



Prosthetic Joint Infection Following Total Hip Arthroplasty—Effect of Choice of Bearing Surfaces and How to Investigate Further—A Review of the Literature

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How to cite this paper: Saad, A. and Shahban, S.A. (2018) Prosthetic Joint Infection Following Total Hip Arthroplasty—Effect of Choice of Bearing Surfaces and How to Investigate Further—A Review of the Literature. *Open Access Library Journal*, 5: e4663. <https://doi.org/10.4236/oalib.1104663>

Received: May 17, 2018

Accepted: June 17, 2018

Published: June 20, 2018

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Abstract

Introduction: Total Hip Arthroplasty (THA) has proved to improve a patient's quality of life. This procedure has become more refined overtime, and subsequently there is huge variation in its execution. Prosthetic Joint Infection (PJI) remains a disastrous complication following this procedure. **Main body:** This article reviews the literature surrounding the various bearing surface options and fixation methods associated with the development of PJI. The current literature is reviewed to best describe how to investigate PJI following THA. **Discussion:** There is evidence supporting that no particular combination of articulating surfaces increases the risk of developing PJI. Cement, impregnated with antibiotics, has been proven to have a lower PJI rate over uncemented prostheses. **Conclusion:** Further research is required to best determine the optimum choice of bearing surfaces and fixation methods. If PJI is diagnosed, the cornerstone to its management is through a Multi-Disciplinary Team (MDT) approach.

Subject Areas

Radiology & Medical Imaging

Keywords

Prosthetic Joint Infection, Infection, Total Hip Replacement, Arthroplasty, Bearing Surfaces

1. Introduction

Total hip arthroplasty (THA) is an operation that has continued to evolve over-

time. When talking about the evolution of THA, one cannot forget to mention Sir John Charnley, who in the 1960's introduced low friction arthroplasty and whose research has led to the developments and novel techniques that we see today. Substantial amounts of research have been conducted to improve failure rates following THA, and even more so with the prevention of post-operative Prosthetic Joint Infection (PJI).

PJI is a serious complication following THA, which can have a significant impact(s) on patient morbidity, and, in some circumstances, can be fatal. With the best of efforts, the rate of developing PJI is between 1% - 2% of all cases [1]. Although the literature reports multiple obscure organisms which can cause PJI, the usual suspects for this complication continue to be *Staphylococcus aureus* and *Coagulase Negative Staphylococcus*, which have been shown to account for up to 50% - 75% of all cases [2].

Although many risk factors have been identified as contributing factors towards PJI, there is growing evidence which supports the theory that the choice of bearing surfaces and/or fixation method may influence this risk. When referring to the different bearing surfaces, the common options remain either metal-on-metal (MoM), metal-on-polyethylene (MoP), ceramic-on-polyethylene (CoP), or ceramic-on-ceramic (CoC). When choosing the fixation method and implanting one can choose to cement both acetabular and femoral components, without cement (uncemented), or to consider a hybrid approach. As of yet, there is no clear consensus to the ideal bearing materials and fixation methods.

2. Main Body

Bearing surfaces

One must not underestimate the importance of choosing bearing surfaces for THA. The choice from the various combinations available is an important one and one that can have significant lasting effects on the patient.

In a report by Madanat *et al.*, they analysed 177,237 cases of THA taken from the Australian Registry (AOAN-JRR), and concluded that, between 1999 and 2013, (CoC) bearings had a lower revision rate for infection when compared to both MoP and CoP. They also found no significant difference in infection rates between CoP and MoP articulating surfaces [3].

A similar study was undertaken in the USA between 2005 and 2014 and included a total of 315,784 elderly patients. This study, did not show a significant difference between CoC and CoP for PJI, but instead concluded that for primary THA with CoP and CoC bearings, there was significantly reduced risk of infection relative to MoP surfaces [4].

Hu *et al.* meta-analysed the literature and compared CoC and CoP only, focusing on the short-term to mid-term follow up. His findings concluded no significant difference between them with respect to loosening, revision and deep infection, following clinical and radiographic follow up [5]. Pitto *et al.* conducted a prospective study in New Zealand and demonstrated that the rate of

early PJI (<6 months) did not appreciably differ by bearing surface; however, in the long-term, CoC hips were associated with a lower risk of revision for deep infection when compared with CoP, MoP and MoM surfaces [6].

Despite the above, Hexter *et al.* conducted a systematic review and meta-analysis of 2272 studies and showed no significant difference between the combinations of articulating surfaces and the development of PJI [7].

Fixation methods

The choice between cemented vs. uncemented procedures has long been disputed by orthopaedic surgeons for both hemi and total hip arthroplasty. Cement has the added benefit of being able to be impregnated with antibiotics, with the aim of reducing the risk of PJI. However, bone cement implantation syndrome (BCIS) is only one of the recognised complications of using cement.

Engesaeter *et al.* analysed the Norwegian registry of 56,275 cemented and uncemented primary THAs, and showed a slightly reduced rate of infection when antibiotic impregnated cement was used [8]. Yoon *et al.* demonstrated an increase in rates of infection following cemented THA, however, no mention was made with regards to if the cement used was impregnated with antibiotics or not [9].

Bone cement during the preparation and implantation phases, reacts exothermically. This heat can lead to osteonecrosis, and ultimately lead to a breeding ground for organisms, a hypothesis put forward by Minakawa *et al.* [10].

PJI—how and when to appropriately investigate

The first stages in the management of suspected PJI requires a thorough history and examination of the patient. Further investigations, both non-invasive and invasive, can be executed accordingly depending on how likely the risk of PJI is deemed at every stage. At the onset of this suspected diagnosis, the patient should be managed with a Multi-Disciplinary Team (MDT) approach.

Haematological investigations are relatively easy to perform, have a quick turnaround time and are generally well accepted from the patient. Inflammatory markers can be of use when investigating for PJI, however a normal result(s) can be misleading. A raised Erythrocyte Sedimentation Rate (ESR) or C-Reactive Protein (CRP) is suggestive of PJI [11] [12].

When it comes to imaging, plain radiographs are frequently unhelpful when trying to exclude PJI [13]. Other studies such as Ultrasound, CT and MRI scans can be helpful when looking for specific diagnoses. Equally a bone scan may be of use when trying to look at cellular activity in relation to infection/oedema. One study by Love *et al.* has found that leukocyte/marrow imaging is especially useful when looking for a hip PJI. The theory behind this was that white cells (associated with infection/inflammation) would tend to accumulate at sites of infection [14].

Other studies have looked at 18F-fluoro-deoxyglucose Positron Emission Tomography (PET) and have shown promising results, however, more research needs to be done before this could become a routine mode of investigation [12].

Further to this, aspiration of the joint in question would be the next step in the investigation of PJI. Further analysis by mean of a White Blood Cell (WBC) count and a percentage of Polymorphonuclear (PMN) cells has shown to have 84% and 82% sensitivity, respectively [15]. If undertaking this procedure, the use of a blood culture bottle can help in the detection of slow growing organisms, and the time between obtaining the sample and sending it to the lab should not be delayed, as this can influence the results accuracy [16].

3. Discussion

When selecting bearing surfaces for THA, the jury is still out with regards to which combination will help to reduce the risk of PJI. PJI aside, their other factors to consider, namely wear properties, patient functional demand, metal allergy, implant availability, financial implications, and, what we are seeing more commonly, patient preference – points of importance and beyond the scope of this article.

The practice of using cement in THA is debated amongst surgeons. Our findings demonstrate that when trying to limit the risk of PJI, then one should consider using antibiotic impregnated cement, or not at all.

Early appropriate investigation is key in helping to diagnose PJI, and to give the patient the best chance of a full recovery. The key in trying to get to this diagnosis starts simply with a thorough history and examination, and early involvement of the MDT.

4. Conclusions

Several studies have looked into bearing surfaces as well as fixation methods to try and investigate their association with the development of PJI. The jury still remains out with regards to the bearing surfaces and fixation methods which reduce the risk of PJI. Consideration of PJI is important, as are the biomechanical properties attached to the different bearing surfaces availablely.

Whatever the bearing surfaces and/or fixation methods, PJI can and does still prove to be challenge for the responsible clinician. A thorough workup and MDT approach are the gold standard when it comes to managing such a patient.

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