Osteolysis in Total Ankle Replacement

How Does It Work?

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KEYWORDS

• Total • Ankle • Replacement • Arthroplasty • Periprosthetic • Osteolysis
• Mechanisms • Pathophysiology

KEY POINTS

- Aseptic loosening of total ankle replacement remains enigmatic regarding its underlying mechanisms.
- Although great scientific efforts have been made to explain the mechanisms, it remains poorly understood, complex and multi factorial.
- Many factors, including age, body weight, activity lesions, implant designs, fixation methods, material properties, immunologic responses and biomechanical adaptations to total ankle replacement all contribute to the development of perioprosthetic osteolysis.

INTRODUCTION

The first observations and reports on periprosthetic osteolysis date back to the 1970's and were followed by scientific works to investigate the pathophysiology and clinical impact on patients, mainly focusing on total hip and knee arthroplasty.

However, only sparse literature exists regarding periprosthetic osteolysis in total ankle replacement (TAR). The first report on periprosthetic osteolysis in TAR was published in 2004 by Knecht and colleagues.[1] Similar to total hip and total knee arthroplasty, periprosthetic osteolysis has been seen as a risk factor for TAR failure and revision surgery.

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CONTEMPORARY TOTAL ANKLE REPLACEMENT DESIGNS

Anatomic designs and improved biomechanical properties of contemporary TAR improved the survivorship of implants.[2,3] As a result TAR regained interest among the orthopedic foot and ankle community and patients. The more TARs are implanted, the greater the potential for complications after the procedures. The mean revision rate per 100 observed component years was 3.29 for TAR compared with 1.29 and 1.26 for total hip and total knee arthroplasty.[4]

OSTEOLYSIS IN TOTAL ANKLE REPLACEMENT

Adverse responses in periprosthetic bone and soft tissues to implant-derived material components of wear debris have been recognized as relevant factors inducing aseptic implant failure.[5] Recent works by Yoon and colleagues,[6] Kohonen and colleagues,[7] and Koivu and colleagues[8] showed that the presence of periprosthetic osteolysis in TAR ranged between 35% and 37% 3 to 4 years postoperatively. Scientific publications have linked TAR failure to periprosthetic osteolysis.[6,8–12] In the publication by Yoon and colleagues,[6] osteolysis associated with TAR was a common phenomenon in the postoperative period. Most of the osteolytic lesions observed were quiescent, but the investigators pointed out that these lesions raise concerns in contemporary TAR because of their incidence rate and the potential for later mechanical failure compared with arthrodesis. Yoon and colleagues[6] recommended early diagnosis and careful evaluation of osteolysis in order to detect those lesions as early as possible and reduce revision surgery and failure rates of TAR.

QUESTIONING POLYETHYLENE DEBRIS–INDUCED PERIPROSTHETIC OSTEOLYSIS

In total hip and total knee arthroplasty it is widely accepted that polyethylene wear leads to osteolysis and thus to aseptic loosening and failure of the implant components.[13] The question is whether polyethylene wear could also be found in TARs with periprosthetic osteolysis and whether this is associated with failure of the TAR. Dalat and colleagues[14] showed extremely high percentages of polyethylene debris in the osteolytic areas of examined TAR. In addition, Vaupel and colleagues[15] were able to show macroscopic and microscopic wear patterns of the polyethylene inserts in 8 failed Agility TAR systems, concluding that polyethylene wear results in component loosening and failure of the implants.

In an early study performed by Kobayashi and colleagues,[16] the shape, size, and concentration of polyethylene particles in the synovial fluid of 15 Scandinavian TARs and 11 posterior-stabilized total knee arthroplasties were investigated. The particles in both groups were similar in shape, size, and concentration. Based on the conclusion that periprosthetic osteolysis in TAR is associated with polyethylene debris, the investigators assumed that the long-term results of second-generation TAR should be comparable with posterior-stabilized total knee arthroplasties. However, this has not been the case. The data from the Norwegian Joint Registry reported a survivorship of only 75% at 10 years for the scandinavian total ankle replaement system (STAR) arthroplasty compared with 95% survivorship at 15 years for the posterior-stabilized total knee arthroplasty.[17,18] This finding questions the sole assumption of polyethylene debris–induced periprosthetic osteolysis in TAR. Certain mechanisms other than polyethylene wear alone may be responsible for or promote development of osteolysis. This statement might be supported by the fact that not all patients with periprosthetic osteolysis reveal polyethylene debris in the histopathologic analysis. Koivu and colleagues[19,20] were able to show that early osteolysis is caused by Receptor Activator of NF-κB