**Introduction:** Polyethylene wear has long been identified as one of the major contributors to periprosthetic osteolysis and subsequent implant loosening and long-term failure [1]. However, unlike in the hip, the osteolysis threshold around total knee replacements is not well established. Part of the problem is the determination of an accurate in vivo wear rate for TKR tibial liners. It is the purpose of this study to investigate a possible relationship between local periprosthetic radiolucencies and the volumetric polyethylene wear rate in cemented cruciate retaining TKRs. It is hypothesized that patients with a higher wear rate will exhibit a higher incidence of loosening.

**Methods:** For this study retrievals from 26 primary TKA patients were available. All retrievals were cruciate retaining total knee replacements of the same design (Nexgen, Zimmer Inc.) and implanted in the same Medical Center. All tibial liners were made from conventional polyethylene. The Ti-alloy tibial baseplate was cemented and had four pegs on the backside and no screw holes. The average time in situ was 4.82 (± 3.2) years. Metrology data for the surface of the tibial liners were obtained with a coordinate measuring machine (SmartScope, OGP, Inc., Rochester, NY) using a laser scanner with two micrometers depth accuracy. A total of 400,000 three-dimensional data points were gathered to reconstruct the articular surface of liners utilizing a novel established autonomous mathematical reconstruction method [2]. Radiographs were available for all patients taken post-op and before revision surgery. Loosening scores were assigned according to a protocol establish by Goldvasser et al. [3]. For this score two areas were defined in the anterioposterior radiograph (femoral-anterior (FA) and tibial-anterior (TA)) and two in the lateral radiograph (femoral-lateral (FL) and tibial-lateral (TL)). Furthermore, each area was divided in two superior quadrants (TA1-2, FA1-2, TL1-2, FL1-2) and two inferior quadrants (TA3-4, FA3-4, TL3-4, FL3-4). It was distinguished between 25-49% of quadrant area affect (score 1) and >50% of quadrant area affected (score 2). Areas that exhibited less than 25% of radiolucency were not considered. Thus, the maximum score per quadrant was 2, per area 8 and the maximum total score was 24.

**Results:** The average total osteolysis score according to Goldvasser et al. was 7.15 (±2.38). Radiolucencies were mainly observed around the tibial component as reflected in the average score in each area: 3.2 (TA), 2.8 (TL), 0.2 (FA), 1.3 (FL). In case of the tibial component radiolucency was limited to the two superior regions: 1.6 (TA1), 1.6 (TA2), 1.4 (TL1), 1.39 (TL2) (Fig. 1). The average volumetric wear rate of all components was 20.4 (±13.5) mm³/yr. There was a positive correlation between volumetric wear and time in situ (R²=0.43, p<0.001). There was no significant correlation between the total loosening score including all areas and the volumetric wear rate (R²=0.016). For the localized areas
TA1 and TA2 the loosening score was compared with the corresponding lateral and medial volumetric wear rates. There appeared to be a trend that implants with a score of 2 exhibited a higher wear rate than those scored with 1, however, this difference was not significant (TA1: p=0.18, TA2: p=0.097) (Fig. 2 a and b). A similar trend was also observed between the total wear rate and score in FL3 (lateral view, femoral component) (p=0.23) (Fig. 2 c). All other areas exhibit no considerable trend.

Discussion: This study compares accurately measured volumetric wear rates from the primary articulating surface with loosening scores of TKR tibial liners after revision surgery. We were unable to demonstrate that the volumetric polyethylene wear rate was related to the degree of loosening. The total loosening score of the entire periprosthetic area exhibited no relationship with the wear rate. Interestingly, there appeared to be slight trends in certain localized areas, especially around the tibial components. A major limitation was the short average time in situ. Since it is well known that osteolysis is a long term problem, a longer time in situ may have pushed the relationships to significance. Furthermore, the applied wear assessment method does not account for backside wear which may impact the results. However, since all components were cemented and the tibial base plates had no screw holes, the impact of backside wear is likely not as important as reported for other TKR designs [4]. Based on the results presented here, it can be concluded that other factors beside the release of polyethylene particles contribute to the observed occurrence of early bone degradation.

Significance: Osteolysis is still the main reason for long term failure of orthopaedic bearings. Currently, the relationship between polyethylene wear and the occurrence of osteolysis and subsequent implant loosening is not well understood.

![Graph](image.png)
Figure 2  a) Lateral wear rate vs. loosening score in area TA1, b) Medial wear rate vs. loosening score in area TA2, c) Total wear rate vs. loosening score in area FL3