Highly cross-linked polyethylene in total hip arthroplasty, present and future

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Comment on: Devane PA, Horne JG, Ashmore A, *et al.* Highly Cross-Linked Polyethylene Reduces Wear and Revision Rates in Total Hip Arthroplasty: A 10-Year Double-Blinded Randomized Controlled Trial. J Bone Joint Surg Am 2017;99:1703-14.

Received: 20 July 2018; Accepted: 10 August 2018; Published: 16 August 2018.

doi: 10.21037/aoj.2018.07.05

View this article at: http://dx.doi.org/10.21037/aoj.2018.07.05

Excessive polyethylene wear after total hip arthroplasty using non-cross-linked ultra-high-molecular-weight polyethylene (UHMWPE) is known to cause osteolysis followed by implant loosening (1,2). To reduce the amount of wear, several manufacturers have attempted to modify bearing surface materials. Highly cross-linked polyethylene (HXLPE) was utilized the processes of gamma or electron beam radiation, to increase the degree of crosslinking within the material. Re-melting process would take on to reduce the amount of oxidation involving to crosslink. As a result, it is expected that wear resistance of the polyethylene increase.

Recently, many studies showed comparative evaluation between HXLPE and UHMWPE. First-generation HXLPEs, such as Marathon (DePuy, Warsaw, IN, USA) (3-6), Longevity (Zimmer, Warsaw, IN, USA) (7-9), Durasul (Zimmer) (10), and XLPE [Smith & Nephew (S&N), Memphis, TN, USA] (11,12), have superior wear resistance for 10 years post-surgery, respectively. Although the cross-linking process differs from each manufacturer (Marathon, 5 Mrad of gamma irradiation; Longevity, 10 Mrad of electron beam irradiation; Durasul, 9.5 Mrad of electron beam irradiation; and XLPE, 10 Mrad of gamma irradiation), their improvement almost yields the potentiation to extend the implant longevity.

Devane and colleagues demonstrated the considerable clinical follow-up study (13). They successfully carried out the prospective double-blinded randomized controlled trial with a single-center study in which polyethylene from a single manufacturer.

The author clearly demonstrated that HXLPE would be associated with less wear than conventional UHMWPE at 10 years following primary THA. Noteworthy, the follow-up rate was 100%, and it was assessed polyethylene wear rates of individual patients with the use of multi-point measurements. In particular, a regression formula that models femoral head penetration was assessed, and bedding-in time in individual patients during the first 2 years was quantified in detail. They showed that HXLPE tended to bed in more quickly and had higher initial creep. These data were in similar with previous report (14).

The authors also demonstrated that, wear rate after bedding-in time and osteolysis in HXLPE was significantly lower than conventional UHMWPE. The reduction of wear rate in HXLPE would be associated with lower rates of osteolysis and improved prosthetic survival. In minor details, they evaluated osteolysis from anteroposterior and lateral radiographs. Three-dimensional analysis is better to evaluate the volumetric osteolysis data using by computed tomography. In addition, the author should be indicated the further data, such as the variance of cup position and BMI. There is no description for symptomatic reason of revision related with wear or osteolysis. In our opinion, usage of cement stem made difficult with the identification of the wear-related reoperation rate. because cement related issues, such as fractures of the cement mantle, cement creep,

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or stem subsidence, may be occurred (7).

In summary of this study, it is a well-planned clinical follow-up study and provided a valuable direction for improving polyethylene wear resistance.

We have some unresolved problems left. There is concerned that several problems are raised in HXLPE, such as biological response to wear debris, or liner breakage (15,16).

A substantial reduction in the prevalence and severity of osteolysis associated with crosslinked re-melted polyethylene wear is referred to as the so-called "osteolysis threshold" concept. It is about 0.1 mm/year, and if it is lower, clinically relevant osteolysis is rare (1,17,18). These phenomena might be related to the following factors.

Thomas reported that, in retrieved polyethylene from total hip replacement cases, rounded particles were either submicron sized, flattened granules or larger 1- to 2-mm sized, roughly spherical beads with an irregularly textured surface (19). Green reported that the volume and size of particles are factors that may activate macrophage, and the most biologically active particles in the phagocytable size range are in the range of 0.3–10 μm (20). Probably it is certain that the amount of wear is an important factor causing osteolysis, but we need to further study that the shape and size of polyethylene wear are factors causing osteolysis. It is considered to be contributing to further improvement of wear resistance.

To reduce the toughness of the polyethylene because the amount of cross-linking and re-melting both increase (21), it would be concern that there would be increased the incidence of fatigue fracture of the cross-linked polyethylene (22-24). This issue may also be related to designs that occurred at the area of stress concentration caused by fixation grooves, rim notches, screw holes or other types of damage.

We once again congratulate the authors and encourage all authors and readers to focus on the direction of HXLPE and accurately evaluate.

Acknowledgments

We would like to thank the editorial board of *Annals of Joint* for inviting us to write this editorial. We read with great interest the article entitled 'Highly Cross-Linked Polyethylene Reduces Wear and Revision Rates in Total Hip Arthroplasty'. We congratulate the authors for this very relevant, interesting and enlightening study.

Funding: None.

Footnote

Provenance and Peer Review: This article was commissioned and reviewed by the Executive Editor-in-Chief, Dongquan Shi, MD, PhD (Department of Sports Medicine and Adult Reconstruction, Drum Tower Hospital, Medical School, Nanjing University, Nanjing, China).

Conflicts of Interest: Both authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/aoj.2018.07.05). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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doi: 10.21037/aoj.2018.07.05
Cite this article as: Mori T, Tsukamoto M. Highly cross-linked polyethylene in total hip arthroplasty, present and future. Ann Joint 2018;3:67.

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