

Symptomatic hip osteonecrosis is a disabling condition with a poorly understood aetiology and pathogenesis. Numerous treatment options for hip osteonecrosis are described, which include non-operative management and joint preserving procedures, as well as total hip replacement (THR). Non-operative or joint preserving treatment may improve outcomes when an early diagnosis is made before the lesion has become too large or there is radiographic evidence of femoral head collapse. The presence of a crescent sign, femoral head flattening, and acetabular involvement indicate a more advanced-stage disease in which joint preserving options are less effective than THR. Since many patients present after disease progression, primary THR is often the only reliable treatment option available. Prior to the 1990s, outcomes of THR for osteonecrosis were poor. However, according to recent reports and systemic reviews, it is encouraging that with the introduction of newer ceramic and/or highly cross-linked polyethylene bearings as well as highly-porous fixation interfaces, THR appears to be a reliable option in the management of end-stage arthritis following hip osteonecrosis in this historically difficult to treat patient population.

Osteonecrosis of the femoral head is a debilitating and potentially devastating condition that has a poorly understood pathogenesis and wide-ranging aetiologies. The most common risk factors are shown in Table I. The most commonly reported laboratory abnormalities include decreased function and concentration of fibrinolytic agents, as well as increased levels of thrombophilic agents. There is no universal consensus regarding the optimal algorithm that can be used to treat patients who have different stages of this condition (Fig. 1). However, non-operative management of hip osteonecrosis includes drugs such as bisphosphonates, anticoagulants, hypoliodemecs, vaso-dilators or non-operative procedures such as extra-corporeal shock wave treatment, pulsed electromagnetic therapy, or hyperbaric oxygen which have all shown efficacy in the reduction of pain, and improved function during early-stages of the condition. During early-stage disease, joint preserving procedures such as core decompression or percutaneous drilling may increase blood flow to the necrotic area by reducing the intra-osseous pressure, thus alleviating pain and improving function. Unfortunately, many of these patients commonly present when they have large lesions, or have progressed to collapse of the femoral head (Figs 2 and 3). In such cases, total hip replacement (THR) is the only option (Fig. 4).

The THR solution
THR is often the only reliable treatment in reducing pain and restoring mobility in patients who have collapse of the femoral head secondary to osteonecrosis. It is estimated that in the United States, approximately 10% of all THRs are performed for symptomatic hip osteonecrosis.

Historically, THR for osteonecrosis has quite poor results. During the 1980s and early 1990s studies by Cornell, Salvati and Pellicci, Stauffer and Chandler et al reported failure rates of between 37% to 53% at approximately five years follow up. These studies made use of ‘first-generation’ cementing techniques and older prosthetic designs. However, according to recent reports this is not the case in the new millennium.

In a systemic review of 67 studies that represented 3277 THRs for osteonecrosis of the femoral head in 2593 patients, Johannson et al reported that after the 1990s, survivorship of primary THRs were superior compared with those performed earlier, with a mean 97% survivorship at six years follow-up. These studies made use of ‘first-generation’ cementing techniques and older prosthetic designs. However, according to recent reports this is not the case in the new millennium.

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associated risk factors demonstrated significantly higher revision rates in patients who had sickle cell disease ($p < 0.001$), Gaucher disease ($p = 0.013$), or end-stage kidney failure and/or transplant ($p = 0.002$), and significantly lower revision rates in patients who had systemic lupus erythematosus, idiopathic disease, or after heart transplant. Tribological advances in the past two decades have led to the development of effective ceramic-on-ceramic and ultra-high molecular weight polyethylene bearings in THR. These bearings have low wear rates and show promise when used in patients with end-stage osteonecrosis at midterm follow-up. In a study of 73 THRs for osteonecrosis...
and at mean follow-up of 8.5 years (7 to 9), Kim, Choi and Kim\textsuperscript{44} reported 100\% survivorship (excluding infection) and mean linear wear of 0.05 mm/year (SD 0.02) using alumina ceramic heads on highly cross-linked polyethylene acetabular bearings. Similarly, in a study of 162 THRs with highly cross-linked polyethylene bearings, Min et al\textsuperscript{45} reported 100\% survivorship (excluding infection) and a linear wear rate of 0.037 mm/year (0 to 0.099) at a mean follow-up of 7.2 years (5 to 10.6).

Other long-term studies have also shown improved results compared with earlier reports. In a study of 148 THRs, Kim et al\textsuperscript{46} reported 98\% stem survivorship (cemented and cementless) but only 85\% cementless cup survivorship at mean follow-up of 17.3 years (16 to 18); the most common reason for revision was related to cup wear or loosening. Although, cup failure is more common than stem failure even in non-osteonecrotic THRs, Titanium or Tantalum highly-porous acetabular cups have shown excellent survivorship in non-osteonecrotic hips at short-term follow-up.\textsuperscript{47-49} For example, Naziri et al\textsuperscript{48} evaluated 288 cementless THRs performed using a highly-porous titanium acetabular cup in 252 patients and reported 100\% survivorship (excluding infection) at a mean follow-up of 36 months (24 to 56). Although longer-term studies are necessary to evaluate these acetabular components in the setting of osteonecrosis, promising stem and cup survivorships appears to be achievable.

Many studies have reported that the outcomes of primary THR have not been affected by previous hip joint preserving procedures at mid-term follow-up.\textsuperscript{50-55} Helbig et al\textsuperscript{56} demonstrated no complications or component loosening, at a mean follow-up of 54 months in series of 15 hips, that were converted to THR after they had previous core decompression. In a study of 15 failed trans-trochanteric rotational osteotomies that were converted to THR, Kawai-saki et al\textsuperscript{50} reported no significant differences in implant survivorship, stability, or Harris hip score\textsuperscript{57} compared with a matching group of 16 hips that had only undergone a primary THR at a mean follow-up of five years.

Ball, Le Duff, and Amstutz\textsuperscript{53} compared 21 failed hip resurfacings that were converted to a standard THR, with 64 standard THRs (both cohorts included osteonecrosis patients), and reported no differences in aseptic loosening, dislocations, Harris hip score or complications between the two groups. Issa et al\textsuperscript{39} evaluated 92 hips in 87 patients who had failed prior hip preserving surgery (35 hips that had previous resurfacing, 9 hips that had a hemi-resurfacing, 29 hips that had a non-vascularised bone grafting, and 19 that had a core decompression). These patients were
compared with 121 hips in 105 osteonecrosis patients who underwent THR and had no prior surgical interventions. At a mean follow-up of 75 months, they reported no significant differences in survivorship, clinical, and radiological outcomes among the groups.

THR for osteonecrosis in high-risk groups

As described earlier, patients who have sickle cell disease, Gaucher disease, or end-stage kidney failure and/or posttransplantation have been reported to be at an increased risk for revision following total hip arthroplasty.37 However, even in these high-risk groups, outcomes of THR have improved over time.58–60 Ilyas and Moreau58 evaluated 18 consecutive patients with a mean age of 28 years (17 to 39) who had undergone simultaneous bilateral cementless bipolar hip replacements. At a mean follow-up of 5.7 years (2 to 10) they reported that no femoral stem was revised. Issa et al43 evaluated 42 THRs for osteonecrosis in 32 sickle cell patients who had a mean age of 37 years compared with 102 THRs in 87 non-sickle cell osteonecrosis patients who had a mean age of 43 years. At a mean follow-up of seven years (3 to 10.5), they reported no significant differences in aseptic implant survivorship (95% versus 97%), Harris hip score (87 versus 88), and SF-36 physical (43 versus 44) or mental component scores (59 versus 58) between the two patient cohorts respectively.

Marulanda et al59 compared the outcomes of two types of peri-operative management (conservative or aggressive protocols) in three patients who had sickle cell anaemia and had undergone 31 separate orthopaedic surgeries for osteonecrosis of the femoral head. In the conservative protocol, patients received packed red blood cells pre-operatively to increase the haemoglobin level to a minimum of 10 g/dl. Fresh frozen plasma or packed red blood cells were given only when excessive bleeding occurred intraoperatively. In the aggressive protocol, patients received pre-operative packed red blood cells with the goal of keeping haemoglobin levels between 9 g/dl and 11 g/dl, and of lowering the haemoglobin S levels to < 30%. Fresh frozen plasma was given when patients’ Factor VII levels were less than 30%. They reported although both protocols were safe in managing these patients, the more aggressive protocol had resulted in lower rates of post-operative complications, transfusions, and the need to resort to supplementary oxygen.

Chang et al60 evaluated 74 hips in 52 patients who underwent THR for osteonecrosis of the femoral head after kidney transplantation with cementless THRs. They reported 96.6% cumulative implant survivorship at a mean follow-up of 10.2 years, which is comparable with survivorship due to other causes of THR. In light of these findings, the outcomes of THR even in these high-risk patients are improving, potentially due to improved medical and surgical management, as well as the use of modern prosthetic designs, including cementless acetabular and femoral fixation.59,62–67

Conclusion

In summary, there have been marked improvements in the current knowledge and management of osteonecrosis of the femoral head in recent decades. Patients who are at risk of developing osteonecrosis should be diagnosed early, mainly because small or medium-sized pre-collapse lesions may be treated with non-operative and joint preservation procedures. Unfortunately, many patients present with late-stage disease when the joint is not salvageable and likely to require a primary THR. It is encouraging that with the introduction of the newer ceramic or highly cross-linked polyethylene bearings as well as highly-porous fixation interfaces, THR appears to be a reliable treatment option for management of end-stage arthritis following hip osteonecrosis in this historically difficult to treat patient population.

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References
