Abstract:

There is no doubt that Total Hip Arthroplasty has been a very successful procedure in terms of pain relief and improving overall quality of life of those who receive it. However it does have a limitation in terms of long term survivorship, which leads to patient's undergoing one or more Revision Total Hip Arthroplasty in their lifetime.

Osteolysis is the commonest cause of aseptic loosening in contemporary Total Hip Arthroplasty.

It could be defined as the process of progressive destruction of periprosthetic bone, characterized on serial radiographs as radiolucent lines and/or cavitation at the bone implant or cement bone interface.
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OSTEOLYSIS IN A WELL FIXED ACETABULAR CUP, RETAIN OR REVISE ???

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There is no doubt that Total Hip Arthroplasty has been a very successful procedure in terms of pain relief and improving overall quality of life of those who receive it.

However it does have a limitation in terms of long term survivorship, which leads to patient’s undergoing one or more Revision Total Hip Arthroplasty in their lifetime.

Osteolysis is the commonest cause of aseptic loosening in contemporary Total Hip Arthroplasty. It could be defined as the process of progressive destruction of periprosthetic bone, characterized on serial radiographs as radiolucent lines and/or cavitation at the bone implant or cement bone interface.\textsuperscript{4,13,17}

Although traditionally it was called the Cement Disease, it has been agreed now that other particles, e.g., metal debris, polyethylene wear particles, bone fragments, are equally active in generating bone resorbing materials, through an inflammatory process.\textsuperscript{13,17}

The prevalence of Osteolysis has varied over the years, in the early 1990’s, with the UMHWPE sterilized in gamma irradiation in air, being the dominant poly liner used in THA, the rate of wear and Osteolysis did range from 10%-70%.\textsuperscript{9}

The degree of symptomatology varies from being completely asymptomatic to catastrophic failure with periprosthetic fractures with or without instability.

The task of the arthroplasty surgeon here lies in identifying the osteolytic process and developing a strategy of when and how to face the osteolytic challenge, in other words having the right choice(s) to deal with this problem.

The pattern of osteolysis differs between cemented and cementless acetabular cups.\textsuperscript{10,18}

In the cemented cup it’s usually a linear pattern that has been described, whereas in the cups that
have been inserted without cement, it’s an expansile pattern.\textsuperscript{10,18}

A layer of fibrous tissue usually gets formed around the cemented acetabular component which may provide to path of least resistance along the planes of the layer, leading to a linear pattern rather than an expansile pattern. There is also a halo of sclerotic bone that usually develops peripheral to a component encapsulated by fibrous tissue. This along with the fibrous layer may serve as a protective barrier to the expansion of the osteolysis to the more deeper, weaker porous cancellous layers of the acetabulum, the pubis & ischium.

These differences in the osteolysis between the cemented and cementless cups does cause a more symptomatic loosening of the cemented cups allowing the patient to present early to the surgeon before substantial bone destruction had taken place.

In contrast, the osteolysis in the cementless cups may present quiet late as symptom may not have developed, or earlier only if detected on serial follow up with radiological diagnosis only in an asymptomatic patient.\textsuperscript{10,18}

A classification system was proposed by Rubash, et al, for the uncemented cups based on the stability of he acetabular shell and the exchangeability of the liner.\textsuperscript{2,12,13}

1. Type I, is the well fixed cup with focal osteolysis and the poly liner is exchangeable, in these cases if the cup position is acceptable it could be retained with change of the head an poly liner as well as debridement of the osteolytic defect.

2. Type II, is a well fixed cup with focal osteolysis but the liner is not exchangeable, for example because the locking mechanism is damaged, shell is worn out or malpositioned, in these cases the entire cup need to be replaced.

3. Type III, is a loose cup requiring a complete revision.

The surgical choices that are available to the contemporary hip arthroplasty surgeons are
basically one of two options.\textsuperscript{2,4,6,10,14}

The first option lies in retaining the well fixed acetabular component, this certainly has it’s own advantages in terms of being a surgery of lesser magnitude as well as a less financial burden, quicker rehabilitation and return to proper functional level in a short time span.

It does carry a risk of limited liner options based on the availability of the liners from manufacturers if they still do exist. The risk of instability has shown to be higher in the cases that were treated with liner change only.

The other option is to revise the cup completely, obviously this is a more extensive surgery with higher associated risks and complications.

It does carry, in addition to all the risks of any revision surgery, a risk of incomplete Osseointegration, extensive bone stock damage, periprosthetic acetabular fracture or even pelvic discontinuity, but on the other hand it also has the advantage of using a larger cup with all the modern liner options, e.g, lateralized offset, harder bearing surfaces, and the ability to use larger head sizes to have a more stable reconstruct.

It might be the only option in certain situations, e.g, infection, gross malposition, loose acetabular component, completely worn out and damaged acetabular shell.\textsuperscript{2}

With both surgical interventions, addressing the osteolytic defect is of paramount importance, which involves aggressive surgical debridement and bone grafting using either autograft or allografts particulate material or bony substitutes.

At the time of surgery if retention of the cup was undertaken, the osteolytic defects could be accessed either through the screw holes or via trap door made in the ilium in the superoacetabular portion.\textsuperscript{13}
This is usually coupled with use of the more modern polyethylene liner that has a proven lower linear and volumetric wear rates, e.g., highly cross linked polyethylene liner.

Preoperative assessment work starts with AP Pelvis & Hip in supine position, with the hip in internal rotation, Judet views. 4

Assessing and quantifying osteolysis should be a critical part of the preoperative planning and preparation of revision Total Hip Arthroplasty.

The earliest hint to presence of osteolysis should arise from the presence of discrepancy in position of femoral head within the hip joint in serial X-rays.

This presence of asymmetric or symmetric wear should incite the surgeon to do a full extensive radiological work up looking for presence or absence of osteolysis.

Conventional X-rays should not be relied upon completely.

They commonly miss areas particularly the area posterior to the acetabulum, retroacetabular area particularly those of the posterior wall.

Conventional X-rays are unlikely to pick the smaller osteolytic lesions. They always tend to underestimate the defect. 16

In terms of imaging modalities to detect and quantify the osteolytic lesion, magnetic resonance imaging (MRI) is considered to be the most sensitive 95% and specific 98%, accuracy was found to be 96%. 16

The sensitivity for detecting lesions by commuted tomography (CT) scan is 75%, while for plain X-rays is 52%. 16

The location of the lesion did not affect the sensitivity of the MRI.

However the lesion size did correlate with the likelihood of it’s detection.

Lesions of sizes greater than 3.0 cubic cm were not missed by MRI.
Although Computed tomography (CT) Scan did also detect lesions greater than 3.0 cm\(^3\), MRI emerged to be the most effective study for detecting smaller size lesions, < 3.0 cm\(^3\).

Unlike in MRI, and just like the conventional radiography, the location of the osteolytic lesion did influence the detection likelihood by the CT scan.

The CT scan was more accurate in measuring the lesion volume compared to MRI.

Since most lesions of clinical concern are more than 3.0 cm\(^3\), both CT scan and MRI remain equally good for their detection rate, the choice of the appropriate modality by the treating surgeon remains a matter of cost control and the lesion location and how symptomatic the patient is. If on plain radiograph an osteolytic lesion is seen and the patient is asymptomatic than further choice of imaging could be done as preoperative planning tool rather than a diagnostic tool for detection of an osteolytic lesion.

Further preoperative work up in a patient with osteolysis who is being considered for surgery does include, a complete knowledge of the component(s) implanted, their manufacturer and availability of compatible liners or any alternate ones that could be still applied to the cup.

The locking mechanism of the implanted acetabular cup needs to be investigated.

In some instances the locking mechanism might have become defective or does not have a good enough track record.

If the availability of a compatible liner can not be guaranteed or the locking mechanism is defective or it’s efficiency is questionable, than alternative fixation method, e.g, cement needs to be considered.\(^{2,14}\)

The track record of the implanted cup is of paramount importance in preop decision making. For example, the modular ARTHROPOR cup (Joint medical products, Stamford,CT) has shown to be associated with delamination of it’s porous coating with 10.6% incidence.
Although infrequent but delamination has also been reported for Harris-Galante cups. Knowledge of the mode of sterilization and shelf life of the liner will help in assessing the overall quality of the liner.  

Intraoperative assessment is the most accurate and reliable method to assess for loosening of the acetabular component, it has to be circumferentially exposed along with the bony edges to assess their relation to each other to enable the surgeon to determine if it’s malpositioned or not. 

The assessment of loosening is determined by surgeon critically examining all areas of bony ingrowth or on growth surfaces as well as the presence of any tissues at the bone implant interface. 

Pressure should be applied firmly, through central axis of the acetabular cup either manually or with a help of acetabular pusher or inserter, or grasping the acetabular cup with a clamp through screw holes checking for any interface motion or expression of any fluid through the interface. Either of these findings do imply that the cup is loose and needs complete revision. 

**ISOLATED LINER EXCHANGE**

When this option is chosen by the surgeon several criteria should be met. 

The acetabular cup should be in an acceptable position and orientation to prevent instability. 

The compatible liners should be preferably available from the same manufacturer. 

Intraoperatively the surgeon may notice evidence of subtle malpositioning which he may try to correct by trialing various types of liners, e.g, lipped liner, lateralized (offset) liners, oblique liners, eccentric liners. If the instability cannot be corrected than the cup has to be completely revised. 

If the liners could be snapped in with the original intact locking mechanism that should be acceptable, alternatively the liner could be cemented into the preexisting well fixed cup. The cementation of the liner into the acetabular component requires that the liner should be smaller (undersized) than the cup to allow for a minimum of 2 mm in thickness of the cement mantle. ²,¹⁴

In cases of elderly patients with recurrent instability, who could be of high surgical risk, cementing a constraint liner remains a good salvage option. ²,¹⁴

The back of the liner and the inner aspect of the well fixed acetabular cup needs to be scored by a high speed burr to facilitate cement interdigitation.

It needs to be emphasized that the commonest side effects that has been reported by various authors in the literature is instability.

Beaule, et al., reported 22% of dislocation in their series of 32 hips in which a liner was cemented in to a well fixed socket.¹

Lie, et al., from reported 28% incidence of dislocation in their study of group of 1649 revision total hip arthroplasty from the Norwegian hip registry. ⁸

Their comparative groups of complete revision in patients with well fixed cup and/or the patients with completely loose cup had a lower chance of re revision.

On the contrary Blaha, reported on their group of 460 cases of revision THA, in 32 cases out of those, they decided to retain the liners, none of those 32 cases required further re revision.²

Few authors recommended using the direct lateral or anterolateral approaches for isolated liner change.

O,Brien et al., reported on their series of 24 THAs that were revised with isolated liner exchange with grafting of the defect, thru direct lateral approach, they had no dislocations. ¹¹
Wade et al., reported on their series of 35 THAs that were revised with isolated polyethylene liner exchange, performed through anterolateral approach, there were 2 dislocations only (6%).

Boucher et al., reported 25% dislocation in their series of 24 THAs that were revised with isolated polyethylene exchange only through posterolateral approach. Complete revision of the acetabular component had become much technically easier with less potential of bone loss.

The explant devices (Zimmer, Warsaw, IN), explant (Innomed, Savannah, GA), have facilitated the removal of acetabular cup without much damage to the host bone stock.

It consists of a pair of two curved osteotome blades (a superficial and a deep) in different sizes. Each pair has the same size diameter.

The first pass is usually by the more superficial blade through the implant bone interface followed by the passing the deeper blade of the same size.

The size of the blade pair is chosen based on the size of the acetabular cup that has been implanted. If screws are there than the liner needs to be removed 1st with liner removal instrument if available, alternatively a screw could be drilled through the liner to push it out from the acetabular cup, and the screw are removed.

A trial liner is than applied to the shell.

An explant with a trial head compatible with the inner diameter of the trial liner to be applied.

The explants does come with variety of commonly used trial heads, 22 mm, 26mm, 28mm, 32mm, 36 mm.

In summary, polyethylene wear and osteolysis remains one of the most common causes
of failure in contemporary THA. It remains the commonest cause of aseptic loosening in THA.
Early identification of poly wear and osteolytic lesion with the option of exchanging the liner may be a useful technique to prevent a more catastrophic failure.
Complete revision could be undertaken in late cases or cases in which the acetabular component is in unacceptable position, infected or damaged still remains an acceptable option.
The surgeon should weight theirs and benefit of both surgical options available to him and be fully prepared to alter the surgical course if the intraoperative findings did not support his original preoperative plan.
Even in cases of preoperatively planned isolated liner exchange only, full preparation must be undertaken to complete revision if it became evident that that’s the appropriate choice to be made.
Due to the higher incidence of dislocation with isolated liner exchange, anti instability measures should be adapted in terms of the surgical approaches and post op rehab and activity precaution.

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