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Heterotopic ossification after total ankle replacement: The role of prosthesis alignment

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ABSTRACT

Background: The aetiology of heterotopic ossifications (HO) after total ankle arthroplasty (TAR) remains controversial. The aim of the study was to evaluate the prevalence and localisation of HO and the effect of alignment.
Methods: 88 TARs with a series of radiological controls and follow-up of 36 months were evaluated. Frontal and sagittal alignment parameters (alfa and beta angle defined by Hintermann) and tibial coverage were evaluated.
Results: The prevalence and grading of HO increased over time, mostly in the posterior gutter. Varus alignment correlated with HO increase in the ventral and lateral gutters the first year. A dorsally located rotational centre correlated with total HO growth and HO in the posterior gutter. These correlations were not detected after 3 years, as HO were seen in all prostheses, regardless of alignment.
Conclusions: HO grow over time with a prevalence up to 100% after 3 years. TAR alignment correlates with gutter-specific HO formation within the first year.

1. Introduction

Heterotopic ossification (HO) is a known phenomenon after total ankle replacement (TAR) with a varying prevalence between 3.8% and 100% [1–6]. Although this periprosthetic extra-osseous bone growth was reported more than ten years ago, its aetiology still remains unclear. Several studies tried to correlate its occurrence with age [3,5], male gender [3,5,7], operation time [3,5], cause of arthritis [1,3,5,7], serum calcium level [7] or different TAR designs [5,8]. Nevertheless, except for implant coverage of osteotomised bone surface i.e., prosthesis undersizing [4,5], no direct aetiological factor for HO formation could be established. HO formation has been observed in up to 100% in some case-series [6]; therefore, it remains questionable whether the sole causative factor for HO formation is TAR undercoverage.

Overall, little is known about HO formation in relation to TAR alignment parameters. Prosthesis malalignment can occur in a multi-dimensional plane. Under the scope of Wolff's law of bone transformation, bone adaptation develops in response to mechanical stress due to deviation of the mechanical axis. In this perspective, frontal or sagittal TAR malalignment could result in increased traction to the ankle ligament complex or to the dorsal neo-capsule of the ankle, thereby leading to new extra-osseous bone formation.

The aim of the study was to evaluate HO prevalence, grade and localisation over time and to detect possible inter-correlations with the TAR alignment parameters.

2. Patients and methods

2.1. Patients

We retrospectively analysed preoperative and postoperative radiographs of patients who underwent primary TAR implantation (Hintegra®, Integra, Plainsboro, New Jersey/Newdeal, Lyon, France) due to ankle osteoarthritis. These patients where consecutively operated on a period between January 2005 to December 2008. All patients with a complete radiological follow-up of at least 36 months were included into this study. Exclusion criteria were any type of revision TAR-surgery or missing radiological follow-up. In total, we included 84 patients with 88 TARs (48 TARs in 46 men and 40 TARs in 38 women; mean age of 55 years, range of 25–83 years, SD 13.6) in the analysis. Most cases of osteoarthritis were posttraumatic in 70.5% of the patients (62/88), followed by primary osteoarthritis in 21.5% of the patients (19/88), and other causes of secondary osteoarthritis (rheumatoid,

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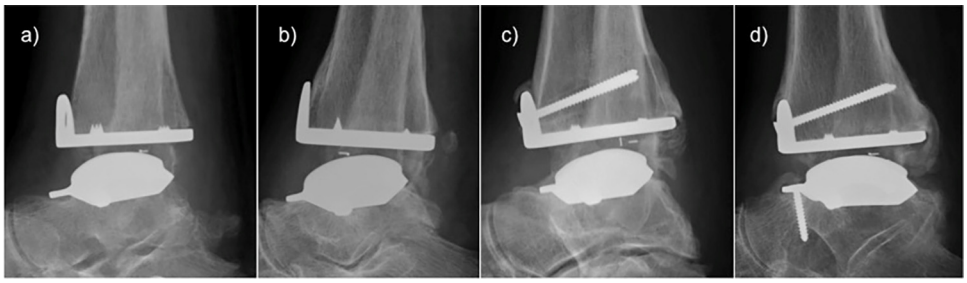

Fig. 1. Grading of HO: Grade 0: no heterotopic ossification (a); Grade 1: small island of isolated osseous formation (b); Grade 2: multiple but not confluent osseous formations (c); Grade 3: confluent and bridging heterotopic ossifications of the posterior gutter (d).

haemophilia, psoriasis, haemochromatosis) were in 8% (7/88) of the cases. All TAR implantations were performed according to the manufacturer's instructions by an experienced orthopaedic surgeon (single surgeon series). The mean operation and tourniquet times were 166 min (64–250 min) and 33 min (3–107 min), respectively. Postoperatively, the patients were immobilised in a short-leg walker with partial-weight bearing for six weeks and had a continuous physiotherapy programme started in the second week after implantation. No additional radiation or medicinal HO prophylaxis was applied.

2.2. Radiographic evaluation

Standardised weight-bearing radiographs were taken preoperatively and postoperatively (at one, six and twelve weeks and annually) in antero-posterior (AP) and sagittal projections. Two independent orthopaedic surgeons who were not involved in the primary operation assessed all radiographs.

Heterotopic ossification was defined as any new osseous formation observed on the postoperative radiographs (AP and lateral views) at least 6 weeks after surgery in the medial, lateral, ventral or dorsal gutter of the ankle. Based on Brooker's classification system of HO [9], we categorized HO after TAR into four categories (Table 1, Fig. 1 a–d).

Furthermore, the role of tibial undersizing, as a parameter for incomplete coverage of the resected distal tibia by the tibial component, was evaluated.

TAR-alignment was evaluated on standard weight-bearing radiographs in AP and lateral views. The frontal alignment of the tibial component was determined on the AP view by measuring the lateral open angle between the longitudinal axis of the tibia and the articulating surface of the tibial component (α-angle) (Fig. 2) as described by Hintermann et al. [2]. According to Paley et al., a varus alignment of the prosthesis was present if α-angle was >92° and a valgus alignment if α-angle was <86° [10].

The sagittal TAR-alignment was defined as the slope of the tibial component that was given by the longitudinal axis of the tibia and the articulating surface of the tibial component (ventral open β-angle) (Fig. 3) [2]. A range between 88–92° was considered normal [10]. An increased slope (<88°) was defined as positive; values >92° were defined as negative slopes.

Table 1
Grading of heterotopic ossification after TAR.

	Grading of HO after TAR (modified after Brooker)
Grade 0	No heterotopic ossification
Grade 1	Small island of isolated osseous formation
Grade 2	Multiple but not confluent osseous formations
Grade 3	Confluent and bridging heterotopic ossifications

The AP-offset, a distance parameter for positioning of the centre of the talar component with respect to the longitudinal tibial axis, was measured on the lateral radiographs according to Barg et al. [11]. The centre of the talus was located either anteriorly (positive value), posteriorly (negative value), or centred on the longitudinal axis of the tibia (value 0). The AP-offset ratio reflects the relation of AP-offset to the tibia TAR-component length (Fig. 4) [11].

2.3. Statistical analysis

Categorical variables are presented as percentages. Differences of categorical variables between groups were analysed by Fisher's exact test for independence and by the McNemar test for paired data. The Mann–Whitney U test was used to compare asymmetric continuous variables between two groups, and the Wilcoxon Signed Rank Test was used for paired non-parametric data. The Bonferroni correction for multiple comparisons was applied. Correlations were determined using the Spearman's correlation coefficient. A p-value < 0.05 was considered statistically significant.

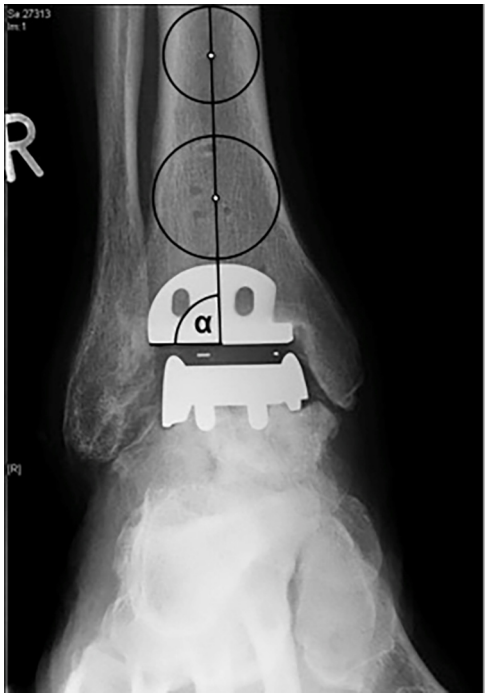

Fig. 2. The frontal alignment of the tibial component was determined on the AP view by measuring the lateral open angle between the longitudinal axis of the tibia and the articulating surface of the tibial component (α-angle).

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