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CASE REPORT

Highly Cross-linked Polyethylene Liner Dissociation from a Cementless Modular Acetabular Shell: Two Case Reports

Shunsuke Kawano*, Motoki Sonohata, Masaru Kitajima and Masaaki Mawatari

Department of Orthopaedic Surgery, Faculty of Medicine, Saga University, 5-1-1 Nabeshima, Saga 849-8501, Japan

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Abstract: Liner dissociation of polyethylene from a cementless acetabular socket following total hip arthroplasty (THA) is a rare complication. Cross-linked polyethylene liner dissociation from AMS-HA shell (KYOCERA Med, Osaka, Japan) occurred in 2 out of the 4153 (0.04%) cases approximately 10 years after undergoing surgery at our institute. First case was an 80-year-old female who underwent right THA along with subtrochanteric femoral shortening osteotomy due to complete dislocation hip, and second case was a 72-year-old male, who underwent right THA due to coxarthrosis. A 26 mm femoral head and CPE liner were used in both cases and the inclination degree of the acetabular socket was within 50°. There was no implant loosening in both cases. There was partial damage in the elevated rim on the alternative side and scratches on the back side in the both extracted CPE liner. It was surmised that liner dissociation was caused due to a problem in the liner fixing format of the push in type of the present model.

Keywords: Total hip arthroprasty, Highly cross-linked polyethylene, Liner dissociation, Cementless modular acetabular shell, Complication, Locking mechanism revision.

INTRODUCTION

Complications of total hip arthroplasty (THA) include dislocation, infection, nerve/vascular injury, thrombus, embolisms, damage, loosening, *etc.* Although polyethylene (PE) liner dissociation from a cementless acetabular socket is not a highly frequently observed complication, it has been reported in particular models such as Harris-Galante cementless prostheses (Zimmer, Warsaw, Ind), *etc.* [1 - 7]. Further, liner dissociation from the acetabular socket is also observed in Hard-on-hard THA using a sandwich-type liner [8 - 14]. Particularly regarding AMS-HA acetabular shells with an Alumina-Bearing-Surface (ABS) liner (KYOCERA Med, Osaka, Japan), there have been several reports on dissociation of the sandwich-type ceramic liner [10, 11, 14], and according to post-marketing surveillance, dissociation of ABS liners has occurred in 649 among 3933 hips (16.5%). PE liners may be selected for AMS-HA acetabular shells; however, there are no reports on liner dissociation when PE liner is used in combination with an AMS-HA acetabular shell.

To our knowledge, this is the first reported case of dissociation of the PE liner from an AMS-HA shell. This report concerns the mechanism of dissociation of PE liner from AMS-HA shell.

The study protocol adhered to the ethical guidelines of the 1975 Declaration of Helsinki, and the institutional review board of the Faculty of Medicine, Saga University at Saga, approved this study. The patients were informed that this case study would be submitted for publication, and they gave their informed consent.

CASES

Case 1 pertains to an 80-year-old woman. She underwent right THA along with subtrochanteric femoral shortening osteotomy taking a posterolateral approach using methods by Hotokebuchi *et al.* [15] under a diagnosis of complete

* Address correspondence to this author at the Department of Orthopaedic Surgery, Faculty of Medicine, Saga University, Nabeshima 5-1-1, Saga 849-8501, Japan; Tel: +81-952-34-2343; Fax: +81-952-34-2059; E-mail: shunsuke-kawano@hotmail.co.jp

dislocation hip. An AMS-HA acetabular shell (outer diameter 44mm, inner diameter 38mm) with a cross-linked polyethylene (XLPE) liner was set in the acetabulum with four screws and a cementless proximal-hydroxyapatite-coated femoral component (a PerFix-HA #13-M stem) was used along with a 26 mm zirconia ball (Kyocera Medical, Osaka, Japan). An AMS-HA acetabular shell is a push in type liner fixing format for gripping the groove of a liner with four clicks, having a structure whereby rotatable fixation contributes to one section (Fig. 1). Regarding the XLPE liner, a calcium-stearate-free GUR 1050 ultra-high-molecular-weight PE resin was used to create a compression-molded sheet stock, which was then machined into the final implant geometry. Prior to machining, the compression-molded sheet was subjected to a process consisting of gamma-ray irradiation of 35 kGy in air to achieve the desired level of cross-linking and then annealed at 110 °C for 12 h in nitrogen to reduce the concentration of free radicals. After machining, the liners were sterilized with 25-kGy gamma-ray irradiation in nitrogen (total 60 kGy) and prepared [16, 17]. The gamma-ray irradiation amount of 60 kGy in total is similar to that reported in most previous studies using XLPE [18]. The inclination angle of the socket was 48 degrees, the anteversion angle was 26 degrees, the vertical distance from the tear drop to the center of the femoral head was 17 mm, and the horizontal distance was 22 mm. No problems were observed until 9 years following surgery (Fig. 2a); however, an aching pain and abnormal sound occurred in the right hip joint after 9 years and 8 months. A plain X-ray revealed that the right femoral head had deviated to the outer upper side of the acetabular socket; however, osteolysis was not observed in the vicinity of the acetabulum and femoral implant (Fig. 2b). Upon Surgery, the XLPE liner had dissociated inwards and downwards from the acetabular socket; however, no problems were observed in the four clicks, which is the liner gripping mechanism of the acetabular socket, with no looseness. Fixation of the femoral component was good with no macroscopic observation of the trunnion, and so revision surgery on the liner was conducted and the ball was exchanged. The extracted XLPE liner was observed with partial damage in the elevated rim on the alternative side and end section surface along with scratches on the back side (Figs. 2c and 2d, Table 1).

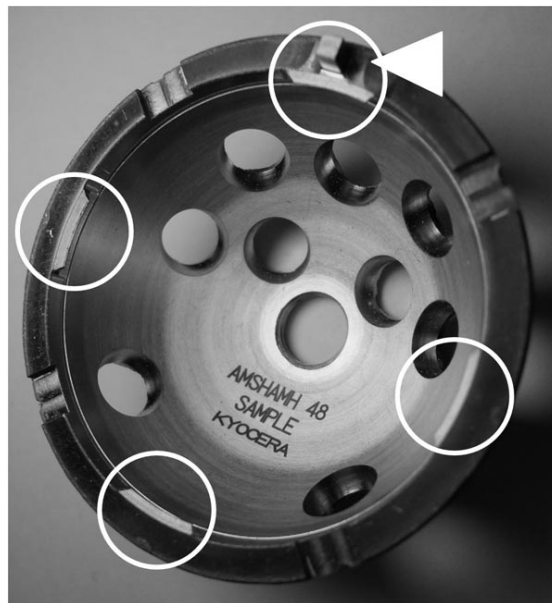


Fig. (1). Photograph showing the AMS-HA acetabular shell. Four nails for holding the polyethylene liner (four circle marks), and one prominently for rotation stability (arrow head mark).

Table 1. Findings from the extracted liner.

	Alternative side		Back side	
	Anterior side	Posterior side	Anterior side	Posterior side
Case 1	Surface of the end face is crushed due to friction with the stem neck following dissociation, which is believed to have caused exfoliation in some areas	Partial damage to the elevated rim and end face surface	Partial scratches from the click of the shell in the upper center	Belt-like scratch marks caused by the click of the shell occurring in the process leading to dissociation

(Table 3) contd.....

	Alternative side		Back side	
	Anterior side	Posterior side	Anterior side	Posterior side
Case 2	Surface of the end face is crushed due to friction with the stem neck following dissociation, which is believed to have caused exfoliation in some areas	Partial damage to the elevate rim and end face surface	Partial scratches from the click of the shell in the lower center	Scratch marks throughout a large area caused by the click of the shell occurring in the process leading to dissociation



Fig. (2a). Photograph showing the Case 1. Nine years post-THA.



Fig. (2b). Nine years and eight months post-THA. Radiographs demonstrated supralateral subluxation of the right femoral head from the acetabular component, but there was no loosening of the acetabular or femoral implants.

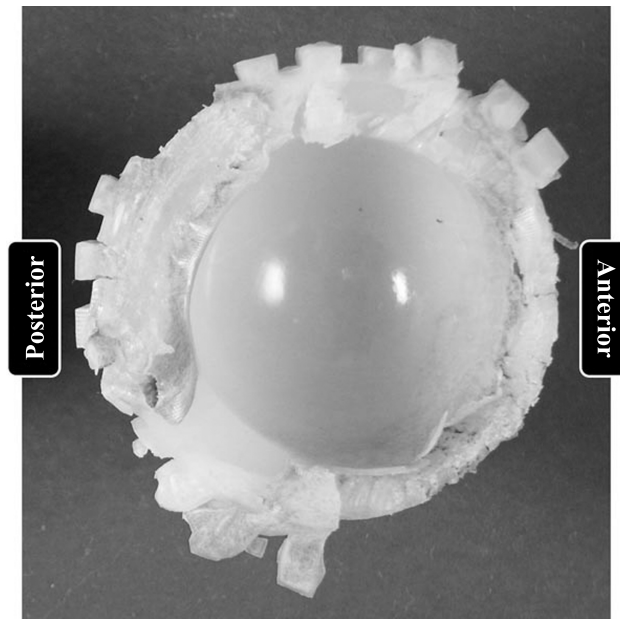


Fig. (2c). The removed acetabular liner that looking alternative side view.

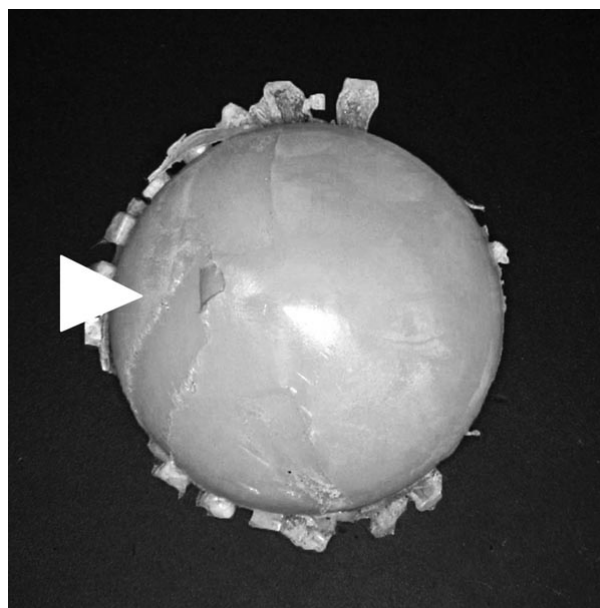


Fig. (2d). The removed acetabular liner that looking back side view. There is scratch by folding nail of liner (arrow head mark).

Case 2 pertains to a 72-year-old man. He underwent right THA from a posterolateral approach due to a diagnosis of coxarthrosis. An AMS-HA acetabular shell (outer diameter 50 mm, inner diameter 44 mm) with an XLPE liner was set in the acetabulum with two screws, and a cementless proximal-hydroxyapatite-coated femoral component (a PerFix-HA #12-M stem) was used along with a 26 mm zirconia ball (Kyocera Medical, Osaka, Japan). The inclination angle of the socket was 50 degrees, the anteversion angle was 1 degree, the vertical distance from the tear drop to the center of the femoral head was 27 mm, and the horizontal distance was 33 mm. Although no problems were observed till 9 years following surgery (Fig. 3a), inguinal pain in the right hip occurred at 9 years and 10 months following surgery. Although a plain X-ray revealed that the right femoral head had deviated to the outer upper side of the acetabular socket, osteolysis was not observed in the vicinity of the acetabulum and femoral implant (Fig. 3b). Upon surgery, the XLPE liner was found to have dissociated to the inner lower part from the acetabular socket in the same manner as case 1. No loosening of the acetabular socket was observed, but damage was observed in 1 among the 4 clicks, which is the liner gripping mechanism of the acetabular socket. Fixation of the femoral component was good with no macroscopic observation of the trunnion, so revision surgery of the acetabulum side was carried out and the ball was exchanged. The

extracted XLPE liner was observed with partial damage in the elevated rim of the alternative side and end section surface along with scratches on the back side (Fig. 3c and 3d, Table 1).



Fig. (3a). Only Figure 3: Photograph showing the Case 2. Nine years post-THA.

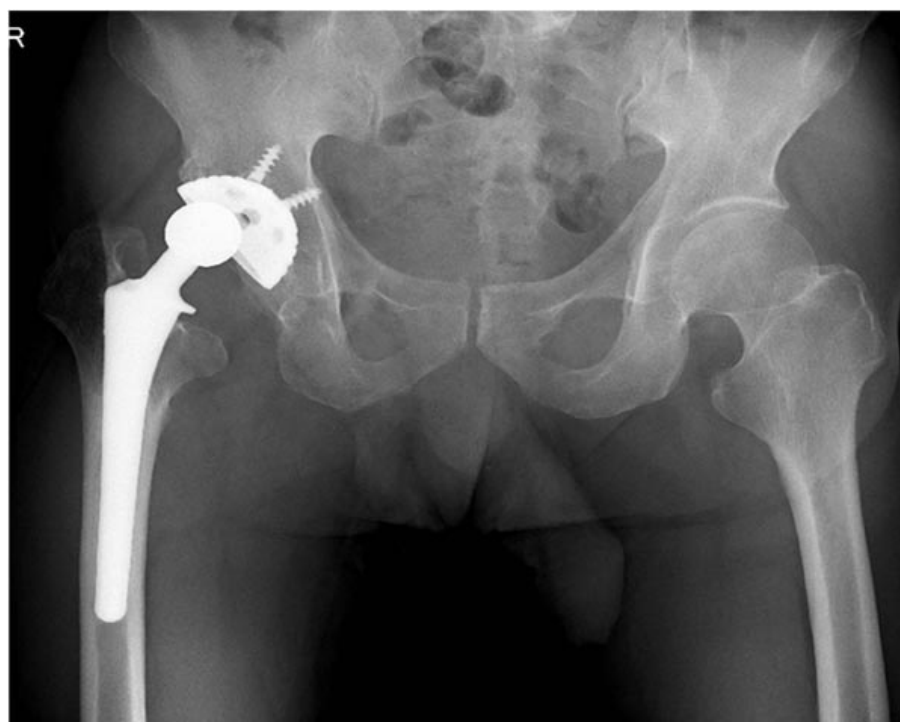


Fig. (3b). Nine years post-THA.



Fig. (3c). Nine years and ten months post-THA. Radiographs demonstrated supra-lateral subluxation of the right femoral head from the acetabular component, but there was no loosening of the acetabular or femoral implants. Removed acetabular liner that looking alternative side view.

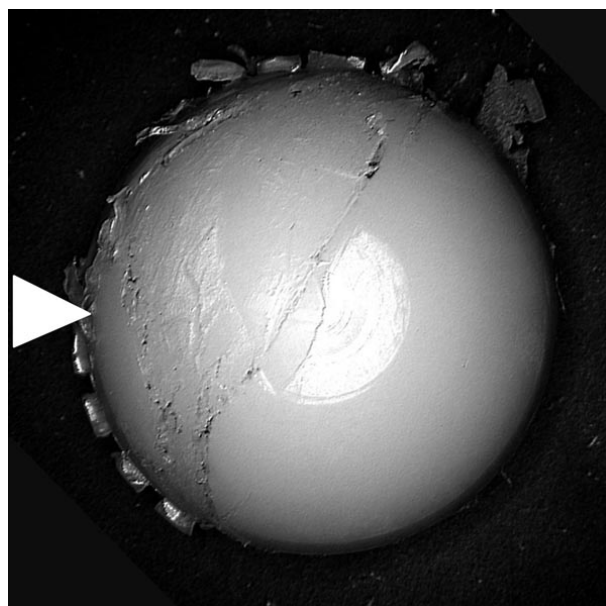


Fig. (3d). Removed acetabular liner that looking back side view. There is scratch by folding nail of liner. (arrow head mark).

DISCUSSION

In this study, we experienced two cases of PE liner dissociation from an acetabular cementless metal socket, which is relatively rare. The inclination degree of the acetabular socket was within 50° , approximately 10 years had passed since surgery, and a 26 mm femoral head and XLPE liner were used in both cases. As of 2016, XLPE liner dissociation has been observed in only 2 of the 4153 cases (0.04%) at our institute, and according to a manufacturer's survey, it has occurred in 11 of 63057 cases (0.02%).

Hara *et al.* reported two cases of damage to the elevated rim of the XLPE liner using the present model. No damage to the conventional PE liner has been reported, and it is believed that damage to the rim of the liner was caused by oxidation due to using the annealed highly cross-linked method, leading to dissociation of the XLPE liner following this damage [19]. It is difficult to verify whether or not the dissociation was caused by this damage or whether the damage

was caused following dissociation; however, the elevated rim of the XLPE liner remained in Case 1, suggesting that dissociation occurred first at least in Case 1, and we concluded that dissociation of the XLPE liner occurred due to sinking of the posterior side inside the shell and rotating of the anterior side downwards, thereby causing friction between the liner and stem neck at the bottom part after dissociation.

There have been several reports on PE liner dissociation from cementless acetabular shells regarding Harris-Galante cementless prostheses. Harris-Galante cementless prostheses are considered problematic in that the PE liner is fixed by gripping the cementless acetabular shell with tines using a push in type liner fixing format [1 - 6]. Gonzalez Della Valle *et al.* mentioned that dissociation of the PE liner of Harris-Galante cementless prosthesis occurs *via* the following three mechanisms: (1) damage due to fatigued tines in titanium sockets; (2) increased micro motion in the socket liner interface; and (3) impingement of the stem neck and liner border [3]. The fixing formats of PE liners to cementless acetabular shells include push in, ring lock, locking groove, *etc.*; however, the liner fixing format of push in and ring lock have come to be considered problematic due to their weak fixing force, and so the locking groove fixing format is recommended [20]. The configuration involving gripping the groove of the PE or XLPE liner with four clicks of the AMS-HA acetabular shell is also a push in type liner fixing format similar to Harris-Galante cementless prostheses, and it is believed that there was a problem with this fixing mechanism. Upon finite element method analysis of the present model, it was found that force concentrated in the clicking part, leading to a loss in the locking machinery when the groove of PE liner is damaged and ultimately causing dissociation. The size of the force is affected by the thickness of the PE liner, with the force increasing as the PE thins. In the present model, no dissociation of the PE liner has been observed in cases using a 22 mm femoral head; however, many cases of dissociation have been observed with sandwich type ABS liners, and it is surmised that the liner thickness is involved in the occurrence of dissociation. Scratch marks from the gripping click have been observed on the back side upon analysis of extracted PE liners, and it is surmised that force concentrated on the clicking part of the liner gripping, causing the locking machine of the clicking part to gradually break, leading to dissociation. Moreover, increased load due to increased alternative torque accompanying enlargement of the femoral head and the structural problem of the rotatable fixation contributing to one area are also believed to cause micro motion and back side wear, which may have enhanced polyethylene liner dissociation.

In other models, Gray *et al.* reported that offset, face-change polyethylene liners dissociate due to enlargement of the inclination angle of the acetabular socket [7]. The inclination angle of the acetabular socket was within 50° in the present cases, and it is believed there were no problems with setting of the socket.

AMS-HA acetabular shells have a problem with the liner fixing format, which may cause dissociation due to an enlarged femoral head, rim impingement, and declined strength at XLPE. Moreover, in recent years, a tendency has been observed for the femoral head to enlarge, with the same problem potentially occurring in other models, and it is believed that a strong locking groove fixing format is required.

CONCLUSION

Attention is required regarding AMS-HA acetabular shells as they are problematically of a push in type liner fixing format having a danger of PE liner dissociation.

LIST OF ABBREVIATIONS

ABS	=	Alumina-bearing-surface
PE	=	Polyethylene
THA	=	Total hip arthroplasty
XLPE	=	Cross-linked polyethylene

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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REFERENCES

- [1] Han CD, Choe WS, Yoo JH. Late dissociation of the polyethylene liner from a modular acetabular metal shell after primary total hip arthroplasty: report of five cases. *Yonsei Med J* 1998; 39(3): 277-82. [http://dx.doi.org/10.3349/ymj.1998.39.3.277] [PMID: 9664834]
- [2] Louwerse RT, Heyligers IC. Late failure of the polyethylene liner fixation in an uncemented total hip arthroplasty. *J Arthroplasty* 1999; 14(3): 391-6. [http://dx.doi.org/10.1016/S0883-5403(99)90070-0] [PMID: 10220198]
- [3] González della Valle A, Ruzo PS, Li S, Pellicci P, Sculco TP, Salvati EA. Dislodgment of polyethylene liners in first and second-generation Harris-Galante acetabular components. A report of eighteen cases. *J Bone Joint Surg Am* 2001; 83-A(4): 553-9. [http://dx.doi.org/10.2106/00004623-200104000-00010] [PMID: 11315784]
- [4] Mihalko WM, Papademetriou T. Polyethylene liner dissociation with the Harris-Galante II acetabular component. *Clin Orthop Relat Res* 2001; (386): 166-72. [http://dx.doi.org/10.1097/00003086-200105000-00021] [PMID: 11347830]
- [5] Werle J, Goodman S, Schurman D, Lannin J. Polyethylene liner dissociation in Harris-Galante acetabular components: a report of 7 cases. *J Arthroplasty* 2002; 17(1): 78-81. [http://dx.doi.org/10.1054/arth.2002.29327] [PMID: 11805929]
- [6] Saito S, Ryu J, Seki M, Ishii T, Saigo K, Mori S. Analysis and results of dissociation of the polyethylene liner in the Harris-Galante I acetabular component. *J Arthroplasty* 2008; 23(4): 522-6. [http://dx.doi.org/10.1016/j.arth.2007.06.004] [PMID: 18514868]
- [7] Gray CF, Moore RE, Lee GC. Spontaneous dissociation of offset, face-changing polyethylene liners from the acetabular shell: a report of four cases. *J Bone Joint Surg Am* 2012; 94(9): 841-5. [http://dx.doi.org/10.2106/JBJS.K.00506] [PMID: 22552674]
- [8] Milosev I, Trebse R, Kovac S, Cör A, Campbell P. Dissociation of the metal inlay from the polyethylene liner in an uncemented threaded cup. *Arch Orthop Trauma Surg* 2005; 125(2): 134-41. [http://dx.doi.org/10.1007/s00402-004-0781-3] [PMID: 15645272]
- [9] Porat M, Parvizi J, Sharkey PF, Berend KR, Lombardi AV Jr, Barrack RL. Causes of failure of ceramic-on-ceramic and metal-on-metal hip arthroplasties. *Clin Orthop Relat Res* 2012; 470(2): 382-7. [http://dx.doi.org/10.1007/s11999-011-2161-y] [PMID: 22045071]
- [10] Akagi M, Nonaka T, Nishisaka F, Mori S, Fukuda K, Hamanishi C. Late dissociation of an alumina-on-alumina bearing modular acetabular component. *J Arthroplasty* 2004; 19(5): 647-51. [http://dx.doi.org/10.1016/j.arth.2004.02.027] [PMID: 15284989]
- [11] Hasegawa M, Sudo A, Uchida A. Alumina ceramic-on-ceramic total hip replacement with a layered acetabular component. *J Bone Joint Surg Br* 2006; 88(7): 877-82. [http://dx.doi.org/10.1302/0301-620X.88B7.17675] [PMID: 16798988]
- [12] Popescu D, Gallart X, Garcia S, Bori G, Tomas X, Riba J. Fracture of a ceramic liner in a total hip arthroplasty with a sandwich cup. *Arch Orthop Trauma Surg* 2008; 128(8): 783-5. [http://dx.doi.org/10.1007/s00402-007-0536-z] [PMID: 18066561]
- [13] Kircher J, Bader R, Schroeder B, Mittelmeier W. Extremely high fracture rate of a modular acetabular component with a sandwich polyethylene ceramic insertion for THA: a preliminary report. *Arch Orthop Trauma Surg* 2009; 129(9): 1145-50. [http://dx.doi.org/10.1007/s00402-008-0662-2] [PMID: 18568354]
- [14] Kawano S, Sonohata M, Shimazaki T, Kitajima M, Mawatari M, Hotokebuchi T. Failure analysis of alumina on alumina total hip arthroplasty with a layered acetabular component: minimum ten-year follow-up study. *J Arthroplasty* 2013; 28(10): 1822-7. [http://dx.doi.org/10.1016/j.arth.2013.04.027] [PMID: 23684661]
- [15] Hotokebuchi T, Sonohata M, Shigematsu M, Mawatari M. A new device for a V-shaped subtrochanteric osteotomy combined with total hip arthroplasty. *J Arthroplasty* 2006; 21(1): 135-7. [http://dx.doi.org/10.1016/j.arth.2005.10.009] [PMID: 16446198]
- [16] Sato T, Nakashima Y, Akiyama M, *et al.* Wear resistant performance of highly cross-linked and annealed ultra-high molecular weight polyethylene against ceramic heads in total hip arthroplasty. *J Orthop Res* 2012; 30(12): 2031-7. [http://dx.doi.org/10.1002/jor.22148] [PMID: 22644564]
- [17] Nakashima Y, Sato T, Yamamoto T, *et al.* Results at a minimum of 10 years of follow-up for AMS and PerFix HA-coated cementless total hip arthroplasty: impact of cross-linked polyethylene on implant longevity. *J Orthop Sci* 2013; 18(6): 962-8. [http://dx.doi.org/10.1007/s00776-013-0456-4] [PMID: 23963589]

- [18] Kurtz SM, Gawel HA, Patel JD. History and systematic review of wear and osteolysis outcomes for first-generation highly crosslinked polyethylene. *Clin Orthop Relat Res* 2011; 469(8): 2262-77.
[<http://dx.doi.org/10.1007/s11999-011-1872-4>] [PMID: 21431461]
- [19] Hara D, Nakashima Y, Yamamoto T, *et al.* Late failure of annealed highly cross-linked polyethylene acetabular liner. *J Mech Behav Biomed Mater* 2013; 28: 206-12.
[<http://dx.doi.org/10.1016/j.jmbbm.2013.08.003>] [PMID: 23995342]
- [20] Tradonsky S, Postak PD, Froimson AI, Greenwald AS. A comparison of the disassociation strength of modular acetabular components. *Clin Orthop Relat Res* 1993; (296): 154-60.
[PMID: 8222419]

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