,5].

Malalignment of the ankle joint was determined postoperatively by the A-P and lateral view X-ray of the ankle joint in weight bearing [1,5,8]. The angle between the long axis of the tibia and a line parallel to the long axis of the talus was determined in the AP projection, and the angle between a line corresponding to the long axis of the tibia and a line perpendicular to the long axis of the talus was measured in the lateral projection. Axis of the ankle joint in the A-P and lateral view was defined using digitalized x-rays and measurement tools. Malalignment was defined as the observation of more than 5° of valgus or varus malalignment at the ankle joint in the A-P view or more than 5° of antecurvatio or retrocuratio malalignment joint in the lateral view [5]. Malalignment was defined in x-rays taken immediately after surgery and in final follow up.

Adjacted-joint arthritis was determined by the A-P and lateral view X-ray of the foot in weight bearing, and the A-P and lateral view X-ray of the ankle joint in weight bearing [1,5,8]. Adjacent-joint arthritis was defined as presence of subtalar joint arthritis or/and talonavicular arthritis and/or calcaneocuboid arthritis [13]. We compared presence of adjacent-joint arthritis in preoperative radiologic data and in postoperative radiologic data.

The Levene's test was performed to assess normal distribution. Mann–Whitney *U* test, Students *t*-test and Wilcoxon Matched Pairs Test were used to analyze the statistical significance of differences between mean values of variables. All analyses were carried out on the assumed significance level of $\alpha = 0.05$ using Statistica 10.0 software.

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