

# QUANTITATIVE ANALYSIS OF POLYETHYLENE WEAR PARTICLES IN TOTAL KNEE ARTHROPLASTIES COMPARISON ON THREE DIFFERENT PROSTHESIS

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## Introduction

The design of articulating surface affects the wear characteristics of polyethylene in total knee arthroplasty (TKA). Although there have been a few reports on the polyethylene wear particles in joint fluid, no information has been available on the influence of the TKA designs. In this study, polyethylene wear particles in joint fluid were retrieved from well-functioning patients and their characteristics were compared with three different design concepts.

## Materials and Methods

Joint fluid was aspirated from 21 well-functioning TKA patients under sterile condition in an operating room. Eight patients had posterior stabilized (PS) TKA (4 I/B II, Zimmer 4 Osteonics Scorpio P/S, Stryker), seven had mobile bearing (MB) TKA (MBK, Zimmer) and six had medial pivot (MP) TKA (ADVANCE Medial-Pivot Knee, Wright Medical Technology) Aspiration was performed at least 6 months after the operation with informed consents.

Polyethylene wear particles were purified using a technique as previously described (1,2). All solutions were filtered through a 0.2µm pore nylon filter to avoid contamination. Briefly, the joint fluids were treated by the same amount of 10N sodium hydroxide at 65 .C for 12 hours, applied to sucrose density gradient (5, 10, 20%) and then ultracentrifuged at 4 .C for 3 hours. The top layers were collected and applied to isoplopanol-water density gradient (0.90, 0.9g/ml) and ultracentrifuged again in 4 .C for 1 hour. Polyethylene particles were collected from the intermediate layer and filtered through 0.1µm polycarbonate filters for Scanning Electron Microscopy (SEM) examination (Figure 1) and computerized image analysis. Total number of polyethylene wear particles contained in the joint fluid was calculated from the number of particles on the filter and the amount of the joint fluid. Particle size and shape were expressed using equivalent circle diameter (ECD), which is the diameter of a circle having the same area as the measured feature, aspect ratio (length/breadth) and roundness (perimeter /B x area). Statistical analyses were performed using analysis of variance (ANOVA) with Boneferroni/Dunn test.

## Results

The total number of particles contained in the joint fluid was  $17.2 \times 10^6$  in MB knees and  $18.9 \times 10^6 - 10.4 \times 10^6$  in MB knees. Joint fluid from MP knees contained less particles ( $9.03 \times 10^6 - 2.42 \times 10^6$ ) although this difference did not reach statistical significance ( $p=?$ ). The morphological characteristics of the particles in each group were shown in Table 1 and all differences between 3 groups were not significant in all parameters. Particle size distributions expressed by ECD in a representative case for each group were shown in Figure 2.

## Discussion

MB TKA has been designed to reproduce normal knee kinematics and to reduce the wear. Some researchers, however, reported the increased concentration of polyethylene wear particles compared to that seen in a fixed bearing prosthesis in the joint fluid in MB TKAs was not higher and equivalent to that seen in PS TKAs. The design concept of MP TKA is to reproduce the physiological pivot-like internal rotation of the tibia using medial ball-and-socket and mobile lateral articulation. The large contact area would decrease the contract stress and thus reduce the wear. However, a concern in this new design was that a large, conforming articular surface may produce smaller and more particles exactly as in hip prostheses. However, a concentration of polyethylene wear particles generated from MP TKA

were not high and their size was equivalent to those generated in the conventional PS design.

There were tendencies that MP TKA generated less polyethylene wear particles and MB TKA generated larger particles although they were not statistically significant. These small differences would have impact on the prevalence of osteolysis in the long term. The authors believe that the extraction analysis of the particles generated in well-functioning prostheses is particularly important to predict the longevity of new design prostheses in early postoperative period.

TABLE 1 | ECD, Aspect Ratio & Roundness in Three Types of TKAs

	ECD (µm)	Aspect Ratio	Roundness
PS	0.795-0.084	2.716-0.192	0.352-0.036
MBK	1.040-0.158	2.415-0.075	0.438-0.033
MP	0.803-0.171	2.286-0.198	0.475-0.038

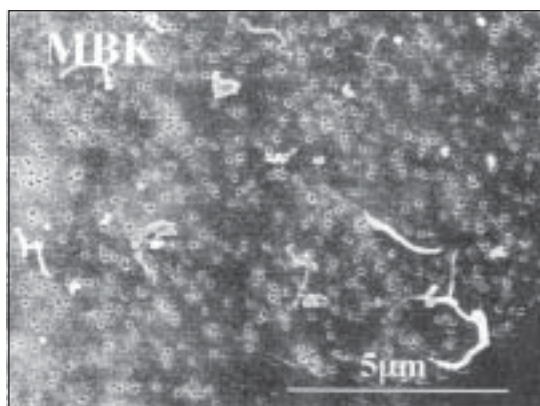


FIGURE 1 | SEM Photograph of MBTKA

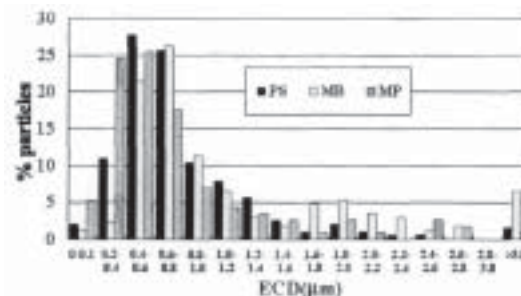


FIGURE 2 | The Size Distribution of Polyethylene Particle in Each Prosthesis



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