The Journal of Arthroplasty xxx (2018) 1–6

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

AAHKS Symposium

Constrained Acetabular Liners

Stephen A. Jones, MRCS, MSc, FRCS(Orth) *

Department of Trauma and Orthopaedics, Cardiff & Vale University Health Board, University Hospital of Wales and University Hospital Llandough, Wales, UK

A R T I C L E I N F O

Article history:
Received 15 January 2018
Accepted 17 January 2018
Available online xxx

Keywords:
revision hip arthroplasty
dislocation
constrained liners
recurrent hip instability
systematic review

A B S T R A C T

Background: Dislocation remains one of the most common complications after total hip arthroplasty. Constrained acetabular liners were developed to address the problem of recurrent instability. They have been in clinical use since the mid 1980s and function by capturing the femoral head.
Method: The aim of this review is to highlight the mechanism of action, development, and advances in constrained liner design, together with an emphasis on the modes of failure and the authors' opinion on the current indications for the use of these implants.
Results: A systematic review of the literature summarizes the current body of published evidence on the results of constrained liners. Overall, at best level III evidence is available. In the 38 studies included, this study considered a total of 2852 constrained liners with a mean follow-up 4.3 years (range 0.8-20 years), which had a mean dislocation and/or constrained failure rate of 11.4% (95% confidence interval 10.3-12.6).
Conclusion: Constrained acetabular liners remain an important option in the armamentarium of the revision hip surgeon. At this point in time with current designs and published results, they should remain a salvage device. The implantation of a constrained liner should be considered when all other factors related to the total hip arthroplasty have been optimized, especially component malposition.

Dislocation remains at the forefront of complications after primary total hip arthroplasty (THA). The natural history of THA dislocation results in a suboptimal outcome for the patient accompanied by the ongoing risk of recurrent instability and revision surgery [1]. Instability after revision THA represents an even greater burden and is the leading indication for re-revision surgery [2]. The past 2 decades of instability management in THA have seen component design take center stage, primarily, with the use of larger diameter femoral heads and the rise in popularity of dual mobility bearings and constrained acetabular liners (CAL).

Mode of Function of CAL

In traditional THA design at the limit of the primary arc of movement, impingement occurs. This impingement can be component-component (eg, femoral neck against acetabular liner), component-host (eg, femoral neck against acetabular osteophyte), or indeed host-host (eg, greater trochanter against acetabular wall). Beyond the point of impingement, levering out of the femoral head occurs. Generally when levering out exceeds 50% of the femoral head diameter (ie, the jump distance), dislocation of the THA occurs. An intact soft tissue envelope acts as a secondary stabilizer to retain the head when levering out occurs. The abductor muscles, particularly the border posterior vertical fibers of the gluteus medius, act as a dynamic lateral stabilizer. Essentially, the function of CAL is akin to that of the soft tissue envelope, and as such, its role is most applicable when the most important muscle stabilizer of the hip joint is deficient (ie, the abductor mechanism).

The principal feature of a CAL is to capture the femoral head. Therefore, at the point of impingement, greater force is required to lever out the femoral head. By the very nature of their design, the capture of the femoral head reduces the primary arc of movement. This is due generally to the buildup of the polyethylene liner extending beyond the equator of the spherical femoral head. The point of impingement, therefore, generally occurs sooner in a CAL, and the femoral head is retained within the liner avoiding dislocation. The forces driving THA movement at the point of impingement are therefore transferred to the polyethylene capture mechanism of the femoral head, the locking mechanism of the CAL

The author of this paper has 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 statement refer to https://doi.org/10.1016/j.arth.2018.01.026.

* Reprint requests: Stephen MRCS, MSc, FRCS(Orth), Department of Trauma & Orthopaedics, Cardiff & Vale University Health Board, University Hospital of Wales and University Hospital Llandough, Wales, UK.

https://doi.org/10.1016/j.arth.2018.01.026

Fig. 1. CAL with a dislodged locking ring.

within acetabular component, and ultimately to the implant-bone interface.

Historical Development of CAL

Sivash [3] first documented the CAL implant in 1969; this was an uncemented metal-on-metal design. This novel implant had a socket and head that were manufactured together and required the surgeon to unitize this with a femoral stem. The authors at that time, more than 4 decades ago, noted that “a constrained device may be associated with decreased range of motion, potential impingement, and enhanced interfacial stresses that may result in increased risks of wear, osteolysis, and loosening.” A statement that remains true for modern designs of CAL.

CALs have been in more mainstream clinical use since the mid 1980s with the initial development of snap-fit designs [4]. First available as custom implants then as a modular design, overall the features were of the polyethylene liner extending beyond the midportion of the femoral head. This requires the surgeon to “snap” the head into the liner at the time of reduction intraoperatively. To protect this polyethylene material buildup, a locking ring is secured in place around the rim of the CAL. It is vital, of course, to ensure that this ring has been placed over the femoral component before stopping the arthroplasty. The tripolar design of CAL has gained popularity after its introduction in the 90s [5]. This should be differentiated from a nonconstrained tripolar articulation [6]. In the tripolar CAL, there is an outer polyethylene liner inside of which sits a bipolar component secured in place with a locking ring. The femoral head that is impacted upon the femoral stem sits inside the bipolar head.

Type I	Bone/cup interface if cementless or bone/cement interface if cemented
Type II	Disengagement of liner from metal cup or failure at liner/cement interface if the liner is cemented into a well-fixed cup
Type III	Locking ring failure or dislocation of the bipolar component
Type IV	Dislocation of the femoral inner head

Fig. 2. Classification of tripolar CAL failure [11].

Fig. 3. Preop X-ray of post-traumatic OA.

Failure Mechanisms of CAL

CALs by the nature of their design have a reduced primary arc of movement, and it is no surprise that retrieval analysis of failed CALs has demonstrated impingement as the universal failure mechanism of the several designs considered [7]. In the snap-fit designs, the locking ring can become dislodged by repeated impingement or indeed poor initial placement may add to this (Fig. 1). This renders the polyethylene liner to liable rapid failure and loss of capture of femoral head and hence dislocation. If the lever-out force at the point of impingement is greater containment force of the CAL, then dislocation may occur. The force may be transmitted to other interfaces, and indeed, failure can occur at any of these. This has been demonstrated clearly with the tripolar design where modes of failure have been classified from types I-IV where failure at each of the modular interfaces has been reported and indeed classified (Fig. 2).

Implant position is critical, no matter what design of CAL is used. If a CAL is inserted into a malpositioned socket, then an even more adverse primary arc of movement will occur. This may well cause excessive repeated impingement within the standard functional range of hip movements required by the patient and lead to rapid failure of the device. Hence, optimization of implant position is

Fig. 4. Postop X-ray with hybrid THA in situ.