

Core Decompression Versus Nonoperative Management for Osteonecrosis of the Hip

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A complete review of the literature disclosed that there were 42 reports of 2025 hips treated by either core decompression (1206 hips) or nonoperative management (819 hips), excluding electrical stimulation, for osteonecrosis of the femoral head. The peer-reviewed published reports included general surveys, prospective studies, and multicenter studies, but excluded case reports. Satisfactory clinical results were reported in 63.5% of hips in 24 studies of core decompression and in 22.7% of hips in 21 studies of nonoperative management. When looking at only precollapse hips, there were 71% versus 34.5% good results, respectively. Recalculation excluding reports by the 4 centers that do the most core decompressions (and report the best results) showed a clinical success rate for core decompression of 53% versus 22.7% for the nonoperatively treated group. Investigators of multiple studies have reported that nonoperative management leads to extremely poor results. Core decompression has been reported

to have a notable effect on the natural history and clinical progression in early stages of osteonecrosis of the femoral head. In view of the limitations of this data, further clarification of this effect only can be obtained by large prospective randomized studies.

Osteonecrosis of the femoral head is usually a relentless process. It leads to collapse of the femoral head and eventual arthritis of the hip joint. In most reported series,^{11,32,50} it is the reason approximately 5% to 12% of patients require hip replacements. Patients afflicted are relatively young (<40 years old),⁶⁷ and the results of arthroplasties for this group indicate that most patients will need to have >1 procedure in their lifetime.^{13,16,25,50}

The natural history of this disease is still unclear, although there are some recent studies analyzing a multitude of clinical and radiologic factors affecting prognosis.^{41,54,61} Many studies report an extremely poor prognosis with a rate of femoral head collapse at >85% at 2 years (symptomatic hips with Stage I or II disease).^{41,42,47,61} It is thought by many that early diagnosis and treatment of osteonecrosis can alter this natural history significantly. Management options for early stages include bed rest, nonweightbearing with crutches, core decompression with or

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without bone grafting, and electrical stimulation. Other more complex surgical treatments for early stages of the disease include osteotomies,^{36,48,59,60} vascularized and nonvascularized bone grafting,^{3,35,45,64} and arthroplasty.^{50,52}

Some early studies of core decompression for osteonecrosis of the femoral head reported a high clinical success rate.^{18,22} Several more recent studies report less favorable outcomes with higher complication rates.^{9,21} Because of the widely varied experiences concerning the efficacy of core decompression from multiple centers,^{9,18,19,21-23,53-58,62} the authors were interested in analyzing the topic.

MATERIALS AND METHODS

A complete review of the English literature from 1960 to 1993 using the "Index Medicus" yielded 35 studies concerning core decompression of the femoral head for osteonecrosis. Case reports that involved <5 patients, for example 1 report of 2 patients with human immunodeficiency virus and osteonecrosis,¹² were not included in this analysis. Also excluded were studies in which no followup information could be identified.^{26,28} Studies in which small cancellous grafts were packed at the apex of the core tract^{53,55} were included, but not studies in which long cortical strut grafts were used.⁸ Reports dealing with core decompression combined with vascularized bone grafting^{3,35,45,64,66} or combined with osteotomies were not included. Special attention was given to avoid duplicate patient information published by authors in multiple reports. A chronological list of the studies is presented in Table 1.

The literature also was examined for reports concerning the natural history of untreated osteonecrosis in which nonoperative treatment methods were used; this yielded 21 studies. Excluded were reports using electrical stimulation.^{1,2,4,63} A chronological list of the studies is presented in Table 2.

This report was based on 1206 hips treated with core decompression from 24 studies and an additional 819 hips treated nonoperatively from 21 studies, including the 2 controlled, randomized studies that were divided into their nonoperative and core decompression arms.^{46,57}

Hips of the reported patients were stratified by the final followup results reported in each study. Specifically, 3 outcome parameters were analyzed: (1) clinical result; (2) evidence of radiographic progression; and (3) need for hip arthroplasty or further surgery. Harris Hip Scoring Systems²⁰ or similar hip rating systems were used to grade the treatment method as a success or failure. For example, a Harris Hip Score of >80 points was considered a success and <80 points was considered a failure. Disease progression on radiographs often was based on each study authors' criteria but generally denoted a change from precollapse to postcollapse stage of osteonecrosis of the hip. The need for arthroplasty also included hips in which secondary salvage procedures (such as osteotomies) were required. Results for each outcome parameter were classified as satisfactory or unsatisfactory for statistical analysis and were independent of the original classifications as published.

Despite the variation in data collection methods used, it was possible to tabulate consistent information on the parameters for most of the studies as presented in Tables 1 and 2. In some reports, the percentage of success and failure rates reported in this article are different from the author's published rates because of the stage rating system used in this study to facilitate interpaper consistency. For example, the numbers reported in this article for the Camp and Colwell⁹ study did not include patients with Stage IV disease because these hips were already in the postcollapse or radiologically graded unsatisfactory category before core decompression.

The studies were reviewed carefully and information on hips were stratified according to the following factors when possible: (1) associated factors; (2) steroid use; (3) length of followup; (4) Ficat and Arlet Stage;¹⁹ (5) other staging systems;⁴⁰ and (6) pre- and postcollapse state of the involved femoral heads by radiologic criteria.

RESULTS

Nonoperative Treatment Group

The overall results for the nonoperative treatment group^{2,4,6,7,14,15,24,31,33,34,38-40,42,46,47,53,56,62,67} revealed that 182 (22.7%) of 819 hips were satisfactory clinically. The outcome as assessed radiographically was comparable,

TABLE 1. Core Decompression

Principal Author	Year	No. Hips	Clinical Success/ Failure (%)	Radiographic Success/ Failure (%)	Hip Replacement		Mean Age in Years (range)	Number of Complications (%)
					Success/ Failure (%)	Followup Months (range)		
Solomon ⁵¹	1981	22	16/6 (73)	-	17/5 (23)	24 (6-48)	None reported	
^a Ficat ¹⁸	1985	133	119/14 (90)	105/28 (79)	-	114 (60-204)	None reported	
^b Camp and Colwell ⁹	1986	40	19/21 (48)	- (68)	34/6 (15)	15 (7-40)	6 (15)	
^c Warner et al ⁶⁵	1987	39	19/20 (49)	17/22 (44)	22/17 (44)	16	2 (5)	
^d Hopson and Siverhus ²¹	1988	21	9/12 (43)	9/12 (43)	12/9 (43)	39 (12-78)	1 (5)	
^e Tooke et al ⁶²	1988	45	29/16 (64)	29/16 (64)	29/16 (36)	36 (12-84)	1 (2)	
^f Meyers ³⁶	1988	12	11/1 (92)	11/1 (92)	11/1 (8.3)	Up to 48	None reported	
^g Saito et al ⁴⁶	1988	35	22/13 (63)	22/13 (63)	22/13 (37)	24-144	3 (18)	
^h Aaron et al ²	1989	50	22/28 (44)	16/24 (32)	22/28 (56)	26-38	None reported	
ⁱ Murray et al ³⁷	1989	51	25/26 (49)	25/26 (49)	25/26 (51)	45 (24-84)	None reported	
^j Stulberg et al ⁵⁸	1989	29	21/8 (72)	8/21 (28)	21/8 (28)	26 (26+)	None reported	
^k Seiler et al ⁴⁹	1989	16	9/7 (56)	-	-	12	None reported	
^l Hungerford ²³	1989	204	123/81 (60)	136/68 (66)	156/48 (24)	36-60	2 (1)	
^m Lausten and Mathiesen ²⁹	1990	29	14/15 (48)	18/11 (62)	14/15 (52)	13 (2-44)	No complications noted	
ⁿ Beltran et al ⁵	1990	34	-	-	18/16 (53)	23 (11-47)	None reported	
^o Stulberg et al ⁵⁶	1990	59	31/28 (53)	31/28 (53)	31/28 (47)	39	3 (5)	
^p Learnmonth et al ³⁰	1990	41	12/29 (29)	8/33 (20)	23/18 (44)	31 (10-84)	None reported	
^q Richards et al ⁴⁴	1991	19	6/13 (32)	6/13 (32)	6/13 (68)	15 (7-30)	None reported	
^r Chan et al ¹⁰	1991	32	28/4 (88)	28/4 (88)	31/1 (97)	15	None	
^s Kristensen et al ²⁷	1991	18	15/3 (33)	6/12 (33)	-	39 (12-60)	None reported	
^t Powell et al ⁴³	1991	28	20/8 (71)	20/8 (71)	23/5 (18)	53 (38-66)	None reported	
^u Steinberg et al ⁵⁵	1992	230	165/65 (72)	165/65 (72)	165/65 (28)	43 (24-132)	None reported	
^v Robinson and Springer ⁴⁶	1993	19	15/4 (79)	15/4 (79)	16/3 (16) 48	39 (24-61)	4 (3)	

^aNo histologic confirmation noted.
^bThirteen surgeons; highest complication rate reported; separated patients into histologically positive and negative. This table only includes Stages I, II, and III results.
^cMajority of patients are steroid associated.
^dMajority of patients are steroid associated; retrospective study of multiple surgeons for small number of patients.
^eRelates continued steroid use with clinical failure.
^fIncludes core decompression patients (17) and core decompression with bone graft (18).
^gDistinct result reported for Stage IIA (sclerotic) versus Stage IIB (cystic).
^hSmall prospective randomized study, shows large difference between clinical versus radiologic success.
ⁱAll patients have pain relief in Stages I and II disease. These figures combine radiographic progression of symptomatology.
^jSmall prospective study; Stages I and II disease show increased Harris Hip Scores.
^kCorrelates size of lesion on magnetic resonance imaging with prognosis.
^lSmall prospective randomized trial, treatment arm.
^mCore specimen in pathology, photograph shows cartilage cap.

TABLE 2. Nonoperative Treatment

Principal Author	Year	No. Hips	Clinical Success/Failure (%)	Radiographic Success/Failure (%)	Hip Replacement		Mean Age (range)
					Success/Failure (%)	Followup (Months)	
Coste et al ¹⁴	1960	100	27/73 (27)	27/73 (27)	-	24	34 (17-80)
Dubois and Cozen	1960	19	1/18 (5)	-	2/17 (90)	-	-
^a Mankin and Brower ³³	1962	9	2/7 (22)	2/7 (22)	2/7 (78)	35	-
Patterson et al ⁴²	1964	30	5/25 (17)	5/25 (17)	-	-	-
d'Aubigné et al ³⁴	1965	90	19/71 (21)	29/61 (32)	-	36 (12-48)	18-75
^b Boettcher et al ⁶	1970	5	1/4 (20)	1/4 (20)	-	72	-
Romer and Wettstein ⁴⁷	1971	46	5/41 (11)	-	-	42	-
Lee et al ³¹	1980	11	0/11 (0)	0/11 (0)	-	66	-
^c Nixon et al ³⁹	1980	6	2/4 (33)	2/4 (33)	2/4 (66)	-	-
^d Crues ¹⁵	1981	118	49/69 (42)	-	-	-	-
Inoue and Takaoka ²⁴	1981	37	6/29 (16)	6/29 (16)	-	4-10	-
Bassett et al ⁴	1984	33	2/31 (6)	7/26 (21)	-	21	-
Steinberg et al ⁶³	1984	55	7/48 (8)	4/44 (8)	4/44 (81)	21	-
Zizic and Hungerford ⁶⁷	1985	15	2/13 (13)	2/13 (13)	-	44	-
Musso et al ³⁸	1986	50	3/47 (6)	-	12/38 (76)	16	44 (13-76)
Tooke et al ⁶²	1988	3	0/3 (0)	0/3 (0)	0/3 (100)	18	-
Bradway and Morrey ⁷	1989	25	0/25 (0)	-	0/25 (100)	20	58 (30-74)
^e Stulberg et al ⁵⁶	1990	26	3/24 (11)	12/15 (44)	5/22 (81.5)	27	39 (15-65)
^f Ohzono et al ⁴⁰	1992	115	37/78 (32)	37/78 (32)	-	60	41 (18-70)
Aaron et al ²	1993	16	7/9 (44)	6/10 (38)	9/7 (44)	24	38 (21-60)
^g Robinson and Springer ⁴⁶	1993	16	7/9 (44)	6/10 (38)	9/7 (44)	48	42 (26-67)
21 studies		819	182/637 (22.7)	146/413 (26.7)	45/174 (20.5)		
Since 1983		354	68/287 (19.2)	74/173 (30.0)	39/146 (21.1)		

^aAll patients with Chandler's disease.^bAll patients with coagulopathies.^cAll patients with renal transplants.^dAll patients treated with steroids.^eControl arm of prospective study.^fNotes size and location of lesion relative to outcome.^gControl arm of prospective study of core decompression.

with 146 (26.7%) of 559 hips showing no progression (femoral head collapse) on radiographs. Eighty percent (174 of 219) of hips required hip arthroplasty or a salvage operation. The mean followup in these studies was 34 months (range, 20 months to 10 years) (Table 2). Results graded by Ficat Stage include hip survival rates of 35% for Stage I, 31% for Stage II, and 13% for Stage III. Stratification by other etiologic and demographic factors such as steroid use, history of systemic lupus erythematosus, or alcohol use did not influence overall percentages. When only reports published since 1983 were analyzed, similar results were found, with only 68 (19.2%) of 354 hips doing well clinically (Table 2).^{2,4,7,38,40,46,53,56,62,67}

Nonoperative treatment as analyzed and reported here included various methods such as full weightbearing as tolerated, partial weightbearing with crutches, and non-weightbearing. There was no difference in outcome for any of these nonoperative treatment regimens. Eleven studies reported successful clinical outcomes in <18% of hips.^{4,7,17,24,31,38,42,47,53,56,62,67} Three studies^{2,15,46} reported >40% success rates. Reasons for a higher success rate for these studies may in-

clude location of lesion, short-term followup, nonorthopaedic surgeon evaluation of patients, and less critically ill patients.

Core Decompression Treatment Group

The overall results of core decompression from 24 reports^{2,5,9,10,18,21,23,27,29,30,36,37,43,44,46,48,49,51,55,56,58,62} revealed a 63.5% (741 of 1166 hips) clinical success rate (Table 1). Close to 63% (711 of 1039) of the hips showed no evidence of disease progression on radiographs. Twenty-three percent (341 of 1039) of the hips required total hip arthroplasty or another procedure during the followup period. The mean followup was 30 months (range, 6–114 months). A compilation of reported complications of core decompression is presented in Table 3.

Stratification of the core decompression group into Ficat stages revealed better results for treatment of osteonecrosis in its early stages. Femoral head survival rate (clinical success) was 84% (190 of 227 hips) for Stage I, 65% (155 of 239 hips) for Stage II, and 47% (40 of 86 hips) for Stage III. Stratification by other etiologic and demographic factors did not influence overall percentages.

TABLE 3. Reported Complications

Principal Author	Number of Complications	%	Complication Type
Camp and Colwell ⁹	6	15	3 subtrochanteric hip fractures 1 nondisplaced fracture of femoral head 1 penetration into joint space 1 core break-off
Warner et al ⁶⁵	2	5	1 femoral neck fracture 1 hematoma
Hopson and Siverhus ²¹	1	5	1 fracture across biopsy tract
Tooke et al ⁶²	1	2	1 intertrochanteric fracture
Saito et al ⁴⁸	3	18	Head weakness leading to early collapse
Stulberg et al ⁵⁶	3	5	2 intertrochanteric hip fractures 1 femoral neck fracture
Hungerford ²³	2	1	1 intertrochanteric hip fracture 1 femoral head blow-out
Steinberg et al ⁶⁵	4	2	1 nonfatal pulmonary embolism 1 femoral deep venous thrombosis 1 pneumonia 1 subcapital fracture

The clinical success rate of core decompression done by the 4 groups with the largest reported series and presumably the most experience with the procedure was 70% (5 studies with 655 patients).^{18,22,54,55,57} Exclusion of these reports from the database reduced the clinical success rates to 53% in the remaining 19 studies encompassing 551 patients. More than 60% of the hips in this subset of 19 studies did not require total hip arthroplasty during the followup period.

Overall, 20 studies reported >50% femoral head survival, of which only 4 studies^{9,21,27,30} had a lower rate of success. In these 4 studies, there was >60% clinical efficacy for core decompression in the early precollapse stages. Seventy-five percent of hips in this group did not require further surgery.

Prospective Studies

Two studies^{46,57} (Table 4) represent the only prospective controlled trials of core decompression versus nonoperative management.

Both studies used magnetic resonance imaging for diagnosis and had a minimum 2-year followup. In both studies, a statistically significant difference was reported in the treatment groups. When combining the results of these 2 studies, it is clear that core decompression treatment for early stage osteonecrosis resulted in increased benefit for survival of the femoral head. Twenty-seven of the 36 (75%) precollapse hips treated with core decompression had a clinically successful outcome. Only 8 of 28 (29%) hips in the nonoperative group had a successful result.^{46,57}

DISCUSSION

This review of the literature revealed that 63.5% of all hips had a satisfactory clinical result after core decompression compared with 22.7% with nonoperative treatment. Results for core decompression were the best at the 4 institutions where the highest number

TABLE 4. Results of 2 Prospective Studies

Study	Ficat Stage	Total	Radiographic Failure	Success Clinically	Surgery or Hip Replacement
Robinson and Springer (1992) ⁴⁶					
Core decompression					
	0	4	0/4	4/14	0/4
	I	6	1/6	5/6	0/6
	II	9	3/9	6/9	3/9
	Totals:	19	4/19	15/19	3/19
Natural history					
	0	2	1/2	2/2	0/2
	I	3	1/3	2/3	1/3
	II	11	8/11	3/11	6/11
	Totals:	16	10/16	7/16	7/16
Stulberg et al (1991) ⁵⁷					
Core decompression					
	I	10	5/10	7/10	3/10
	II	7	5/7		2/7
	III	11	11/11	8/11	3/11
	Totals:	28	21/28	8/28	8/28
Natural history					
	I	5	4/5	1/5	4/5
	II	7	4/7	0/7	7/7
	III	10	3/10	1/10	9/10
	Totals:	22	11/22	2/22	10/28

of procedures were done. The nonoperative results by stage for hip survival were Stage I, 35%; Stage II, 31%; and Stage III, 13%. For core decompression, the hip survival rates were 85% for Stage I, 65% for Stage II, and 47% for Stage III.

The authors tried to analyze the reasons why some studies had better or worse results using core decompression than others. In studies reporting the highest success rates, it is possible that patient populations had less severe osteonecrosis or contained a greater proportion of a certain patient population such as alcoholics.¹⁷ In addition, perhaps some of the patients did not have biopsy-proven osteonecrosis¹⁷ and therefore their clinical result would have been superior with or without a core decompression. Certain authors may have had more favorable results because of the large number of core decompressions they are doing, because one would expect complication rates to decrease as the number of procedures done at a center increase. In these centers, there may be an increased awareness of earlier diagnosis by referring physicians combined with a more aggressive treatment standard by the orthopaedic surgeons. Sometimes 1 or a limited number of surgeons do the procedure so the operative technique is optimally standardized, and they report a <2% complication rate.^{17,22} Recent studies have reported that factors such as size and location of the lesion are important in terms of prognosis.^{5,40,54,55,61}

In studies with lower success rates with core decompression, contributing factors may include a patient population with more advanced disease⁶⁵ or a patient group continuing on high doses of steroids.²¹ These studies generally include fewer patients, so that less experience with the technique or less standardization of the technique may occur. One study⁹ included 13 surgeons doing the procedures, and technical variability may have increased the complication rate, which was 15%. To further illustrate the problem of surgical variability, 1 study with poor results included cartilage caps in the core specimens described in the procedure, and in the pathol-

ogy photos³⁰ which were not characteristic of those in other studies.

The results of all core decompression studies were pooled to highlight some controversies concerning this procedure. It has been difficult to analyze the results of core decompression for osteonecrosis as published in various studies because of the small number of patients in any 1 study and the varied stratification of hips in each. Interpretation of these current results should be made in the context of the limitations. This work is an analysis based on articles from a long time span (range, 1960–1993) applying varying rehabilitation protocols, numerous surgeons, and numerous centers around the world with varying standards of care. The lack of consistent followup in many studies, with sparse long-term results reported, also is acknowledged. Several of the above limitations and criticisms are inherent or present in almost every study reviewed.

The need for a large prospective and randomized trial to further clarify these issues is evident. The 2 studies that were done prospectively do show the improved efficacy of core decompression.^{46,57} Unfortunately, the small size and multiple confounding factors in both studies limit their generalizability.

Nonoperative management for osteonecrosis of the hip has been shown in multiple studies to yield extremely poor results with an overall pooled 22.7% clinical success rate. In contrast, core decompression resulted in a pooled clinical success rate of 63.5% for early stages of osteonecrosis. The procedure, if done without technical problems, is much less complicated when compared with surgical alternatives such as vascularized grafting. Complications mostly included hip fractures with rates ranging from 0% to 18%, with the centers doing a high number of procedures having complication rates <5%. Core decompression provides pain relief for a large number of patients and, considering the youth of the patient population, seems a reasonable initial surgical intervention. In the future, newer treatments such as electrical stimulation, os-

teotomy, and vascularized fibular grafting can be compared with the data compiled in this study.

The authors advocate core decompression because of the pain relief often obtained. Because the nature of any individual's femoral head prognosis will be unknown, patients treated with core decompression should be observed carefully for disease progression based on symptoms and changes on radiographs, or both. If progression is seen, other methods such as osteotomy or bone grafting can be used to attempt to salvage the femoral head.

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