Osteonecrosis of the femoral head: Etiology, imaging and treatment

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Received 8 March 2007; received in revised form 9 March 2007; accepted 12 March 2007

Abstract

Osteonecrosis of the femoral head is a disabling clinical entity affecting young adults that usually leads to destruction of the hip joint. A high index of suspicion is necessary for the diagnosis due to the insidious onset of the bone infarcts and the lack of specific clinical signs at the early stages. Many etiology-associated factors have been identified reducing thus the number of idiopathic cases. A number of joint salvaging treatment options are available if early diagnosis can be achieved. MR imaging has been proved to be a highly accurate method both for early diagnosis and for staging of the disease. Replacement of the hip joint is the last resort for pain relief and function, although non-desirable because of the young age of the affected population.

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Keywords: X-ray/diagnosis; MR imaging/diagnosis; Osteonecrosis; Avascular necrosis; Femoral head; Surgery; Hip

1. Introduction

Osteonecrosis or avascular necrosis of the femoral head, a recalcitrant disease characterized by death of the osteocytes and the bone marrow, is caused by inadequate blood supply to the affected segment of the subchondral bone. It has also been called “the coronary disease of the hip” by Chandler as the disease simulates the ischemic condition in the heart [1]. Immediately after the ischemic insult the osseous tissue initiates a repair process with osteoclastic resorption of the dead trabeculae and apposition of new bone. The normally functioning joint undergoes fatigue failure of the weakened resorbed trabeculae with subsequent fracture which results in collapse of the subchondral bone, pain, and limitation of hip function.

Osteonecrosis of the femoral head (ONFH) most commonly affects young adults in the third and fourth decade of their life. It is currently diagnosed with an increasing incidence: every year 10,000 to 20,000 new cases are diagnosed in the USA [2,3] and it is believed that 5–12% of total hip arthroplasties each year are performed to treat this disease [2,4]. Although one femoral head is initially affected, bilateral involvement in two years may reach up to 72%. With the exception of patients diagnosed with systemic lupus erythematosus (SLE), the disease affects mainly men with a ratio of 7/3 in relation to women [5]. The disease is characterized by an insidious onset without specific clinical symptoms and signs. A poorly localized and vague ache around the hip joint, at the lower pelvis, the medial aspect of the thigh and at the buttocks should always raise suspicion of ONFH. Subsequently, this may lead to early diagnosis, prior to articular surface collapse.

It has been estimated that 30% of the patients with collagen diseases and sickle cell anemia, will develop osteonecrosis of the femoral head in their lifetime. Considering that the non-traumatic etiology ONFH affects mainly patients at risk, such as organ transplant recipients, those receiving steroids, patients with SLE, coagulopathy and dislipidemias, the treating physicians need to be aware of this clinical entity and its absence of specific early complaints. The current paper will review the established knowledge on the etiology, imaging and treatment strategy, in patients suffering from ONFH.

2. Etiology of osteonecrosis of the femoral head

Patients diagnosed with osteonecrosis can be divided into two groups: (a) patients with no apparent etiologic or risk factor and
(b) patients with clearly identified etiology. Thus, osteonecrosis can be idiopathic (primary) or secondary. Diagnosis of idiopathic osteonecrosis nowadays is less frequent than it used to be as more causative factors have recently been identified. A number of diseases or pathological conditions are now associated with ONFH including trauma or surgery at the hip, hypercortisonism, hyperlipidemia, dysbaric phenomena, autoimmune diseases, endotoxic reactions, smoking, alcoholism, clotting disturbances, and hypofibrinolysis, that may cause increased tendency for intravascular coagulation (Table 1). In cases of trauma, the resulting osteonecrosis is better understood as the vascularity around the femoral head is severely disturbed. In patients with a subcapital fracture, vascularity of the femoral head depends only on the perfusion from the ligamentum teres which normally provides the blood supply to 10–20% of the femoral head. In patients with a hip dislocation, blood supply from the ligamentum teres is interrupted and perfusion of the femoral head depends on the severity of the injury of the retinacular vessels around the dislocated head and the pressure of the intracapsular hematoma. Surgery for pelvic or acetabular fractures can also be a cause for ONFH as the nourishing vessels of the head may be injured or may need to be cauterized.

In non-traumatic cases, despite progress in the diagnosis of the disease, a definite causative mechanism has not yet been recognized or generally accepted. Genetic risk factors have been identified such as heritable coagulation disorders, hemoglobinopathies and lipid storage diseases. Intravascular coagulation appears to constitute the most commonly encountered pathogenetic mechanism through which various unrelated risk factors lead to ischemia and subsequent death of bone and marrow cells [6]. Both thrombophilia (increased tendency for thrombosis), and hypofibrinolysis (reduced ability to dissolve thrombi) cause intravascular coagulation and have been associated with ONFH. There are studies though which have not been able to reach the same conclusion. Mutations of factors in the normal coagulation pathway have been shown to increase coagulability and tendency to thrombosis [7–11].

Pathogenesis of ONFH is multifactorial. Certain etiologic factors are able to cause the disease by virtue of their action alone, whereas others may have synergistic action with endogenous or exogenous agents.

3. Imaging

Regardless of the cause, the compromised blood supply to the femoral head leads to ONFH. The role of imaging has multiple aims: to rule out disorders presented with painful hip that may mimic ONFH, to confirm a clinically suspected ONFH in high risk patients, to investigate multiple skeletal ONFH locations, to stage the disease for optimal treatment planning, to monitor the treatment and to depict any complications of the disease or the treatment.

3.1. Conventional radiology and scintigraphy

Plain radiographs have been for long the basic imaging investigation for identification and staging of ONFH [12,13]. The radiographic findings include:

(a) Sclerosis surrounding an osteopenic area (Fig. 1). The sclerotic rim is a reactive bone remodeling at the necrotic-viable osseous junction. This pattern characterizes the stage II according to the modified Ficat–Arlet, Steinberg’s and ARCO systems.

(b) A crescent lucent subchondral line resulting from a subchondral fracture (Fig. 2). The presence of the “crescent” sign in the absence of segmental flattening, classifies the lesion as stage III in all major staging systems.

(c) Segmental flattening of the femoral head with or without joint space narrowing and secondary osteoarthritis (Figs. 3–5). This pattern is consistent with advanced ONFH.
Fig. 1. A young adult male patient with a history of renal transplantation and right hip pain for the last 3 months. The plain radiograph shows a sclerotic rim (arrows) surrounding a lysis which corresponds to the necrotic area.

When plain radiographs demonstrate subchondral collapse, further imaging is only required for the opposite hip.

Although still considered the basic initial imaging for suspected ONFH, radiographs exhibit high specificity for advanced disease but low sensitivity for early disease. Depiction of early disease is important since early diagnosis is directly associated with prognosis. Bone scintigraphy with $^{99m}$Tc-methylene diphosphonate, shows high sensitivity for early detection since the radionuclide activity reflects osteoblastic activity and blood flow which are absent in ONFH [14,15]. For symptomatic disease the method is able to provide positive findings in 2–3 days after the onset of symptoms (“cold within hot”) and later “hot lesion” reflecting revascularization (Fig. 6). However, for the asymptomatic ONFH there are not many available data to suggest the diagnostic usefulness of the method. In addition, bone scintigraphy suffers from important limitations such as radiation dose, poor spatial resolution, inability to accurately discriminate the lesion from other disorders and inability to quantify the lesion and therefore to contribute to prognosis estimation. It remains though the only imaging modality yet, that can depict multi-focal osteonecrosis of the skeleton.

Fig. 2. Patient with idiopathic hip osteonecrosis. The frog leg radiograph shows the lucent “crescent” sign (arrows) which represents a subchondral fracture. The femoral head contour is intact.

Fig. 3. A middle-aged male patient with right hip osteonecrosis and recent deterioration of pain. (a) The plain radiograph shows the reactive sclerotic rim surrounding the lytic necrotic area (thick arrow), the subchondral fracture (small arrow) and a segmental articular collapse (long arrow) in keeping with advanced osteonecrosis. The joint space width is normal. (b) The patient underwent total hip replacement 4 years later. The sagittally sliced gross section of a femoral head obtained at surgery, shows the subchondral fracture (crescent sign) (arrows).
3.2. MR imaging

MR imaging is considered the method of choice for detecting and staging the ONFH due to its multiplanar imaging, superb soft tissue contrast and ability to discriminate fat from other tissues in the bony marrow [15–17]. MR imaging achieves excellent sensitivity for early ONFH detection [18,19]. In one study, MR imaging achieved a sensitivity of 100% as opposed to 81% for scintigraphy [20]. A circumscribed subchondral “band-like” lesion with low signal intensity on T1-w images is pathognomonic [14]. This finding is not depended on the plain radiograph being normal or suggesting ONFH (Figs. 7 and 8).

The “double-line” sign is seen on T2-w Spin Echo or Turbo Spin Echo sequences and consists of a low signal intensity outer rim and a high signal intensity inner rim (Fig. 9). This sign was introduced by Mitchell et al. [14] and was considered pathognomonic for ONFH since the outer rim represents the reactive bone and the inner rim the vascular and repair tissue at the necrotic-viable osseous interface. This sign was present in 80% of the lesions but in that study no correlation with the radiographic stage was attempted. The region within the “double-line” sign may demonstrate hypo-, iso- and hyperintensity relative to the normal marrow. According to the signals on T1-w and T2-w images, a classification scheme was proposed, ranging from class A (fat) to class D (fibrous tissue) [14]. This scheme though was not ever used widely as it did not correlate with radiographic staging, clinical presentation and prognosis. The etiology of the “double-line” has been challenged in the literature. It has been reported that a transposition of the frequency and phase-encoding axis results in reversal of the positions of the bright and dark rims, suggesting the presence of a chemical shift artifact (Figs. 10 and 11) [21–23].

Chemical shift artifacts are due to protons in fat being mismapped relative to water protons. Due to small differences in precession frequencies between water and fat protons, signals from different chemical structures may occupy different positions in the image, even if the signals originate from the same spatial position [24]. It can be only notified on the frequency encoding direction axis for all the Spin Echo (SE), Turbo (Fast) SE and the in-phase GRE sequences. Chemical shift artifacts, due to their nature, are more prominent in higher field strengths and can be reduced or eliminated by (a) increasing the receiver bandwidth settings, (b) increase pixel size and (c) by introducing chemical saturation slabs (chemical fat sat) or use inversion...
Fig. 7. Young adult patient with symptomatic osteonecrosis of the left hip. (a) The plain AP radiograph of the asymptomatic right hip joint looks unremarkable. (b) The coronal T1-w Spin Echo MR image shows the typical for osteonecrosis “band-like” sign with a low signal intensity rim surrounding the necrosis (arrow).

Fig. 8. Symptomatic osteonecrosis of the left hip. (a) The plain AP radiograph shows a poorly defined subchondral sclerosis (arrow). The actual margins of the lesion cannot be determined accurately. (b) The coronal T1-w Spin Echo MR image shows the “band-like” sign surrounding the necrosis (arrow).

Fig. 9. The “double-line” sign in a patient with a history of corticosteroid administration. The axial T2-w Turbo Spin Echo MR image shows bilateral osteonecrosis with the typical low signal intensity outer rim and the high signal intensity inner rim (arrows). Joint effusion is seen in both hip joints.
Fig. 10. The axial T2-w Turbo Spin Echo MR image with shifted frequency encoding axis compared to Fig. 9, shows the low signal intensity representing the outer rim medially (small arrow) and the inner rim laterally (arrow). The reverse is seen with the high signal intensity rim. The whole appearance is compatible with a chemical shift artifact.

prepulses and appropriate TI’s in IR sequences (Figs. 11 and 12) [25,26]. With the wide availability of high-field MR scanners, T2-w images are no more acquired with SE but with the faster Turbo (Fast) SE sequences. The sequences with increased echo train length, suffer from an inherent artifact, the “bright” fat due to the JJ-coupling effect [27]. Therefore, these sequences are usually combined with spectral fat saturation and thus the “double-line” sign is not seen anymore but manifests instead as a “bright band-like” sign. The “bright” line corresponds to the vascular and repair tissue in the periphery of necrosis and is evident in fat suppressed turbo (fast) T2-w and contrast-enhanced T1-w images (Fig. 12). In conclusion, we suggest that the “double-line sign” has the characteristics of a chemical shift artifact. However, the artifactual origin of the “double-line sign” does not reduce its diagnostic value for ONFH diagnosis for those who apply conventional T2-w SE or non-fat suppressed Turbo (Fast) SE sequences.

Joint effusions are seen in about half the patients with ONFH regardless of the presence of articular surface collapse [28]. Although not yet clarified, joint effusion might result from an ONFH-related synovitis (Figs. 9, 12 and 13). Joint effusions are correlated with pain and are commonly found together with bone marrow edema [29]. An old observation that patients with ONFH demonstrate red to yellow femoral neck marrow conversion was not confirmed by other studies [30]. Lesions of limited size in asymptomatic patients, who have normal radiographs, might undergo spontaneous resolution [31].

A basic MR imaging examination to rule out ONFH and to detect other disorders should include coronal T1-w and coronal STIR sequences with large field of views. In case of marrow abnormalities, small field of view focused in the abnormal area with fat suppressed T2-w and cartilage specific sequences should be applied. Contrast enhancement provides increased signal to noise ratio which allows for images with increased spatial resolution. In the absence of any other finding, contrast enhanced images show enhancement at the reparative interface (Fig. 12b). Contrast studies may also be useful for preoperative evaluation of the femoral head contour and for monitoring a vascularized graft. Small field of view images obtained with phased array coils, should be tailored to multiple planes, the oblique axial included as being useful for evaluating the anterosuperior surface. Early studies [32,33] showed that decreased enhancement occurs in the necrotic femoral head marrow, but this was not widely accepted as an additional imaging finding of hip ONFH.

3.3. Bone marrow edema

The presence of bone marrow edema (BME) in MR imaging, has been a source of controversy in the literature. Distinction between reversible and ONFH-related BME is of crucial importance because ONFH is a progressive clinical entity requi-
Fig. 12. A 45-year-old male patient with a history of lymphoma and pain in the left hip. (a) The fat suppressed T2-w Turbo Spin Echo coronal MR image shows bone marrow edema in the left hip (long arrow), an osteonecrotic area subchondrally and joint effusion. The high signal intensity “band-like” rim in the asymptomatic right hip (small arrow) corresponds to an early osteonecrosis. The contrast enhanced fat suppressed high resolution T1-w Spin Echo axial oblique MR images show the enhancing rim surrounding the ischemic area in the asymptomatic right hip (arrow in (b)) and the enhanced bone marrow “edema” in the left hip (c). In the left hip, there is also synovitis and joint effusion (arrow), low signal intensity of the necrotic area as compared to the asymptomatic side (small arrow) and a thin enhancing linear structure representing the subchondral fracture (thin long arrow).

ing a joint preserving treatment whereas transient osteoporosis resolves spontaneously and surgery is unnecessary. The presence of BME in ONFH seems to correlate highly with pain (Figs. 12 and 13) [34]. BME was considered for long to represent the early phase of the disease, with subsequent evolution into definite ONFH [28,35–37]. The BME though, in the absence of subchondral lesions seems to almost always correspond to hip transient osteoporosis [38,39]. Transient osteoporosis is almost always unilateral and the subchondral lesions that might exist are thin and short, probably representing trabecular insufficiency fractures which never proceed to form a circumscribed band [38].

It has been shown that patients with ONFH of the femoral head do not show MR imaging findings of BME in the early stages of the disease [40]. In another study presenting early findings in ONFH, BME was never found before the appearance of the “band-like” sign. The latter seems to represent the initial osteonecrotic change (Figs. 7 and 12) [41,42]. Further studies showed that BME is a poor prognostic sign since it develops after the onset or worsening of hip pain and correlates with the subsequent collapse of the femoral head suggesting progression to advanced ONFH [29,40,43,44]. Contrast enhanced images show persistent and homogenous enhancement of the BME area regardless the cause. It should be stressed though that in transient osteoporosis, enhancement is delayed and extends up to the subchondral bone [39,45] whereas in ONFH there is no enhancement of the necrotic area circumscribed by the “band-like” sign (Figs. 12 and 13). Diffusion weighted imaging does not seem to offer significantly in the differential diagnosis of BME in the hip since non-restricted diffusion seems to occur in both the ONFH and transient osteoporosis [45]. Further studies are required to address the value of this technique with quantitative evaluation of the apparent diffusion coefficient maps.
3.4. Quantification, staging, prognosis and postoperative monitoring

Many studies have shown that the size of necrosis is important in predicting whether a fracture and further joint destruction will occur [46–48] (Fig. 14). Methods of quantification vary from simple to sophisticated, requiring advanced software [49,50]. Limited data exist on the reproducibility and interobserver variation of these quantitative techniques [51]. Early attempts to quantify the size and location of the lesion with radiographs were not widely applied [52]. Indeed, the size of the lesion on plain radiographs is often difficult to assess and might not correlate with its actual size on MR imaging (Fig. 8). The extent of femoral head involvement has been estimated with MR imaging as percentage of the weight-bearing area [53], index of necrotic extent [47], and absolute necrotic volume [49]. The location of the lesion is also very important for further deterioration or not [50]. A study published in the current issue based on ONFH hips treated with vascularized grafting, showed that volume analysis may contribute to a simple classification schema for assessing prognosis [50].

Another study published in the current issue showed that MR imaging with its multiplanar imaging capability, is superior to plain radiographs for detecting the femoral head collapse [54]. This is important in terms of accurate treatment planning. With regard to the presence of subchondral fractures, one study showed that MDCT is superior to MR imaging [55]. In the postoperative patient, MR imaging may depict occult insufficiency fracture following a core decompression. It has been found that patchy areas of enhancement within the necrotic subchondral area, is an indication of repair [35]. In keeping with this, we have found contrast studies to be particularly helpful for monitoring the incorporation of a vascularized graft and revascularization of a previously necrotic area (Karantanas, unpublished data) (Fig. 15).

3.5. Multiple sites of involvement

MR imaging is able to depict ONFH lesions in high risk asymptomatic patients [16,19]. Whether asymptomatic patients at risk should be screened, is still not clarified. Symptomatic patients though who have already a diagnosis of ONFH, should be evaluated with MR imaging. A single T1-w sequence in the coronal plane is able to rule out ONFH, reducing thus the cost of
Fig. 15. Plain radiographs and contrast enhanced fat suppressed T1-w axial oblique Spin Echo MR images of a 24-year-old male patient with hip osteonecrosis treated with vascularized fibular graft. (a) The 3-month postoperative plain radiograph (bottom) shows the graft (long arrow) extending up to the necrotic area. The corresponding MR image (top left) shows the graft (long arrow), the enhancing bone marrow edema (thick arrow), and the enhancing rim (short arrow) surrounding the necrotic subchondral lesion. (b) The 6-month postoperative plain radiograph (bottom) shows no change in the graft (arrow) but the previous necrotic area shows some increased sclerosis (black arrow) in keeping with deterioration. Clinically the patient was improving. The corresponding MR image (top right) shows the normal incorporation of the graft with surrounding enhancement (arrowheads), reduction of the bone marrow edema and revascularization of the previously necrotic lesion (thin arrow) with associated reduction in the size of the low signal intensity necrotic bone (thick arrow). The MR findings suggest reversion of the osteonecrotic process.

A rapid (<1 min) MR imaging protocol has been successfully applied for screening femoral head ONFH [56]. For full body screening, this method achieves agreement with the regular examination in 99% of lesions [57]. This high sensitivity results from advances in software, phased array coils and hardware including moving table facility.

4. Treatment options

Management alternatives for ONFH vary from joint salvaging procedures including electrical stimulation, proximal femur rotational osteotomy, core decompression sequestrectomy and replacement with bone cement, non-vascularized cancellous or cortical bone grafting of the lesion, muscle-pedicle bone grafting, and free vascularized fibular grafting. The most commonly used procedures are rotational osteotomy, core decompression, and free vascularized fibular grafting. Factors affecting the out-
come of these procedures include patient’s age, etiology and stage of osteonecrosis, and size and location of the osteonecrotic lesion [58–72].

Preservation of the femoral head with osteonecrosis depends on prevention of collapse of the structurally compromised necrotic bone. Non surgical management with partial weight bearing can only be selected for early stages and very small lesions. Even in those cases, it has been proved ineffective in 80–90% of patients [59,73]. Other conservative treatment options include hyperbaric oxygen, biphosphonates, aspirin, and lipid clearing factors [68]. A meta-analysis of studies with core decompression or conservative treatment [66] demonstrated success rates (defined as no further surgical intervention) of 61%, 59% and 25% for conservative treatment of osteonecrosis stages I, II and III, respectively, according to Steinberg’s classification [63]. Core decompression, one of the least invasive surgical procedures, may be efficacious in early stages and small size lesions of osteonecrosis, although concerns were raised because of its potential to weaken the cancellous bone within and adjacent to the necrotic area(s) [58,62,66,74]. Finite-element models have demonstrated that core drilling of a lesion could have major implications for the structural integrity of the head [75,76]. On the other hand, core decompression that was originally performed as a diagnostic procedure has been advocated as a technique capable of interrupting the disease process when performed before subchondral collapse. The meta-analysis that evaluated studies with core decompression [66] technique or conservative treatment for femoral head osteonecrosis, demonstrated that further surgical intervention was necessary in 16%, 37%, and 71% after core decompression of osteonecrosis stages I, II and III, respectively, according to Steinberg’s classification [4]. The best results of this procedure can be expected in osteonecrotic femoral heads with segmental lesions (intact lateral pillar), prior to collapse and with radiographic signs of sclerotic bone [77].

Cortical bone grafting of the femoral head may offer structural reinforcement, particularly if the graft penetrates deeply into the superocentral or lateral aspect of the lesion [76]. The rationale for vascularized bone grafting for osteonecrosis in Steinberg stages II–V includes femoral head decompression that may interrupt the cycle of ischemia and intraosseous hypertension; removal of the sequestrum that could inhibit revascularization of the femoral head; filling of the surgically created defect with cancellous graft, periosteum and a viable cortical strut, to support the subchondral area with cal- lus formation and restructuring of the core of the femoral head [49,61,62,65,67,70,74,75,77,78].

Recently trabecular metal rods implanted in the femoral head with or without the addition of autologous growth factors have been advocated as an alternative to prevent collapse in stages I–III. Because of the surface characteristics (pore dimensions and 3D structure similar to the cellular structure of bone) of these metal implants, high volume bone ingrowth is encouraged and collapse is prevented.

Finally, procedures such as osteotomies aim to the alteration of the weight-bearing zone of the acetabulum to the necrotic portion of the femoral head, by displacing the affected area of the femoral head. Several osteotomies have been described (flexion, varus, valgus and rotation, intertrochanteric and subtrochanteric) to reduce the loading forces to the necrotic lesion, with limited success rates [60,67,79]. Sugioka reported an 82% survivorship rate in a 14-year follow-up series [64].

Biologic augmentation is an adjunct to all femoral head preserving procedures. The use of bone morphogenic proteins and the transplantation of autologous cultured mesenchymal stem cells (MSCs) are the most recent tools that may aid healing and increase the success rate of salvage procedures [80,81]. However, the most appropriate carrier to contain the growth factors or the MSCs to be implanted has not yet been standardized.s

The benefit from the aforementioned procedures, which may prevent or at least delay total hip arthroplasty is important since preoperative diagnoses of osteonecrosis and young patient age are independent risk factors for total hip arthroplasty failure [82].
4.1. Total hip arthroplasty

Total hip arthroplasty (THA) in patients with ONFH has the most predictable outcome in terms of pain relief and function [80, 83, 84]. Indications of THA are not well defined but it should be considered as the procedure of choice in circumstances such as (a) ONFH with advanced secondary osteoarthritis, (b) necrotic lesions on the acetabular side in association with head collapse and (c) Ficat stage IV in older patients [80, 84]. Middle age patients with variable head involvement are in a gray zone where THA is one of the various procedures that could be proposed.

The most controversial issue is the durability of the THA in the ONFH population as patients are mostly affected in their third or fourth decade of life. Several authors reported that survivorship of THA in ONFH is inferior when compared to the general population [85]. This is likely attributable to the age of this group, the gender distribution and the underlying diagnosis [86–88]. Whether osteonecrosis per se leads to inferior implant to bone fixation remains uncertain [83]. Ethanol abusers, corticosteroid use, SLE or organ transplant patients had worse results than those with osteoarthritis while patients with idiopathic ONFH did not. All-cemented prostheses tend to fail in a higher rate than in patients with osteoarthritis but with modern hybrid third generation cementing techniques, improved results have been reported. Recent studies with contemporary uncemented designs reported results comparable to the general patients population [89, 90]. Complication rate has been also higher in ONFH population treated with THA. Certain subgroups among these patients are in increased risk of infection especially patients suffering from sickle cell disease or SLE and patients with immunosuppression [91, 92]. Ethanol abusers are in an increased risk of dislocation [83, 86]. Intraoperative complications due to bone geometry and quality in sickle cell disease and patients with renal failure and severe soft tissue complications in SLE patients are also a great concern [92, 93]. In patients with Steinberg stage III, femoral involvement and younger age hip resurfacing or hemi-resurfacing as well as conventional hemic-arthroplasty have been employed as time buying procedures with limited success. Great caution is needed for the selection of candidates for hemisurface and total surface procedures. According to Beaule et al., osteopenia and large (>1 cm) cysts on the femoral head, constant findings in ONFH patients, are the main risk factors for loosening of the femoral component [94]. Secondary osteoarthritis changes in the acetabular side has to be ruled out in hemisurface procedures while loosening of the femoral component and femoral neck fractures are the main concerns regarding the surface procedures [95] awaiting new materials and further evaluation from larger series and longer follow up. Pain relief and functional outcome is consistently inferior with hemisurface procedures comparing to THA [96].

In summary, THA in patients with ONFH provides excellent results in terms of pain relief and functional improvement, while survivorship might be impaired and complication rate might be higher due to high functional expectations in these subgroups and the demographic distribution of these patients. Hemisurface and total surface procedures, although challenging, have not been proved equally successful as THA.

5. Conclusions

With regard to imaging, either with plain radiographs or with MR, the most important information that the clinicians require, include: (1) estimation that the lesion is not associated with collapse, (2) the size and location of the necrotic segment, (3) in case that the lesion has collapsed, it is useful to evaluate the degree of femoral head depression, and (4) evidence of the acetabular involvement with signs of secondary osteoarthritis. Challenging roles for MR imaging include contribution to accurate staging by evaluating the degree of collapse, investigation for multiple skeletal involvement and monitoring the surgical treatment.

References


