Arthroplasty Today 6 (2020) 5–8

Contents lists available at ScienceDirect

Arthroplasty Today

journal homepage: http://www.arthroplastytoday.org/

Case report

Polyethylene liner dissociation with the Pinnacle acetabular component: should we be concerned?

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ARTICLE INFO

Article history:
Received 12 June 2019
Received in revised form
14 November 2019
Accepted 2 December 2019
Available online 9 January 2020

Keywords:
Pinnacle
Liner dissociation
Acetabular cup

ABSTRACT

Between 2007 and 2018, 535 total hip arthroplasties using the uncemented Pinnacle acetabular component (DePuy Synthes, Warsaw, IN) and polyethylene liner were implanted in our unit. Of these, 6 patients presented acutely with liner polyethylene dissociation, giving a rate of liner dissociation of 1.11%. All dissociations were atraumatic. Failure occurred at mean 37 months (range 4.5 to 130 months). Radiologically, all acetabular components were within safe zone of abduction and mean anteversion was 10 degrees (range 2-20). In one case, there was posterior impingement against the femoral neck due to femoral malalignment. All patients underwent head and liner exchange with no repeat failures. Despite excellent long-term results, the frequency of dissociated polyethylene liners is a cause of concern with the Pinnacle acetabular component.

Introduction

Over recent years, there has been a move toward uncemented acetabular components. [1,2]. The majority are modular which allows for flexibility and adaptability in total hip replacements. It gives options for screw fixation, various liner configurations, and may allow straightforward revision for dissociation or liner wear.

Although it has advantages, modularity also has potential problems. One issue is dissociation of the liner from the metal shell. It was mostly reported in first-generation uncemented components such as the Harris-Galante 1 (Zimmer Biomet, Warsaw, IN) [3,4]. Early locking mechanisms and incongruity between the liner and shell were thought to be the main causes of failure. Improvements in component design have reduced the incidence of this problem such that it is now rarely seen in contemporary designs.

Current modern acetabular designs have recessed liners to reduce the risk of rim fractures and improved locking mechanisms at the perimeter [5]. The Pinnacle acetabular system (Depuy, Warsaw, IN) was introduced in 2003. It is now one of the most commonly used acetabular components [1,2]. It uses a taperloc locking mechanism with 6 antirotation devices or tabs at the periphery which provide rotational stability but do not affect pull-out strength. This provides better conformity but reduced pull-out strength in comparison with the DuraLoc system (Depuy, Warsaw, IN) which used a locking ring. [6] Nonetheless, clinical results from registries and prospective studies with the Pinnacle system have been excellent and a 97% to 94% survival is reported at 5 and 10 years, respectively, by Kindsfater et al in a multicentre study [7]. However, there have been an increasing number of reports of polyethylene liner dissociation from several countries [8-12]. Dissociation can be early or late and have usually been with no trauma. This problem has been rarely reported with other contemporary modular acetabular systems [11].

We have used the Pinnacle acetabular component since 2007 in our unit and have seen 6 polyethylene liner dissociations. We are aware of reports from other centers in our country [12]. The purpose of this study is to report a further series of liner dissociations, calculate the incidence in our center, and to identify possible reasons for this uncommon complication.

One or more of the authors of this paper have disclosed potential or pertinent conflicts of interest, which may include receipt of payment, either direct or indirect, institutional support, or association with an entity in the biomedical field which may be perceived to have potential conflict of interest with this work. For full disclosure statements refer to https://doi.org/10.1016/j.artd.2019.12.001.

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https://doi.org/10.1016/j.artd.2019.12.001

Case series

Departmental audit data identified 6 patients who underwent revision for liner dissociation of a Pinnacle acetabular component in our unit. Our local database was cross-referenced to the New Zealand National Joint Register (NZNJR) to identify all patients who had undergone total hip arthroplasty (THA) with a Pinnacle acetabular component and a polyethylene liner in our unit since its introduction. The NZNJR captures details of all arthroplasties performed in our country and has 98% compliance. It also includes details of revisions of registered arthroplasties performed at any center in the country [1]. No revisions of this cohort were recorded from other centers. The operative records and radiographs of all patients who had been revised were checked to confirm the diagnosis of liner dissociation and ensure that the reason for revision had not been miscoded.

Details of all patients identified with liner dissociation were recorded including their history since the start of new symptoms. Index THA operation notes were reviewed for details of the procedure and components used. Postoperative anteroposterior and lateral radiographs were reviewed to assess acetabular cup abduction and anteversion. Anteversion was measured on a cross-table lateral radiograph [13]. The operative findings at revision surgery were recorded.

Between 2007 and 2018, approximately 5200 primary THAs were performed in our unit; of these, 535 utilized a Pinnacle acetabular component with a polyethylene liner. Marathon highly cross-linked polyethylene was used in all cases. All procedures were either carried out by a fellowship trained arthroplasty surgeon or a senior trainee supervised by a consultant. 277 (52%) were used in combination with an uncemented femoral component and 269 (48%) with a cemented femoral component (hybrid). A metal head was used in 226 (42%) and a ceramic head in 309 (58%). A 32 mm head was used in 293 (55%) and a 28 mm head in 234 (44%) with 8 cases (1%) using a 36 mm head.

During this period, 6 patients presented to us with acute liner dissociation. Details are summarized in Table 1. Four had their index THA for end-stage osteoarthritis and two were for acute fracture neck of femur. Five were performed using the direct lateral approach and one via a posterior approach. The mean time to presentation with dissociation was 37 months (range 4.5 months to 10.8 years). There were no recorded concerns about the liner seating during the index THA. Three patients were asymptomatic till the failure of liner occurred. Two had a subjective feeling of subluxation in the months before presentation and one had new onset pain a few weeks before actual dissociation. Plain radiography was diagnostic with asymmetry of the femoral head within the acetabular component (Fig. 1). The mean abduction angle of the acetabular cup was 39 degrees (range 35 to 42). The mean anteversion was 10 degrees (range 2 to 24).

At the revision, all acetabular components were well fixed and the liner clearly loose. Typically, the superior 3 tabs had sheared off (Fig. 2). In 5 hips, acetabular and femoral components were well positioned. In one hip, there was posterior impingement of the femoral neck on the polyethylene secondary to excessive anteversion of the femoral component. The acetabular shell was retained, a new liner inserted, and the femoral component revised. One acetabular component had signs of pitting due to the metal head articulating against it. It was retained because of the age of the patient who died 3 years later due to an unrelated medical illness. All acetabular components were retained and a new polyethylene liner inserted after checking the locking mechanism integrity in 5 cups. In one patient, a new liner was cemented into the metal shell because of concerns about the competency of locking mechanism. The femoral head was exchanged in all cases. No further complications have been recorded in revised patients at their most recent follow-up.

Discussion

The Pinnacle acetabular system has been in use since 2003 with excellent long-term survivorship. It is currently the most widely implanted acetabular system in New Zealand [1]. Mid-term and registry reports are encouraging with survivorship for all-cause revision of 97.6% at 5 years [14] and 95% at 10 years [7]. Despite this, there have been increasing numbers of reports of liner dissociation of the Pinnacle system [8,10,11].

Liner dissociation was a problem with early designs of modular uncemented acetabular systems especially the Harris-Galante [3]. A more robust locking ring was used in second-generation designs

Table 1
Cases with Pinnacle liner dissociations.

No	Age	Gender	Indication	Time to presentation (months)	Implants	Approach	Cup Abd.	Cup Anteversion	Revision type	Intra-op findings
1	69	M	OA	12.3	Pinnacle/Corail (KHO) 56/28 mm MOP No screws	Lateral	38	10	Change of liner	Well-fixed cup. Acceptable alignment and no impingement
2	87	M	NOF #	13.1	Pinnacle/Corail (KHO) 56/32 mm COP No screws	Posterior	35	24	Change of liner	Pitted but well-fixed cup. Accepted due to age and comorbidities. (RIP 3 years post revision due medical illness)
3	58	M	OA	4.43	Pinnacle/Corail (KLA) 54/28 mm COP No screws	lateral	40	4	Change of liner	Well-fixed cup. Acceptable alignment and no impingement
4	64	M	OA	58.3	Pinnacle/Corail (KHO) 56/28 mm COP No screws	lateral	41	2	Cemented liner in existing cup	Well-fixed cup. Impingement against femoral neck in external rotation due to stem anteversion. Subsequently revised to tapered fluted modular stem with less anteversion.
5	70	M	OA	130	Pinnacle/Corail (KHO) 58/28 mm COP No screws	Lateral	37	10	Change of liner	Well-fixed cup in acceptable alignment and no impingement
6	61	F	NOF #	5	Pinnacle/Exeter V40 50/28 mm COP No screws	Lateral	42	11	Change of liner	Well-fixed cup. Acceptable alignment and no impingement

OA, osteoarthritis; NOF #, neck of femur fracture; KHO, high offset Corail stem; COP, ceramic on polyethylene bearing; MOP, metal on polyethylene bearing.

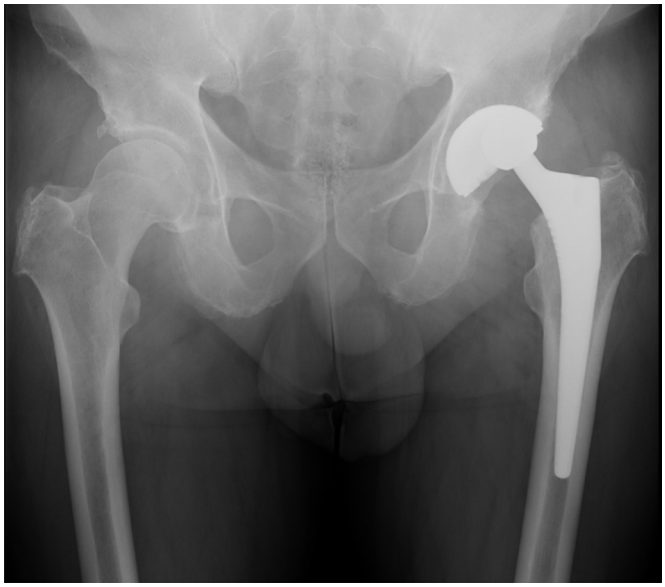

Figure 1. Internal subluxation of femoral head within the socket.

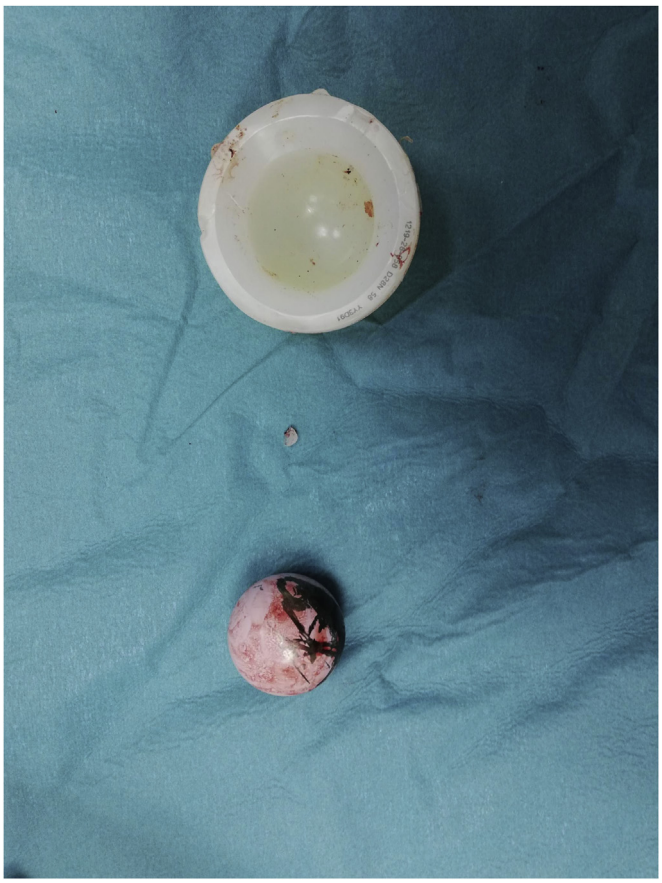

Figure 2. Retrieved polyethylene insert and head showing fractured tabs and deformed shape.

such as the Duraloc [6]. A taperloc mechanism was introduced in the Pinnacle component to accept both polyethylene and ceramic or metal bearings with 6 tabs to resist rotation. The liner was also changed from conventional polyethylene to a highly cross-linked polyethylene (Marathon) irradiated to 50 kGys, which improved wear characteristics but at the expense of mechanical strength [15,16]. The effect these changes has is a reduced pull-out strength of the liner [17].

It is not clear what the incidence of liner dissociation is for the Pinnacle system. The rate of liner dissociation in our unit is 1.11%. We are confident of the rate as we were able to check operative details of all revisions of the cohort recorded in the NZNJR. In the largest series of liner dissociation, Yun et al reported on 23 cases of liner dissociations in 2646 THAs from 3 arthroplasty centers in the United States (incidence: 0.3%-0.83%) [8]. Singleton reported 6 liner dissociations in 253 (2.4%) THAs [12]. By contrast, Napier et al reported only 8 polyethylene liner dissociations from 4751 Pinnacle acetabular components from a single center (0.17%) [11].

Increased rates of dissociation of liners from the Pinnacle component have not been identified from registry data. Jameson reported 10 cases of liner dissociations in 35,386 Corail Pinnacle THAs from the National joint registry of England and Wales [14]. However, only 13,923 of these used polyethylene liners giving an incidence of 0.07% if all dissociations were of polyethylene liners. Registry data in Australia and New Zealand does not have a specific field for liner dissociation as a cause. We found that the reason for revision may be entered as dislocation, acetabular loosening, or "other cause". Therefore, this particular problem may be underestimated in registries. The Pinnacle cup is performing very well in other respects. The revision for dissociation rate is low compared with other reasons for early revision such as dislocation and infection so it may go undetected in registry data unless specifically searched for.

It is not clear why there are multiple reports of dissociation with the Pinnacle acetabular component and not with other contemporary systems. This suggests a problem with the locking mechanism which may be less forgiving than other systems. The Pinnacle system allows for the use of neutral, lipped, lateralized, and a 10° face changing liner option. Liner dissociation may be more common in neutral and face changing liners compared with lipped ones. In Yun's series, 13 of 23 liners were neutral, 9 were +4 10 degrees lateralized with only one lipped liner [8]. A neutral liner was used in 5 of 6 of our cases, and in all cases from Singleton and Kagan [10,12]. This is a little surprising as an elevated lip may be more likely to lead to eccentric loading, rim fractures, or impingement than a neutral liner. However, the polyethylene liner in the Pinnacle system sits slightly proud of the metal rim. Therefore, if the neck impinges on the cup, it will contact the polyethylene first even in neutral liners. Prominence of screw heads could potentially contribute to incorrect seating of the liner. However, screws were not used in any of our cases and do not appear to be associated with dissociation in other series.

There has been little discussion on surgical approach as a factor influencing dissociation. A lateral approach was used in 5 of 6 cases in our series. Singleton reported all their dissociations occurred with the lateral approach and none with a posterior approach [12]. Kagan used a direct anterior approach in all their cases [10]. By contrast, there was a very low incidence of dissociation in Napier's series using neutral liners and a posterior approach [11]. It is not clear why approach should have an effect. With a lateral approach, it is our practice to place the acetabular component in less anteversion and to use a neutral liner rather than a lipped liner which we prefer with a posterior approach. Visualization of the acetabulum can be more difficult with a lateral approach which could lead to problems with soft tissue interposition. A good view of the acetabulum can and should be obtained with any approach and it is important to clear any soft tissue to ensure concentric seating of the liner before final impaction.

In our series and most other reports, most THAs were reported to be functioning well before dissociation. This suggests that the liner was correctly seated at the time of surgery. Early dissociations

occurring within the first 2 years have been reported to be associated with acetabular malposition such as a high abduction angle or over/under anteversion [9,18,19]. However, in our series, all were within the safe zones of abduction described by Lewinnek et al [20]. In only one case was there posterior impingement, which was thought to be due to femoral component malposition. In Napiers's series, 2 of 4 cases with overabducted acetabular components had a recurrent liner dissociation [11]. They thus recommend revision of the acetabular component in such cases. Late dissociations at 5 to 10 years in well-positioned THAs strongly suggest that there is a problem with the Pinnacle locking mechanism.

There may be further patients who have some instability of the liner but do not develop frank dissociation. Three patients in our series had some prodromal symptoms of pain or subluxation in the months preceding the actual dissociation. This diagnosis needs to be considered. However, radiological diagnosis is difficult in such patients. One had a radiograph taken due to a subjective feeling of subluxation which showed a congruent hip joint. Computed tomogram (CT) is a well-recognized tool in assessment of polyethylene wear and component alignment in hip arthroplasty [21]. We are unaware of any cases where a CT has been used to detect polyethylene dissociation; however, a thin-slice metal suppression CT may detect subtle changes not evident on plain radiographs.

Treatment of liner dissociations should be individualized. In cases where the acetabular component is well aligned with an intact locking mechanism, a head and liner exchange may be appropriate. We have not observed recurrent liner dissociation in our series. If impingement or malalignment is present, a revision of either acetabular or femoral component should be considered to reduce the risk of redissociation. Cementing a liner into a well-fixed acetabular component is an option if there are concerns about the integrity of the locking mechanism.

Summary

Liner dissociation is an important complication seen with the Pinnacle acetabular component. Although some cases could be attributable to technical issues such as incomplete seating, impingement or malalignment, the increasing numbers reported with this device, especially at long-term follow-up, coupled with the lack of reported dissociations with other contemporary modular acetabular components suggests that there are problems with the locking mechanism. Comparative studies of similar acetabular components and mechanical testing under different loading conditions may help to provide the answers.

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