

The Advantages of Core Decompression for Treating Avascular Necrosis

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Abstract: There are many approaches to the treatment of early stages of avascular necrosis of the femoral head. Unfortunately, none is completely effective. The purpose of this publication is to discuss the specific advantages and disadvantages of core decompression and to compare it to other selected procedures. During a fourteen-year period, 406 hips were treated by a single surgeon at the Hospital of the University of Pennsylvania with a modified core decompression with supplemental bone grafting. This was a prospective study in which objective methods of measurement were used. Outcome was determined by the change in clinical status using Harris hip scores, radiographic resolution or progression using the quantitative University of Pennsylvania system for staging, and the need for total hip replacement. Five complications occurred in the entire group of 406 cases, including two fractures resulting from falls in the first postoperative month. In 297 hips with a minimum two year follow up, 36% required total hip replacement at a mean of 29 months: 26% in Stage I, 34% in Stage II, 31% in Stage III, and 48% in Stage IV. Results correlated with both stage and extent of the lesion. In hips treated before collapse (Stages I and II) total hip replacement was required in 22%, 39% and 40% respectively of small ("A"), medium ("B"), and large ("C") lesions. The safety and effectiveness of core decompression, both in previous publications and from our own experience, was then compared to other selected prophylactic procedures. Most of these were more complex than core decompression, the incidence of complications was higher, and the number of patients in individual studies was often quite limited. Because of the many variables in published reports, it is difficult to compare the relative effectiveness of different procedures, however, the results with certain approaches appeared better than with core decompression, especially for more advanced lesions. We concluded that core decompression is a relatively simple, safe and effective procedure, especially for smaller lesions treated before femoral head collapse. It has many advantages over more complex procedures, which have a higher incidence of complications. However, there is a great need for objective, prospective, multicenter studies to compare the safety and effectiveness of the various approaches to treating avascular necrosis and to determine the specific indications and contraindications for each.

Introduction

Nontraumatic avascular necrosis (AVN) of the adult hip is being diagnosed in approximately 10,000 to 15,000 new patients annually in the United States alone and accounts for approximately 10% of the total hip replacements performed.

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It is generally agreed that without specific treatment, the large majority of clinically diagnosed cases will progress to collapse of the femoral head and require some form of arthroplasty. Since this disease occurs in younger patients, our goal is to diagnose and treat these patients early in an attempt to prevent or at least retard femoral head collapse. Over the years, a number of approaches have been recommended. Unfortunately, none is completely satisfactory.

During the early 1960's Arlet and Ficat performed core biopsies on a small number of patients with avascular necrosis in order to examine the pathologic changes taking place [3,13]. This procedure frequently produced immediate relief of preoperative pain, and it was felt that this was because of a decompression of the increased intraosseous pressure found to be present in the femoral head and neck of patients with AVN. Subsequently, it was used as a therapeutic rather than as a diagnostic procedure and was referred to as "core decompression."

Since that time, several reports on core decompression have appeared in the literature. The reported safety and effectiveness have varied considerably. In 1985 Ficat and Arlet reported on 133 hips in Stages I and II treated by core decompression. They found "good to very good" results in 90% of hips on clinical evaluation and in 79% on radiographic evaluation [13]. In 1986 Camp and Colwell retrospectively reviewed 42 core decompressions performed by 13 separate surgeons [8]. 60% of hips treated before collapse failed either clinically or radiographically and all hips treated after collapse were considered clinical failures. Four patients sustained postoperative fractures. Thus the question of the safety of this procedure was raised. In 1995 Koo et al found only symptomatic relief after core decompression but no effect in preventing femoral head collapse when compared to nonoperative management in a small number of hips with AVN [19]. In a comprehensive review of the literature published in 1996, Mont, Carbone and Fairbank reviewed 42 separate reports involving 2,025 hips. 819 were treated nonoperatively and 1,206 were treated by core decompression. Satisfactory results were found in only 23% of hips treated nonoperatively, as compared with 64% of hips treated by core decompression. In hips evaluated before collapse, good results were obtained in only 35% treated nonoperatively, as compared with 71% treated with core decompression [21].

In 1981, after experiencing poor results treating patients

with avascular necrosis “conservatively,” we began to perform a modified type of core decompression with a supplemental cancellous bone graft at the University of Pennsylvania. During the ensuing fourteen years, 406 cases were performed by the senior author. Preliminary results were previously reported in the *University of Pennsylvania Orthopaedic Journal* in 1997 [29] and will be only summarized here. We will also briefly review other investigators’ experience with this and other procedures. Conclusions will then be drawn regarding the advantages and disadvantages of core decompression as compared to other selected approaches.

Core Decompression with Bone Grafting at the University of Pennsylvania

Under the image intensifier and with the patient on a fracture table, an 8 mm core of bone was removed from the center of the necrotic lesion using Michele trephines. The core proceeded to within 5 mm of the articular surface. Using the same entry site in the lateral femoral cortex, two 6 mm cores of bone were removed from the periphery of the lesion. The viable cancellous bone obtained from the intertrochanteric region was then thinned with a rongeur and placed very loosely into the central core. The two smaller core tracks were left open. Patients were placed on partial weight bearing using crutches for three months. In several instances the procedure was performed on both hips under the same anesthetic.

Between 1981 and 1995, 406 procedures were performed by a single surgeon. Results were determined by clinical evaluation, using the Harris hip scores, radiographic resolution or progression, (using the University of Pennsylvania system for staging), and the need for total hip replacement. The results were compared to 55 hips treated nonoperatively prior to the start of the series and to results reported in the literature. Hips ranged from Stage I (preradiographic) to Stage IV (femoral head flattening without acetabular involvement).

Five complications occurred in the entire group of 406 hips including 2 fractures, which resulted from hard falls during the first month following surgery. Two hundred ninety-seven hips had a minimum two-year follow up. Of these, 107 (36%) required THR at a mean of 29 months. THR was performed in 26% of hips in Stage I; 34% in Stage II; 31% in Stage III; and 48% in Stage IV. Thus results were better in hips treated prior to femoral head collapse than in those treated after femoral collapse, but no differences were noted between hips in Stages I, II or III. In Stages I and II combined, THR was performed in 22%, 39%, and 40% respectively of small (“A”), medium (“B”), and large (“C”) lesions. Thus the results in hips with small lesions were significantly better than those in hips with moderate to large lesions. In hips not requiring THR, 39% were radiographically stable and the mean Harris hip score improved by 10 points. There was no correlation between symptoms and outcome in hips treated before collapse and no correlation with etiology except for patients in whom both corticoste-

roids and alcohol were implicated. These did slightly worse than other groups. All patients in this series were treated with bone grafting in addition to core decompression, and no attempt was made to evaluate the effect of the graft itself.

These results correspond closely with those reported in the literature from groups with significant experience with this technique [12,13,21,23,27–29]. We concluded that, compared to nonoperative or symptomatic management, core decompression with or without a cancellous bone graft was a safe and effective procedure for the treatment of early stages of avascular necrosis. In hips with moderate degrees of femoral head flattening, other methods of prophylactic treatment were recommended, including free vascularized fibular grafting.

Other Procedures for the Preservation of the Femoral Head

Other procedures which have given encouraging results in the treatment of early stages of avascular necrosis include electrical stimulation with pulsing electromagnetic fields, various types of osteotomies, and different grafting procedures. These include cancellous and cortical grafts, with and without either a vascular pedicle or surgical vascularization. Recently the use of a free vascularized fibular graft has received a good deal of attention.

Electrical stimulation

Different types of electrical stimulation, both alone and as a supplement to operative procedures, have been used to treat avascular necrosis. Of these, promising results have been reported with the use of pulsing electromagnetic fields [1,2,15]. Experience with this device is limited and it is not available for routine use in the United States at this time.

Osteotomies

Various types of proximal femoral osteotomies have been used in the treatment of avascular necrosis of the femoral head over the past thirty years. These are technically difficult procedures, and are not frequently used in the United States. Results vary considerably and subsequent arthroplasty may be compromised. Two basic types of osteotomies have been employed: varus or valgus, usually combined with flexion or extension; and rotational.

The rationale upon which these osteotomies are based is the ability to move the diseased area of the femoral head out of the region of major weight bearing and to replace it with an essentially normal articular segment. This is extremely difficult to accomplish with varus or valgus osteotomies except in cases where the lesion is extremely small. The indications for these procedures have been narrowed considerably over the years and results which initially seemed promising deteriorated significantly with the passage of time [16,20,22,26].

Rotational osteotomies, on the other hand, can rotate the head in the central axis of the neck 90 or more degrees without significantly impairing the function of the hip. The

head can be rotated either anteriorly [30,31] or posteriorly [4]. These procedures are technically demanding and specific indications must be followed closely. Sugioka [30,31], Atsumi [4], and other investigators, particularly in the Far East, have reported good to excellent results, even after femoral head collapse. However, investigators in the United States have not been able to duplicate them [10].

Grafting procedures

Many different types of grafting procedures have been reported in patients with avascular necrosis. These have included cancellous and cortical bone, both vascularized and nonvascularized. Autografts and allografts have been used.

Structural grafts

In 1949 Phemister described the use of tibial strut grafts for the treatment of post-traumatic osteonecrosis [24]. Subsequently other investigators modified this technique and used both nonvascularized fibular and tibial strut grafts in traumatic and non-traumatic osteonecrosis [5–7,11]. In long term follow up studies, excellent results were reported in patients treated prior to femoral head collapse, provided that the grafts were well placed. No difference was noted between allografts and autografts [7].

Cancellous grafts

Several methods have been described for using cancellous bone grafts to treat AVN of the femoral head employing a variety of surgical approaches, with and without arthrotomy. In 1994 Rosenwasser et al performed a thorough debridement of the necrotic lesion through a window in the anterior aspect of the femoral neck [25]. The cavity was then filled with cancellous graft obtained from the ipsilateral ilium. Their series included 15 hips with Stage II and III disease followed 10 to 15 years. Good to excellent clinical results were obtained in 13 (87%). Gardeniers et al recently reported their results with a similar procedure in which debridement of the necrotic lesion was performed through the lateral femoral cortex without arthrotomy of the hip. The authors considered their success rate to be 83% with an average Harris hip score of 94 points [14].

Free Vascularized Fibular Grafting (FVFG)

In 1979 Brunelli and Brunelli in Italy⁹ and Urbaniak [9,32] in the United States began using a free vascularized fibular graft for the treatment of osteonecrosis. Since that time a small number of investigators have reported a significant degree of success with this procedure [9]. Urbaniak et al have performed well over 1000 of these procedures. In their first 715 patients, clinical survivorship was 82% with a minimum follow up of two years [33]. However, 24% of patients had donor site complications, although many were minor [34].

In 1996, an excellent symposium on osteonecrosis was presented at Duke University under the sponsorship of the American Academy of Orthopaedic Surgeons and the

American Orthopaedic Association [9]. Seven groups of investigators from different institutions reported their experience with free vascularized fibular grafting. Many different techniques and indications were used, and the methods for evaluating results varied considerably. All authors reported favorable results and most indicated that the lesion size and stage were important in determining outcome. Of 1,303 procedures performed at these institutions, there was a survivorship of 83% in hips followed greater than two years. The survivorship was 88% in hips treated before femoral head collapse [9]. Yoo et al initially reported their experience with this approach in 1992 [36] and more recently in 1999 [35]. In 86 hips with a minimum eight-year follow up, 72% were graded good to excellent and 28% fair to poor. Sixty-one percent showed no radiographic progression [35].

FVFG is a technically demanding and time-consuming procedure. It requires special equipment and the participation of an experienced microvascular surgeon. It should, therefore, be done only at selected centers. The complication rate is not insignificant and if bilateral procedures are needed, it is usually necessary to delay the second by several months.

Discussion

There are both advantages and disadvantages of core decompression as compared to other methods for treating earlier stages of avascular necrosis. Among the advantages are the following: It is a procedure with which we have had thirty years of experience; it is relatively simple and requires no special equipment or expertise; it is a short procedure with little blood loss and it has been performed by some on an outpatient basis; if done carefully, the complication rate is extremely low; protected weight bearing is required for only six to twelve weeks; it can be done bilaterally under the same anesthetic when indicated and does not require a delay of three or more months for the second hip as with some other procedures; it can be used for several other joints in addition to the hip; it can be done as an isolated procedure or it can be supplemented by cancellous bone grafts, bone morphogenetic protein, demineralized bone matrix, and electrical stimulation; and it does not compromise a future arthroplasty if required. It is effective in hips treated prior to collapse, especially in those with smaller lesions. In our series we had 80% satisfactory results in this group.

The major disadvantage of core decompression is that it is not as effective as we would like it to be, especially in treating hips with larger lesions or in those after collapse has already begun. However, even in this group results are significantly better than with "conservative" management. In our series, 50% of these hips required no further surgery as compared to only 10% to 20% of hips treated non-operatively.

A number of other approaches to prophylactic treatment of the hip with avascular necrosis have been discussed briefly. In many instances there are relatively few series with small numbers of cases reported, and the follow-ups

are often short. Many of these procedures are technically quite difficult, the incidence of postoperative complications is much higher than with core decompression, and later conversion to total hip replacement might be compromised. Nevertheless, encouraging results have been reported by some authors with pulsing electromagnetic fields, rotational osteotomies, nonvascularized strut grafts, and cancellous bone grafting, as well as with free vascularized fibular grafting. From the reports available, it is very difficult to determine the relative safety or effectiveness of these various procedures.

Recently there has been increasing interest in free vascularized fibular grafting, and some of the reports cited indicate that it may be one of the most effective treatments, especially after femoral head collapse. The major disadvantages of this procedure are associated with the need to harvest the patients' own fibula and perform the microvascular anastomosis. Is this necessary? The few studies which have addressed this issue indicate that it may be [17,18]. However, other studies indicate that equal or nearly equal results can be obtained with simpler procedures such as a nonvascularized tibial or fibular allograft [5–7] or with cancellous grafting alone [14,25]. If these can be substantiated by other investigators, it might be more difficult to justify free vascularized fibular grafting as it is now performed except in selected circumstances.

At the present time core decompression, with or without bone grafting has its supporters, as do other approaches to treating AVN. There are certain advantages and disadvantages to each. We badly need prospective, multicenter studies using identical, objective parameters so as to compare both the safety and effectiveness of these various procedures. If this can be carried out, we will then be able to make valid comparisons between these approaches and establish the specific indications and contraindications for each.

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