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ORIGINAL STUDY

Endoscopically assisted core decompression in avascular necrosis of the femoral head

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The authors have used bone endoscopy (medulloscopy) to improve the accuracy of the conventional technique for core decompression and grafting in 36 hips with avascular necrosis of the femoral head. Endocopy was found to facilitate debridement of the necrotic bone and to decrease the risk of perforation of the cartilage during debridement. The endoscopy-assisted technique failed, however, to improve the final outcome of core decompression and grafting in more advanced stages of osteonecrosis. Based on this experience, the authors do not recommend core decompression, with or without endoscopic assistance, in advanced stages of avascular necrosis, but they suggest using endoscopic assistance during decompression in small-size lesions.

Keywords : hip osteonecrosis ; core decompression ; endoscopy ; medulloscopy.

INTRODUCTION

It is generally accepted that, without specific treatment, 70 to 80% of hips with established avascular necrosis (AVN) will show clinical and radiographic progression (*14*). Accordingly a number of prophylactic procedures have been used in an attempt to halt the progression of the disease (*4,9,13,18,27*). The most frequently used procedure worldwide is core decompression. Both very good and unacceptable outcomes have been reported in literature for core decompression (*6,7,14,25, 26,27*). Following the initial description by Arlet and Ficat in 1968 (*1*) recent publications have reported a poor outcome, especially in advanced AVN and large lesions in the femoral head (*6,13,27*). Biplane fluoroscopy (*4,13*), intra osseous pressure measurement (*6,7*), intra-osseous venography (*7*) and computer assisted placement of the core track have all been used to increase the precision of the procedure and to intra-operatively establish the diagnosis of osteonecrosis.

Hip arthroscopy has also been used to make the distinction between early pre- collapse and collapsed stages (*23*). To the best of our knowledge no paper so far has described the use of bone endoscopy (medulloscopy) to improve the surgical precision of core decompression (*3,17*). The first purpose of our study was to examine the endoscopic anatomy of the core track during core decompression. The second purpose was to find out whether small lesions in the femoral head were

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more easily found using endoscopy of the core track. The third purpose was to document and reduce the risk of blow-out and cartilage perforation during core decompression. The fourth purpose was to find out if arthroscopy-assisted impaction grafting of the necrotic area in the femoral head would prevent disease progression and femoral head collapse. The final purpose was to find out whether endoscopy of the core track would improve the success rate of core decompression.

MATERIAL AND METHODS

Thirty-six hips (27 patients) with established osteonecrosis were included in this retrospective single-surgeon study. The osteonecrosis was steroid related in 11 patients, idiopathic in 5 patients and related to alcohol intake in 11 of the patients. All patients underwent a similar surgical procedure. Antero-posterior and frog lateral radiographs were taken pre-operatively, at one and six weeks post-operatively and subsequently every four months. All standard radiographs were graded by the method of Ficat *(1,7)*. In addition, the lesion size was quantitatively assessed by the ARCO classification system for osteonecrosis *(24)*. A pre-operative MRI scan was available in 27 patients. Radiographic failure was defined as a progression in Ficat stage or a progressive collapse of more than 2 mm. Failure rates were estimated using Kaplan-Meier survival analysis of the hips. Clinical failure was defined as the need for total hip arthroplasty.

Videotape and video prints of the endoscopic views were recorded. The operating records and video recordings were searched for intra-operative complications like cartilage perforation, femoral head blow-out, intra-operative femoral crack or fracture, excessive bleeding or inability to endoscopically localise the necrotic zone.

Surgical technique for core decompression of the hip

Patients were positioned supine on a standard traction table. The fluoroscopy monitor was positioned on the contralateral side and the endoscopy tower on the ipsilateral side.

Cancellous bone grafts were first harvested from the outer table of the anterior iliac crest using an acetabular reamer, a technique originally described by Sanders *(2,21)*.

The vastus lateralis ridge on the lateral aspect of the proximal femur was localised under fluoroscopy control. A longitudinal incision was made over the lateral aspect of the proximal femur, extending distally no more than 5cm from the vastus lateralis ridge. The incision was slightly more distal in obese patients, to allow correct orientation of the core track, which should be approximately 120° to the long axis of the femoral shaft. After cleavage of the subcutaneous fat, the fascia lata was split in the direction of its fibres. The conjoint tendon was located with the examining finger. The posterior origin of the vastus lateralis muscle was split in an L-shaped fashion to expose the lateral femoral cortex. A narrow blunt Hohmann retractor was used to retract the muscle belly of the vastus lateralis, anteriorly. A tissue-free access to the lateral femoral methaphysis is necessary to prevent interference of the soft tissue with the scope. This is facilitated by insertion of a narrow sharp retractor which is manipulated posteriorly to penetrate the dorsal margin of the origin of the vastus lateralis.

A threaded guide wire was inserted into the lateral femoral cortex distal to the vastus lateralis ridge. Care was taken to avoid making a distal entry portal at the level or below the level of the lesser trochanter, to avoid creating a stress riser *(1,17)*.

As the necrotic lesion in the femoral head is usually located anteriorly, a slightly posterior entry portal in the coronal plane was chosen to avoid overdrilling the anterior femoral neck. The threaded guide wire was inserted into the estimated necrotic area under fluoroscopy control, both in the anterior-posterior and lateral view. A 7 mm cannulated drill, normally used for ACL-reconstruction (ARTHREX, USA), was inserted over the guide wire. A 7-mm drill hole was created into the necrotic area ; a 9-mm tunnel was created in large size femoral heads. The core track was washed out using pulsatile lavage to decrease the intramedullary bleeding. A 0° straight 5 mm laparoscope (STORZ, Germany) was inserted into the core track, to check if the necrotic area was reached and the cartilage was not perforated.

If the necrotic area was not found, a second 7 or 9-mm tunnel was drilled using the same lateral entry hole and was again endoscopically inspected (fig 1).

This step was repeated until the necrotic area was clearly visualized. The tunnel was then enlarged to 10 mm in small femoral heads and 12 mm in larger heads. This drill was taken to within 5 mm of the articular surface, taking care not to perforate the cartilage. Using 9 to 12 mm anterior cruciate ligament cannulated reamers (ARTREX, USA) the necrotic zone was debrided under careful endoscopic and fluoroscopic control. The necrotic bone was carefully washed out by pulsatile lavage. In three cases we combined endoscopy of the core track with arthroscopy of the hip joint itself. The

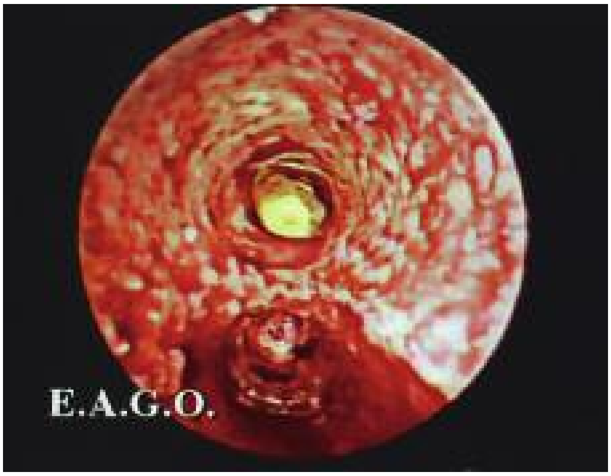

Fig. 1. — View inside femoral head with inferior tunnel in healthy bone and superior tunnel reaching the necrotic area.

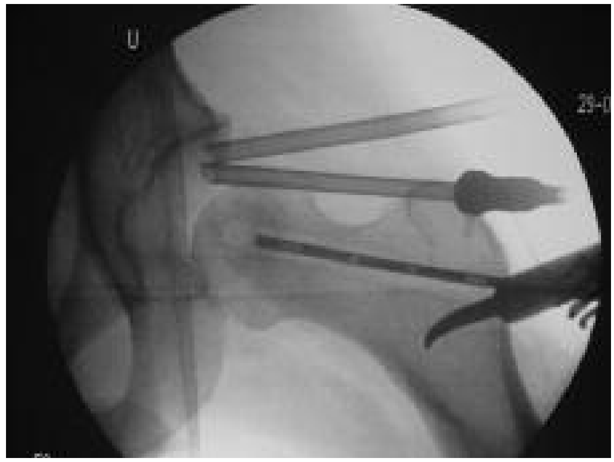

Fig. 2. — Image intensifier view of simultaneous endoscopy of the core track and arthroscopy of the hip joint.

necrotic lesion is most often located in the anterior superior part of the femoral head , an area which is easily inspected with an anterior or anterolateral arthroscopy portal. Figure 2 shows combined endoscopy of the core track and arthroscopy of the hip joint.

Finally the debrided zone and tunnel were checked endoscopically, and the harvested cancellous bone was impaction grafted in the core track and the debrided zone. Standard 5ml standard plastic syringes with a cut tip were used to facilitate insertion of the cancellous graft into the core tract. Standard 10 mm AO bone impactors were used to compact the bone chips into the necrotic area of the femoral head

The core track was then filled up with more loosely impacted bone graft. In four patients the femoral head was debrided and the core track was stabilized by a tantalum rod (Zimmer®, Warsaw, IN, USA). The wound was washed out before closing.

Patients were allowed partial weight bearing (50%) for eight weeks, then they were allowed to walk without assistance, but were urged to avoid undue stress to the hip for one year.

RESULTS

We were able to localise the necrotic bone with endoscopic assistance in every single case. Endoscopically a very sharp border can be seen between the bleeding healthy bone and the devascularised necrotic bone area, which appears completely white or yellowish (fig 3). We were surprised to

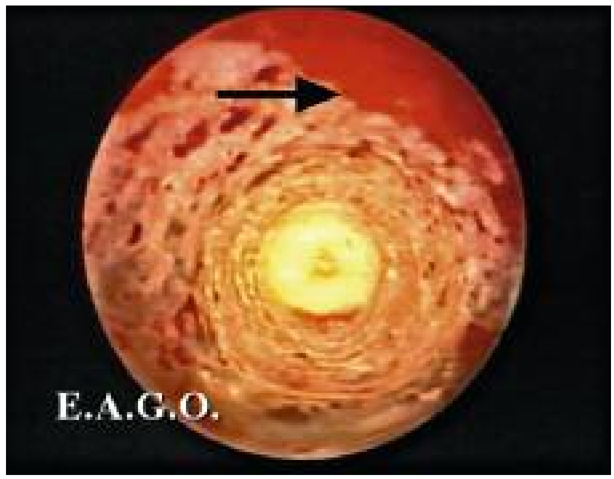

Fig. 3. — Clear border can be seen between healthy and necrotic bone ; Arrow marks subchondral bone plate.

see how in 11 of the hips the first small tunnel did not reach the necrotic area, especially in small-size lesions. There were three cases with arterial bleeding inside the healthy bone of the core track. Approaching the subchondral bone, a colour change from white to more yellow could be seen between the necrotic area and the subchondral bone. There were three cases of accidental cartilage perforation (fig 4). This cartilage perforation was not seen using fluoroscopy and was only observed when the core track was endoscopically inspected. All three perforations occurred during the first half of this study. This was classified as a failure in our

Fig. 4. — Accidental perforation of femoral head cartilage

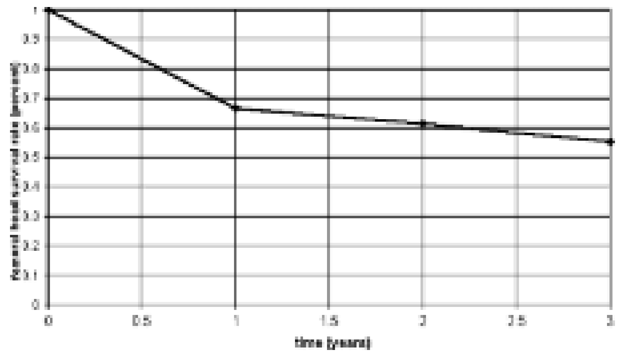

Fig. 5. — Kaplan Meier femoral head survival rate at one, two and three years.

final follow-up. These three patients had a poor outcome and ended up with a total hip replacement. There were no cases of intra-operative or post-operative femoral fractures. There were no cases of post-operative deep infections. Three patients who received a tantalum rod subsequently underwent conversion to resurfacing hip arthroplasty, leaving the tantalum rod in place.

One patient with bilateral advanced osteonecrosis had a poor outcome and subsequently underwent bilateral total hip replacement in another institution.

The femoral head survival rate was 55% at three years, as shown in fig 5.

There was a statistically significant correlation between the FICAT stage ($p < 0.05$), the size of the lesion ($p < 0.05$) and the survival of the femoral head at two years. All patients with advanced stage disease (Ficat stage 3, Steinberg stage 3 and 4) showed progression of the disease towards femoral head collapse.

DISCUSSION

If untreated, 70 to 80% of the hips with clinically established osteonecrosis show progression to collapse and osteoarthritis, and most of these eventually come to total hip arthroplasty (*11*). Accordingly some form of prophylactic management is indicated in the early stages of osteonecrosis. Core decompression is one of the most popular treatment options in early stage disease (*1,4,6,7,9,11, 13,14,18,25-27*).

Bone endoscopy was first described by Härle in 1985 (*8*). There are reports on the use of bone endoscopy in revision hip arthroplasty, treatment of osteomyelitis, bone grafting and inspection of bone cysts (*8,10,12,15,16,20,22*). To our knowledge the *in vivo* use of endoscopy of the core track during core decompression of the hip has not been reported so far.

A sharp border was seen in every single patient between healthy and necrotic bone. Endoscopy of the core track facilitated the detection and localisation of small AVN lesions in the pre-radiological phase of osteonecrosis. Although we were able to visualise and document cartilage perforation during the core decompression in three instances, we were not able to completely prevent it.

Endoscopy of the core track, combined with impaction of cancellous bone grafts in the necrotic area did not improve the final outcome of core decompression in advanced stages of osteonecrosis. This is in line with previous reports on core decompression and impaction grafting without endoscopic assistance (*19,27*).

Endoscopic core decompression can be done with standard available endoscopic equipment ; we personally favoured the use of a 5 mm diameter 0° forward looking laparoscope. The latter was easier to use than the 4 mm standard arthroscopes. Using arthroscopes we found that we lost orientation inside the core track. Our surgical technique for decompression and grafting was very similar to the technique described by Rijnen *et al* (*19*). This group has several publications on core decompression with generally a better outcome than other reports. They use autografts from the trochanter for impaction grafting of the femoral head, filling up the rest of the core track with allograft. The abundant amount of autograft harvested from the iliac crest in our technique limited the need for allograft. We were however unable to reproduce their success rate. This might be explained by the fact that they used specially designed impactors of different sizes to achieve firm impaction. They also used solidly impacted bone chips made from fresh frozen allografts. We only used standard impactors with various sizes to impact the autograft in the femoral head.

Our study had some limitations. It is a retrospective study on a small number of patients, and not all of them had post-operative MRI, while MRI is currently used routinely to assess the success rate of core decompression (*5*). Although we had no post-operative infections in our series, the use of extra arthroscopic equipment theoretically might increase the risk of infection in a patient population which is likely to need joint arthroplasty later on.

The use of autografts from the iliac crest caused transient donor site pain and prevented the procedure to be performed on an outpatient basis. However this donor site pain is transient and well tolerated. We have reported on this donor site morbidity in a previous study (*2*). Bleeding inside the core track often obstructs the view and frequent wash out of the core track is necessary to maintain visualisation.

Sekiya *et al* (*23*) described the use of arthroscopy to document the accurate position of core decompression of the hip. They performed arthroscopy of the hip joint itself to position the guide wire for an 8mm cannulated reamer. They described how the use of the arthroscope eliminated the possibility of missing the lesion and, in addition, prevented inadvertent over reaming of the necrotic area and penetration of the articular cartilage.

Sekiya *et al* published a study on 93 patients who underwent arthroscopy of the hip joint during core decompression (*23*). They concluded that there was poor correlation between pre-operative staging on MRI and the actual arthroscopic findings. Although we have only limited experience (3 cases), endoscopy of the core track can easily be combined with arthroscopy of the hip joint itself, as both use the same patient set-up and equipment (*22*).

Furthermore the necrotic lesion is most often located in the anterior superior part of the femoral head, an area which is easily inspected with an anterior or anterolateral arthroscopy portal. We agree with Sekiya *et al* (*23*) that evaluation of the articular surface is of value to avoid attempted salvage of a completely delaminated femoral head. The results of this surgical procedure may be enhanced in the future by the development of better video equipment and by the combination of core decompression with the use of osteoinductive or angiogenic agents to enhance bone formation and repair. Even with currently available endoscopy equipment we would encourage surgeons to combine core decompression procedures with bone endoscopy of the core track. Direct endoscopic visualisation of the core track helped us to find small-size lesions in the femoral head, to prevent or at least recognise accidental cartilage perforation, and to limit blind steps during core decompression.

CONCLUSION

Endoscopy of the core track is a simple and effective technique to increase the accuracy of core decompression in the treatment of early-stage AVN of the hip. It is a simple way to visualise the topography of osteonecrosis and to prevent or document cartilage perforation during core decompression. Endoscopy of the core track was useful to localise small-size lesions. We were able to document but not entirely prevent cartilage perforation, although all perforations occurred during the first half of this study, reflecting the learning curve of the procedure.

However, medulloscopy combined with impaction of cancellous bone graft did not improve the final outcome of core decompression in advanced stages of osteonecrosis, compared to conventional blind decompression. Future prospective randomised studies should define whether or not endoscopically assisted core decompression has an advantage over blind core decompression in early-stage osteonecrosis.

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