

# OSTEONECROSIS OF THE FEMORAL HEAD

## A STUDY OF 101 HIPS TREATED WITH VASCULARIZED FIBULAR GRAFTING

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**Background:** The present study evaluates the minimum five-year results of vascularized fibular grafting for the treatment of osteonecrosis of the femoral head. The purposes of the present study were to review the results of fibular grafting in a large series of patients and to determine the indications for this procedure.

**Methods:** Eighty-six patients (101 hips) were followed clinically for a minimum of five years (or until the time of death). The study group included fourteen Marcus-Enneking stage-2 hips, twenty-three stage-3 hips, and sixty-four stage-4 hips. Three patients (three hips) died from unrelated causes before the five-year evaluation, and two patients (two hips) died after the five-year evaluation. Radiographic assessment was performed with use of the Marcus-Enneking grading system, and clinical assessment was performed with use of the Harris hip-scoring system. The end point was conversion to total hip arthroplasty. Patient satisfaction was also assessed.

**Results:** Sixty-two hips (61%) survived until the time of the five-year follow-up, and forty-two hips (42%) survived until the time of the interview (at a median of eight years postoperatively). The average Harris hip score was  $58 \pm 13$  at the time of presentation and  $80 \pm 15$  at five years. Eight (57%) of the Marcus-Enneking stage-2 hips, sixteen (70%) of the stage-3 hips, and thirty-eight (59%) of the stage-4 hips survived for at least five years. Of the eighty-one living patients (including forty-one who had a successful outcome and forty who had had a failure), forty-six patients (including twenty-one who had a successful outcome and twenty-five who had had a failure) stated that they would undergo the procedure again.

**Conclusions:** Vascularized fibular grafting may provide a chance for normal hip function in the intermediate or long term in carefully selected patients with osteonecrosis of the femoral head.

**Level of Evidence:** Therapeutic Level IV. See Instructions to Authors for a complete description of levels of evidence.

Osteonecrosis of the femoral head progresses to collapse in up to 70% to 80% of all cases<sup>1</sup>. Unfortunately, numerous studies<sup>1-8</sup> have shown that nonoperative treatment is associated with an unacceptably high rate of failure. Recent follow-up studies on the treatment of this condition with use of cementless prostheses have yielded improving results<sup>2,9-14</sup>, but patients with osteonecrosis tend to fare worse when compared with age-matched patients without osteonecrosis<sup>9,13</sup>. Thus, a biological solution is optimal for this challenging patient population.

Various osteotomies have been attempted, but these technically demanding procedures have yielded mixed results that often are difficult to reproduce<sup>15-20</sup>. Core decompression has demonstrated some success for the treatment of

noncystic femoral heads that have not collapsed<sup>21</sup>, but it has been less successful following collapse<sup>1,21-24</sup>. A few groups have reported encouraging results in association with the use of vascularized fibular grafts<sup>23,25-30</sup>. Although the procedure is technically challenging to perform and requires a motivated patient because of the extensive recovery period, it aims at halting the degenerative process and restoring a more normal level of function. Moreover, it may be a reasonable way to salvage a collapsed femoral head. The purposes of the present study were to examine the results of vascularized fibular grafting in a large case series and to determine the indications for this procedure.

### Materials and Methods

#### Study Group

We evaluated the results for eighty-six patients (101 hips) who had been managed with free vascularized fibular bone-grafting for the treatment of osteonecrosis of the femo-



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ral head from 1985 to 1997. All patients were followed clinically for a minimum of five years (or until the time of death), and all living patients were recently contacted for an interview at a median of eight years (range, five to fifteen years) postoperatively. No patient was lost to follow-up.

Patients were divided into four groups on the basis of etiology. Alcohol abuse, defined as the consumption of more than six beers (72 oz [355 mL]) per day, was considered an etiologic factor for four patients (5%) and six hips (6%). Trauma, defined as a fracture of the femoral head or neck, was considered an etiologic factor for eleven patients (13%) and twelve hips (12%). Steroid use, defined as an exposure to at least 2000 mg of prednisone, was considered an etiologic factor for forty-two patients (49%) and fifty-four hips (53%). Finally, osteonecrosis was considered to be idiopathic in twenty-nine patients (34%) and twenty-nine hips (29%).

The study group included fifty male patients (mean age, forty years; range, nineteen to sixty-one years) and thirty-six female patients (mean age, thirty-four years; range, sixteen to fifty-four years). Bilateral disease was diagnosed in twenty-seven patients and was treated in fifteen (ten male patients and five female patients). The exclusion criteria for patients who were diagnosed with osteonecrosis but were not treated with a vascularized fibular graft were disease that had progressed radiographically beyond Marcus-Enneking stage 4 or a scheduled total hip arthroplasty.

### *Surgical Technique*

The hip is approached through a curved anterolateral incision, and an interval is created between the anterior fascia of the gluteus medius and the tensor fasciae latae. The vastus lateralis is lifted from the lateral part of the femur and is separated from the iliotibial band. With use of fluoroscopy, the femoral head is decompressed and as much necrotic bone is removed as possible. A guide-pin is placed by hand through the soft tissue in the line of the anticipated core channel. Typically, it passes through the proximal-lateral femoral cortex at the level of the lesser trochanter (or just proximal to it). Reamers are then driven into the femoral head to within 5 mm of the subchondral bone. The core channel is enlarged in 1-mm increments with use of reamers of increasing diameter, usually to a diameter of approximately 19 mm. We create the largest core channel possible considering the diameter of the proximal part of the femur. The ipsilateral fibula is exposed, and the middle third containing the nutrient vessels is harvested for grafting. The peroneal pedicle is short, being approximately 1 cm in length. The amount of the fibula that is harvested is based on the length of the channel that is created during the decompression stage of the procedure. When this step is complete, the descending branches of the lateral femoral circumflex artery are mobilized to a 3 to 4-cm pedicle found in the interval of the rectus femoris and vastus lateralis. Microsurgical techniques are then used to anastomose the peroneal and recipient vessels while the fibular strut lies temporarily on the anterior aspect of the thigh. Following satisfactory observation of perfusion for twenty to thirty minutes, the composite

is routed under the vastus lateralis and is inserted into the core channel. Cancellous bone from the greater trochanter and from reaming is finger-packed down the core channel. The graft is then inserted, and correct placement is confirmed with fluoroscopy.

The patient is managed with a below-the-knee cast and is instructed not to bear weight for six weeks. At six weeks, the patient may bear partial weight but is instructed to use crutches for an additional three to five months. Physical therapy is provided on an as-needed basis.

### *Evaluation and End Points*

Hip function, radiographic evidence of progression of disease, and conversion to total hip arthroplasty were used as the end points in the present study. Function was classified, according to the Harris hip score<sup>31</sup>, as excellent (91 to 100 points), good (81 to 90 points), fair (70 to 80 points), or poor (<70 points). The extent of osteonecrosis was graded with use of the radiographic scale described by Marcus and Enneking<sup>32</sup>. At the time of presentation, fourteen hips (14%) had stage-2 osteonecrosis, twenty-three (23%) had stage-3 osteonecrosis, and sixty-four (63%) had stage-4 osteonecrosis.

### *Statistical Methodology*

Kruskal-Wallis analysis of variance was used to determine whether there were any significant differences with regard to the Harris hip score, the Marcus-Enneking stage, etiology, age, or gender between patients who met any of the three endpoint criteria and those who did not. The level of significance was set at  $p < 0.05$ . A power analysis was not performed.

## **Results**

### *Graft Survival*

Three patients (three hips) died of unrelated causes during the initial five-year follow-up period (at one, three, and four years), and two patients (two hips) died during the subsequent follow-up period (at nine and ten years). Of the 101 hips in eighty-six patients, forty-two hips (42%) in thirty-six patients (42%) had an intact fibular graft at the time of the last follow-up, at a median of eight years (range, five to fifteen years) postoperatively. Fifty-seven hips (56%) had a conversion to total hip arthroplasty at a mean of  $3 \pm 3$  years after grafting. The rate of graft survival was 88% at one year, 73% at two years, and 61% at five years.

With regard to etiology, twenty-five (46%) of the fifty-four hips with steroid-related osteonecrosis survived until the time of the latest follow-up, with a mean survival time of  $4 \pm 3$  years for the hips that had conversion to total hip arthroplasty. Three of the twelve hips with trauma-related osteonecrosis survived, with a mean survival time of  $4 \pm 2$  years for the hips that had conversion to total hip arthroplasty. Twelve (41%) of the twenty-nine hips with idiopathic osteonecrosis survived, with a mean survival time of  $4 \pm 3$  years for the hips that had conversion to total hip arthroplasty. Two of the six hips with alcohol-related osteonecrosis survived, with a mean survival time of ten years for the hips that had conversion to total hip

TABLE I Rates and Durations of Graft Survival

Etiology	Survival Rate*		Duration of Graft Survival Before Failure† (yr)
	At Five Years	At Time of Interview	
Steroids	59% (32 of 54)	46% (25 of 54)	4 ± 3
Alcohol	100% (6 of 6)	33% (2 of 6)	10 ± 0
Trauma	50% (6 of 12)	25% (3 of 12)	4 ± 2
Idiopathic	62% (18 of 29)	41% (12 of 29)	4 ± 3
Total	61% (62 of 101)	42% (42 of 101)	3 ± 3

\*The data are given as the percentage, with the number of hips in parentheses. †The data are given as the mean and the standard deviation.

arthroplasty. Table I illustrates the five-year and most recent survival rates. Figure 1 illustrates the relationship between the etiology and the survival rate.

Twenty-one (58%) of the thirty-six female patients underwent conversion to a total hip arthroplasty at a mean of 3 ± 3 years (range, one to eleven years), whereas thirty-six (72%) of the fifty male patients underwent conversion to total hip arthroplasty at a mean of 4 ± 3 years (range, one to ten years).

With regard to age, three of nine hips in patients who had been fifteen to twenty years old at the time of the index procedure underwent conversion to total hip arthroplasty at an average of 8 ± 5 years (range, three to eleven years), thirteen (54%) of twenty-four hips in patients who had been twenty-one to thirty years old at the time of the index procedure underwent conversion to total hip arthroplasty at an average of 5 ± 3 years (range, one to ten years), twenty-two (59%) of thirty-seven hips in patients who had been thirty-one to forty years

old at the time of the index procedure underwent conversion to total hip arthroplasty at an average of 4 ± 3 years (range, one to ten years), thirteen (59%) of twenty-two hips in patients who had been forty-one to fifty years old at the time of the index procedure underwent conversion to total hip arthroplasty at an average of 4 ± 2 years (range, one to seven years), and six of nine hips in patients who had been fifty-one years old or older at the time of the index procedure underwent conversion to total hip arthroplasty at an average of 3 ± 2 years (range, one to eight years) (Fig. 2). Analysis of variance showed no significant difference, with the numbers available, between surviving hips and converted hips with regard to the age of the patient at the time of the procedure ( $p = 0.27$ ).

#### Clinical Outcome

The average preoperative Harris hip score was 58 ± 13 (range, 24 to 100). At one year, the average Harris hip score associated

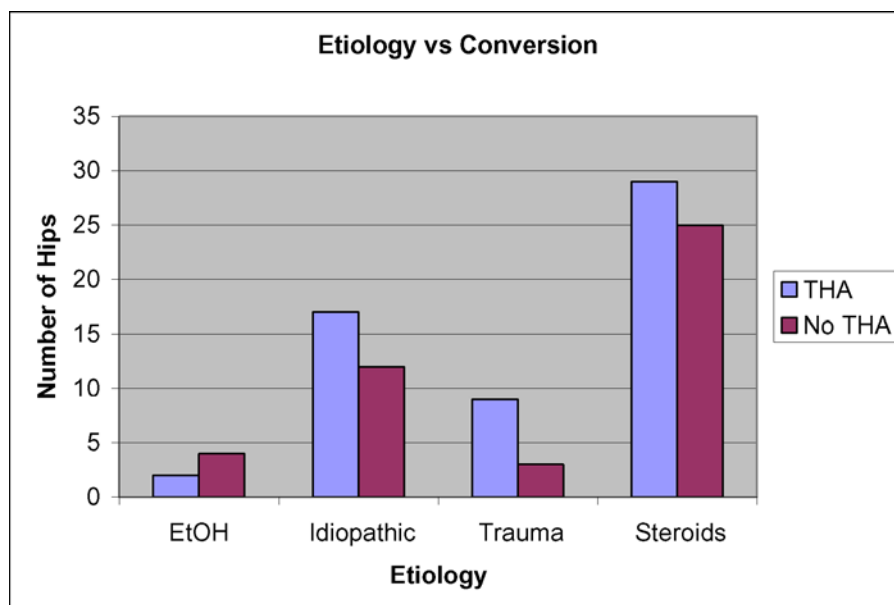


Fig. 1

Histogram illustrating the relationship between etiology and conversion to total hip arthroplasty. Steroid-induced osteonecrosis, followed by idiopathic osteonecrosis, comprised the largest groups in this study. At five years, the overall survival rate was 61%, but by a median of eight years, the total survival rate declined to 42%.

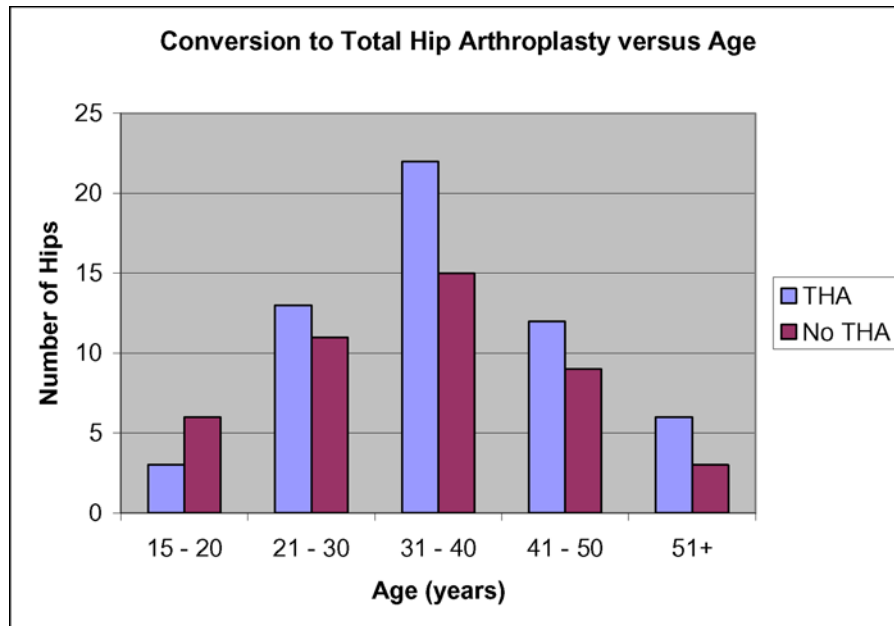


Fig. 2

Histogram illustrating the relationship between age and conversion to total hip arthroplasty. The rates of conversion according to age are proportionally similar and provide no obvious exclusionary criteria.

with the eighty-nine remaining grafts was  $79 \pm 15$  (range, 30 to 100). At two years, the average Harris hip score associated with the seventy-four remaining grafts was  $81 \pm 16$  (range, 28

to 100). At five years, the average Harris hip score associated with the sixty-two remaining grafts was  $80 \pm 15$  (range, 37 to 100). There was no significant relationship, with the numbers

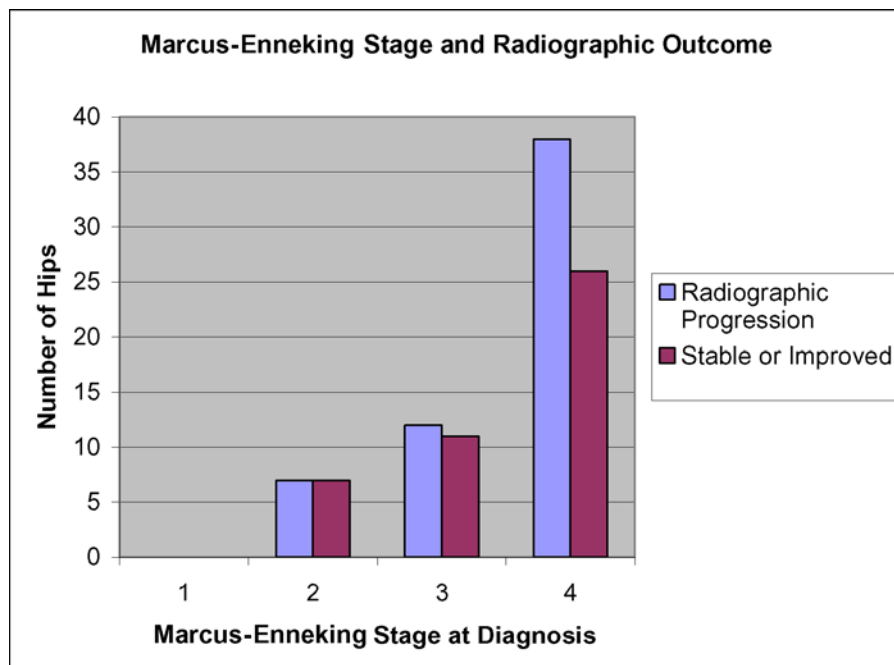


Fig. 3

Histogram illustrating the relationship between the Marcus-Enneking stage and the radiographic outcome. At a median of eight years, radiographic progression of disease was seen more commonly in hips that had been diagnosed with more advanced osteonecrosis.

available, between the radiographic stage at the time of diagnosis and the postoperative Harris hip score. There was no significant difference, with the numbers available, in terms of the preoperative Harris hip score for hips with poor and successful outcomes ( $p = 0.38$ ).

### **Radiographic Outcome**

Seven (50%) of the fourteen Marcus-Enneking stage-2 hips went on to collapse at an average of three years (range, one to eight years), with 57% surviving at five years. Fourteen (61%) of the twenty-three stage-3 hips went on to collapse at an average of five years (range, one to eleven years), with 70% surviving at five years. Thirty-eight (59%) of the sixty-four stage-4 hips underwent total hip arthroplasty at an average of 4.0 years (range, one to ten years), with 59% surviving at five years (Fig. 3). With the numbers available, we found no correlation between the Marcus-Enneking stage and the radiographic outcome ( $p = 0.50$ ).

### **Patient Satisfaction**

In the group of eighty-one surviving patients, twenty-one (51%) of those who had a successful outcome and twenty-five (63%) of those who had had a failure were satisfied and reported that they would undergo the vascularized grafting procedure again. Thirty-three of the thirty-six patients with surviving grafts at the time of the interview reported a decrease in their requirement for pain medication. Fourteen patients (42%) reported no limitations, nine (27%) were mildly limited, seven (21%) were moderately limited, and three (9%) were very limited in day-to-day activities. Eighteen (55%) reported no interference with sexual activity, eight (24%) reported a minor inconvenience, three complained of moderate difficulties, two were able to engage in intercourse only with extreme effort, one was totally unable to engage in intercourse, and one was not sexually active.

### **Complications**

Ten patients had development of trochanteric bursitis at the site of a fixation screw, but these screws are no longer used. One patient had development of thrombophlebitis in the donor leg nine months postoperatively. One patient had skin breakdown at the donor site one month postoperatively and was successfully managed with a split-thickness skin graft. One patient sustained an intertrochanteric fracture four years postoperatively during a motor-vehicle accident. Five patients had symptoms that were consistent with neurapraxia in the donor leg, but all symptoms resolved by two years.

### **Discussion**

While vascularized fibular grafting is not a new treatment for osteonecrosis of the femoral head, it is not widely performed and large studies with long-term follow-up are rare. A study by Urbaniak et al.<sup>30</sup> most closely parallels our series. However, neither the five-year overall survival rate nor the five-year Harris hip scores in the present study were as encouraging as those in the report by Urbaniak et al.<sup>30</sup>. This finding may be

related to two differences in surgical technique. First, we perform the fibular harvest in series with the core débridement. This eliminates the need for a second surgical team but adds time to the procedure. Increased surgical time may result in a lower-quality graft and a less successful outcome. The other major difference is the length of the graft and its vascular pedicle. Urbaniak et al.<sup>30</sup> used a 13-cm graft and a large pedicle. Our method involves harvesting only the required amount of graft and a shorter pedicle<sup>33</sup>. As the donor fibular graft pedicle was short, connecting it to the recipient vessels of the lateral femoral circumflex artery required greater recipient vessel mobilization for an end-to-end anastomosis. While the initial length of the graft is most likely unimportant, the shorter pedicle may affect the perfusion of the graft adversely. None of the six-month radiographs showed failure of a graft to incorporate, at least to some degree; therefore, we believe that this factor did not contribute to an adverse outcome.

It stands to reason that the more advanced the disease, the worse the prognosis. Surprisingly, we found no relationship between the initial radiographic stage and the final clinical outcome or the overall rate of graft survival. The five-year results were more encouraging for the stage-3 and 4 hips than for the stage-2 hips. We cannot draw any direct conclusions from this finding as our sample may have been inadvertently skewed or there may have been a statistical anomaly.

The prevalence of ankle pain in the present study differed from that in other series. Twelve percent of the 189 patients in the study by Vail and Urbaniak<sup>34</sup> reported ankle pain at five years, whereas no patient in the present study had this problem. This finding may be attributed to the smaller amount of fibular bone removed during our procedure.

One concern that cannot be overlooked is the severe socioeconomic cost of living with osteonecrosis of the femoral head and the associated psychosocial problems that plagued our patients. This disease cripples patients in the prime of life, rendering them unable to work and curtailing most activities that are typical for patients in this age-group. Unemployment, drug and alcohol abuse, family instability, and divorce plagued many of the patients in the present series, and many of the patients were receiving disability compensation. Because of the itinerant lifestyles of many of these patients, the effort to locate them was difficult.

The social behavior of many of our patients may have contributed adversely to the result. Several patients with varying outcomes were intoxicated or exhibited drug-seeking behavior when they were initially contacted. Many patients also reported having had bouts of major depression or bipolar episodes and exhibited many Axis-II traits during their interviews. Future studies investigating the psychological profile of these patients may be helpful with regard to assessing subjective and objective outcomes.

We believe that this bone-grafting technique potentially postpones the need for arthroplasty in young patients and offers the possibility of long-term benefits in selected patients, but careful patient selection is imperative to ensure the best possible outcome. ■

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