

N. Aigner · W. Schneider · V. Eberl · K. Knahr

Core decompression in early stages of femoral head osteonecrosis – an MRI-controlled study

Accepted: 4 October 2001 / Published online: 17 January 2002
© Springer-Verlag 2002

Abstract We treated 45 hips with idiopathic necrosis of the femoral head stages I–III with core decompression. Average age of patients was 41 (27–68) years and average follow-up 68.9 (31–120) months. In 30 hip joints in stage I, 29 showed no radiographic progression and a complete remission of the changes consistent with necrosis on MRI at the last follow-up. In 27 patients the clinical result – based on the Harris Hip Score (HHS) assessment – was excellent (average HHS 91.9 points). Of nine hips in stage II, four had received a total hip arthroplasty, one had deteriorated to stage IV, and four were still classified as stage II (average HHS 95 points). Of six hips in stage III, three had received a total hip arthroplasty and three had deteriorated to stage IV (average HHS 73 points).

Résumé Nous avons traité 45 hanches présentant une nécrose idiopathique de la tête fémorale de stade I–III par décompression. L'âge moyen des malades était de 41 (27–68) ans et le temps moyen de suivi de 68,9 (31–120) mois. Pour 30 hanches de stade I, 29 n'ont montré aucune progression radiographique au dernier recul et une complète régression des anomalies IRM. Chez 27 malades le résultat clinique était excellent (HHS moyen 91,9 points). De neuf hanches au stade II, quatre avait reçu une arthroplastie totale, une s'était aggravée au stade IV et quatre étaient encore classées comme stade II (HHS moyen 95 points). De six hanches au stade III, trois avait reçu une arthroplastie totale et trois s'étaient aggravés au stade IV (HHS moyen 73 points).

Introduction

Despite growing experience with idiopathic necrosis of the femoral head only few facts about the pathogenetic mechanisms have been firmly established. Intraosseous

hypertension has been measured and reported, even at early stages of the disease [1, 5, 8, 9, 11, 20, 22]. Because of the compartmental structure of the proximal femur the elevated pressure may play an important pathogenic role.

Without surgical treatment prognosis is poor [12, 16, 19]. The bony repair mechanisms are mostly insufficient. Based on the pathogenetic assumption of a compartment syndrome of the femoral head the therapeutic principle of core decompression was established [5, 4, 2].

There is controversy in the literature about how effective this therapeutic procedure is [5, 9, 11, 12, 13, 16, 20, 24]. The aim of this study was to assess the efficacy of core decompression in early stages of osteonecrosis of the femoral head.

Patients and methods

Between 1993 and 1995, 51 core decompressions in 41 patients with idiopathic osteonecrosis of the femoral head were performed at our institution. Thirty-nine patients (49 hips) with stage I–III necrosis according to the classification of Association Internationale de Recherche sur la Circulation Osseuse (ARCO) [14] were included. Two patients (four hips) were lost to follow-up.

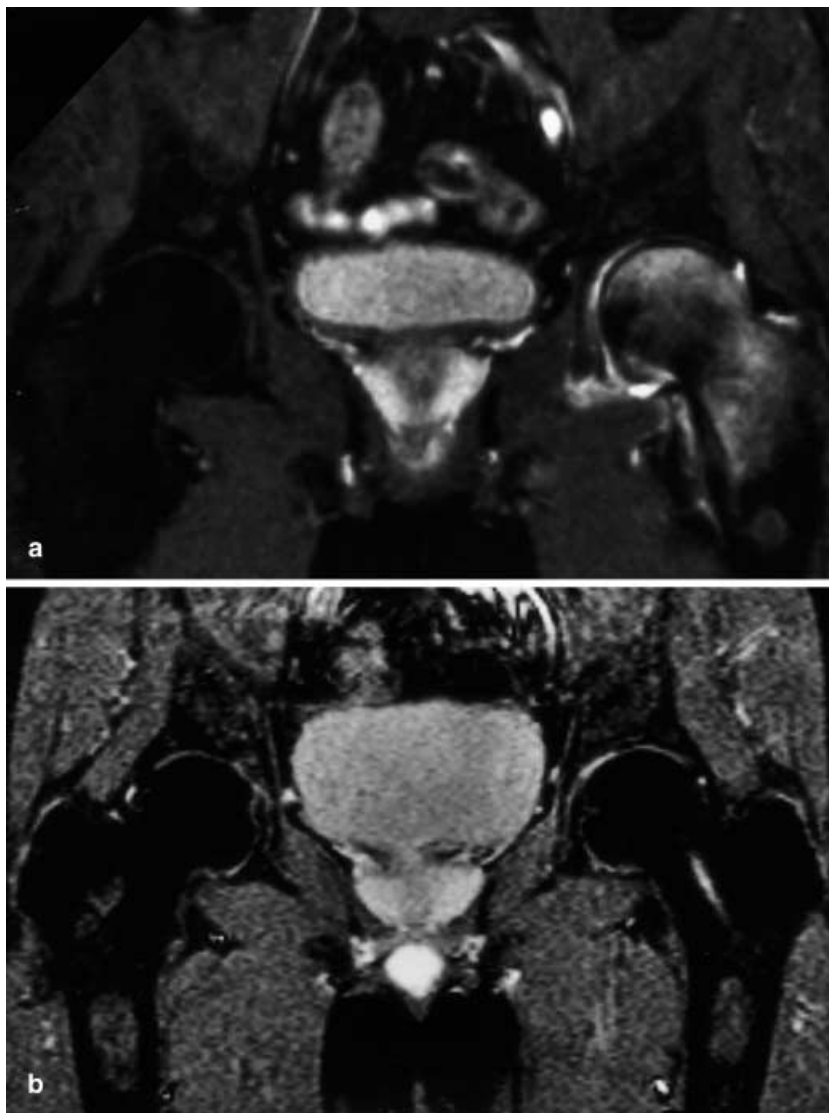
Thirty-seven patients with 45 treated hip joints were followed clinically, radiographically, and by magnetic resonance imaging (MRI) 68.9 (31–120) months after surgery. There were 33 men and four women with a mean age of 41 (27–68) years at time of surgery. Eight patients had involvement of both hips. The diagnosis of early necrosis of the femoral head was established on the basis of patient history, the existence of risk factors (especially visible involvement of the contralateral hip), plain radiographs, and MRI changes. Clinical assessment was based on the level of pain and function according to the Harris Hip Score (HHS) [6]. Radiographic classification was based on the recommendations of ARCO [14]. Preoperatively, 30 hips were classified as stage I without demarcation of a necrotic area (bone marrow edema), nine hips as stage II (2xIIA, 5xIIB, 2xIIC), and six hips as stage III (1xIIIA, 4xIIIB, 1xIIIC) lesions.

Surgical technique

Core decompression was performed on all patients under general anesthesia with the aid of an image intensifier. Using a lateral ap-

N. Aigner (✉) · W. Schneider · V. Eberl · K. Knahr
Orthopedic Hospital Vienna – Speising, Speisinger Strasse 109,
A-1130 Vienna, Austria
e-mail: n.aigner@ping.at
Tel.: +43-1-80182-295, Fax: +43-1-80182-285

Fig. 1 **a** MRI of bone marrow edema of the femoral head ARCO-Stage I with wide extension into the intertrochanteric region. **b** One year after core decompression the MRI shows normal signal patterns without signs of bone marrow edema or osteonecrosis. The canal after core decompression is still visible.



proach, a 3 mm trocar was inserted into the greater trochanter, the femoral neck, and head. With the aid of an 8 mm hollow trephine a core of bone was removed under biplane image intensifier control. Care was taken not to damage the subchondral lamina of the femoral head. After surgery patients were non-weight-bearing for six weeks.

Results

Stage I

At the time of last follow-up (mean 69 (31–120) months) 29 hips in ARCO stage I showed no radiographic progression and a complete remission on MRI of bone marrow edema (Fig. 1). Only one had deteriorated to a stage IIIA (HHS 66 points). Our clinical assessment resulted in 91.9 points (66–100). Twenty-seven hip joints were classified as good or very good, and three as fair.

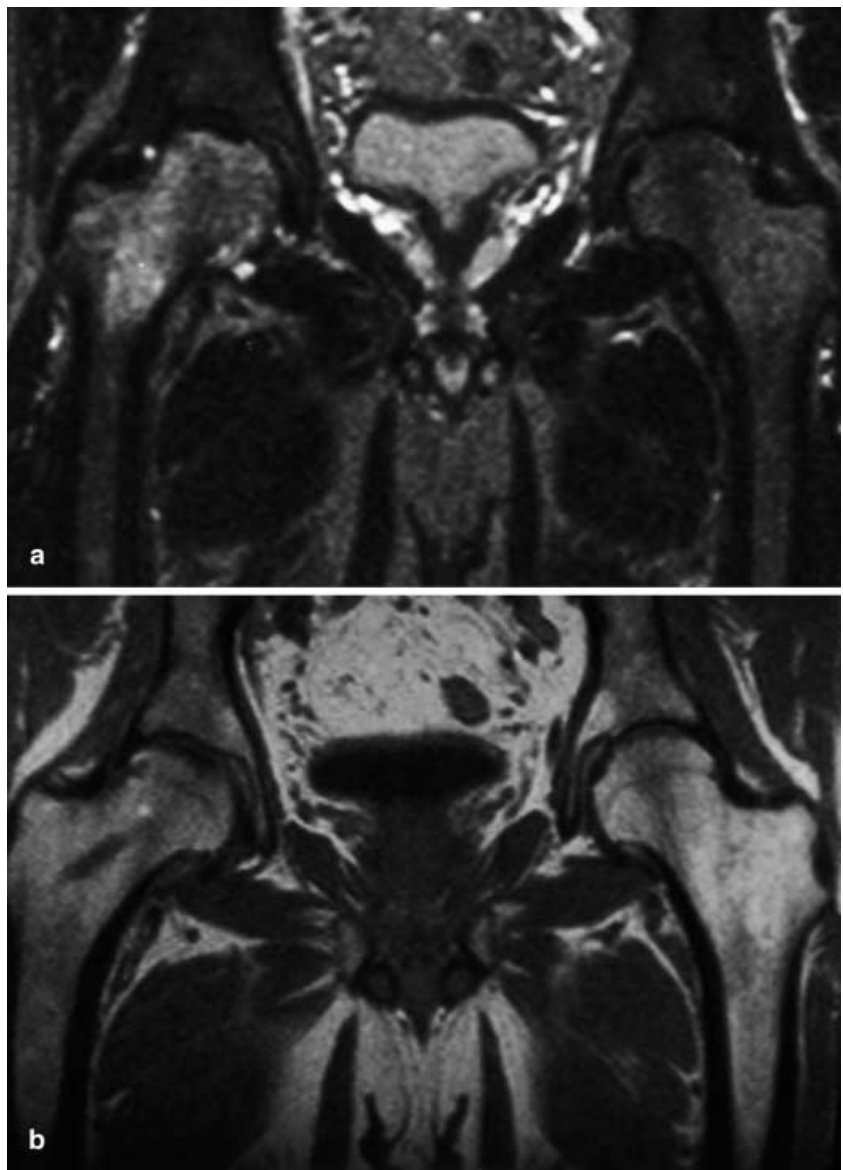
Stage II

Four of nine hips with ARCO stage II showed no progression on plain radiographs and MRI (2xIIA, 2xIIB) after a mean of 69.2 (34–92) months. All were classified clinically as good or very good, three with complete pain relief. The HHS improved from 79 (73–93) points preoperatively to 95 (86–100) points at follow-up. In one case (stage IIB) progression led to a stage IV with an HSS of 64 points after a follow-up period of 61 months. Despite daily pain and discomfort the patient refused to have a total hip replacement. Four hip joints (2xIIB, 2xIIC) required a total hip arthroplasty after a mean of 46.5 (18–84) months.

Stage III

Three of six hips (2xIIIB, 1xIIIC preoperatively) were converted to a total hip arthroplasty after an average of

Fig. 2 a MRI of osteonecrosis of the femoral head ARCO Stage III B. **b** Six years following core decompression MRI shows slight progression to ARCO stage IV osteonecrosis.



16 (14–18) months. The three remaining hips (1xIIIA, 2xIIIB) had deteriorated to stage IV (Fig. 2) after 72 (59–84) months, with a clinical outcome of 73 (44–89) points. One patient will undergo arthroplasty; the other two refused further surgery due to lack of severe subjective complaints.

Discussion

There is controversy in the literature as to the effectiveness of core decompression in the early stages of idiopathic necrosis of the femoral head. In 1985 Ficat [4] presented a series of 133 patients treated with core decompression, reporting that 94% of those in stage I and 82% in stage II had good clinical results. Radiographically, 87% and 67% showed good or very good results respectively.

Tooke et al. [22] found no radiographic progression and good clinical results in all of ten stage I hips after a mean of 2 years. Eleven of 26 hips at stage II had deteriorated clinically and radiographically. More recently, Stulberg et al. [20] presented the results of 122 hip joints treated with core decompression. The success rate (clinical success, absence of radiological progression, no further surgical intervention) was 89% for stage I and 66% for stage II. They observed three subtrochanteric fractures in two patients. In 1995 Fairbank et al. [3] reported on long-term results of core decompression for Ficat stages I, II, and III of 128 femoral heads in 90 patients. After an average follow-up of 11 years no further surgery was necessary for 88% of the hips in stage I, 72% in stage II, and 26% in stage III. More than half of the hips had progressed radiographically by at least one Ficat stage. In 1997 Powell et al. [15] presented 66% “good-to-excellent” clinical results. In 1991 Stulberg et

al. [21], in a prospective randomized study of 55 hips, found a 70% clinical success rate for operatively treated stage I hips (stage II: 71%, stage III: 73%), in contrast to 20% clinical success for conservatively treated stage I hips (stage II: 0%, stage III: 10%). Simank et al. [18] reported on 94 core decompressions with significantly better survival probability for hips with preoperative Steinberg stages 0, I, and II compared to stages III, IV, and V.

Other authors could not confirm these excellent results. Camp and Colwell [1] reported on 31 patients with 40 core decompressions with 60% clinical or radiological progression after an average follow-up of 18 months. Hopson and Siverhus [7] had similar results in 17 patients (20 hip joints) with 60% classified as failures. Both authors described core decompression as a relatively ineffective procedure accompanied by a high risk of intra- or postoperative fractures (5% to 15%). They also believed that functional exploration of bone (pressure measurement, stress tests, and venography) was of little diagnostic help.

In 1995 Koo et al. [10] presented a randomized trial on 37 hips with early stages of osteonecrosis. Eighteen were assigned to core decompression group and 19 to conservative treatment. At a minimum follow-up of 24 months 78% of the core decompressed hips and 79% of the nonoperated hips developed collapse of the femoral head. In 1996 Markel et al. [12] found a clinical success rate of 45.5% in Ficat stage I, 37.5% in stage IIA, 14.3% in stage IIB, and 25% in stage III.

Saito et al. [16] reported 47% poor clinical and 53% poor radiological results for 17 stage I hip joints. They believed that core decompression is more of a diagnostic than a therapeutic aid and that any therapeutic effect is achieved at the expense of reduction of the mechanical load-bearing capacity of the femoral head. Learmonth et al. [11] shared the view that once necrosis has appeared core decompression does not essentially influence the course of the disease. They reported on 12 hips in stage I with 58% clinical and 75% radiographic progression,

and 29 hips in stage II with 76% clinical and 86% radiographic progression.

Yoon et al. [24] retrospectively reported results of 39 core decompressions. They found two failures in 14 preoperatively mild cases, four failures in seven moderate cases, and 16 failures out of 19 severe cases.

Despite these pessimistic reports the prognosis of the natural history of the disease or the results of conservative treatment are clearly worse than the worst published results of core decompression. Clear differences can be identified in the patient samples of the various studies published in terms of age, sex, particular primary disease, and risk factors, especially in those associated with corticoid-induced necrosis. The techniques used for core decompression are not always identical, and different diagnostic criteria are used to establish the presence of femoral head necrosis. Nevertheless, all these factors only partly explain the discrepancies between the various published results.

Our own results – 90% clinical and 96.7% MRI success at stage I, and 44.4% good clinical and radiographic results at stage II, justify the recommendation to use core decompression as treatment of choice in early stages of femoral head necrosis.

Paying attention to appropriate surgical technique we consider this procedure to be without significant risk. In our series we encountered no severe complications, especially no postoperative femoral fractures. We saw only one postoperative crural vein thrombosis, which took a favorable course.

Core decompression as a part of Ficat's "functional exploration of bone" [4] has lost its importance since MRI became the "gold standard" in diagnosing early stages of the disease. Our MRI-controlled study shows prognostic differences, especially in early stages of osteonecrosis, as has been published by other investigators [17, 23, 24]. In these early stages the differentiation between bone marrow edema syndrome and early stages of osteonecrosis is only possible using MRI. Therefore, we

Table 1 ARCO classification

	Stage 0 Initial	Stage I Reversible early	Stage II Irreversible early	Stage III Transitional	Stage IV Late
Imaging methods	All negative	Radiography and CT – negative; MRI or scan – unspecific signal or accumulation	Radiography and CT – unspecific subchondral changes; MRI – typical necrotic area; scan – "hot spot" or specific "cold in hot spot"	Radiography and CT – subchondral fracture line ± flattening of femoral head; MRI – unspecific signal; scan – eventual "hot in hot spot"	Radiography, CT, and MRI – narrowing of joint cavity, signs of secondary osteoarthritis, eventual acetabular participation; scan – "hot spot"
Localization of necrosis	None	A: medial, B: central, C: lateral	A: medial, B: central, C: lateral	A: medial, B: central, C: lateral	None
Size of necrosis	None	A: small (<15%), B: moderate (15–30%), C: large (>30%)	A: small (<15%), B: moderate (15–30%), C: large (>30%)	None	None
Subchondral fracture/flattening of femoral head	None	None	None	A: minimal (<2 mm), B: moderate (2–4 mm), C: maximal (>4 mm)	None

recommend using the ARCO classification (Table 1), as it takes into account radiographic, CT, MRI, and bone scan aspects, as well as size and localization of the lesion. Based on these criteria core decompression is our treatment of choice in cases with ARCO stage I osteonecrosis of the femoral head and those cases of ARCO stage II with medially or centrally located lesions smaller than 30%. In more advanced cases core decompression reduces pain for only a short period. Total hip replacement has to be considered, especially in stage IIC and III lesions with more extended necrotic areas.

References

- Camp JF, Colwell CW (1986) Core decompression of the femoral head for osteonecrosis. *J Bone Joint Surg [Am]* 68:1313–1319
- D'Aubigne M (1970) Cotation chiffrée de la fonction de la hanche. *Rev Chir Orthop* 56:481–486
- Fairbank AC, Bhatia D, Jinnah RH, Hungerford DS (1995) Long-term results of core decompression for ischemic necrosis of the femoral head. *J Bone Joint Surg [Br]* 77:42–49
- Ficat RP (1985) Idiopathic bone necrosis of the femoral head. Early diagnosis and treatment. *J Bone Joint Surg [Br]* 67:3–9
- Ficat RP, Arlet J (1980) Functional investigation of bone under normal conditions. In: Hungerford DS (ed) *Ischemia and Necrosis of Bone*. Williams & Wilkins, Baltimore
- Harris WH (1969) Traumatic arthritis of the hip after dislocation and acetabular fractures: Treatment by mold arthroplasty. An end result study using a new method of evaluation. *J Bone Joint Surg [Am]* 51:737–755
- Hopson CN, Siverhus SW (1988) Ischemic necrosis of the femoral head. Treatment by core decompression. *J Bone Joint Surg [Am]* 70:1048–1051
- Hungerford DS, Lennox DW (1985) The importance of increased intraosseous pressure in the development of osteonecrosis of the femoral head: Implications for treatment. *Orthop Clin North Am* 16:635–652
- Kantor H, Weissinger M, Meznik CH, Eschberger J (1986) Preradiologic stage of idiopathic femur head necrosis demonstrated by intraosseous pressure measurement. *Z Orthop* 124:102–106
- Koo KH, Kim R, Ko GH, Song HR, Jeong ST, Cho SH (1995) Preventing collapse in early osteonecrosis of the femoral head. A randomized clinical trial of core decompression *J Bone Joint Surg [Br]* 77:870–874
- Learmonth ID, Maloon S, Dall G (1990) Core decompression for early atraumatic osteochondrosis of the femoral head. *J Bone Joint Surg [Br]* 72:387–390
- Marcus ND, Enneking WF, Massam RA (1973) The silent hip in aseptic necrosis. *J Bone Joint Surg [Am]* 55:1351–1366
- Markel DC, Miskovsky C, Sculco TP, Pellicci PM, Salvati EA (1996) Core decompression for osteonecrosis of the femoral head. *Clin Orthop* 323:226–233
- Mont MA, Jones LC, Pacheco I, Hungerford DS (1998) Radiographic predictors of outcome of core decompression for hips with osteonecrosis stage III. *Clin Orthop* 354:159–168
- Powell ET, Lanzer WL, Mankey MG (1997) Core decompression for early osteonecrosis of the hip in high-risk patients. *Clin Orthop* 335:181–189
- Saito S, Ohzono K, Ono K (1988) Joint-preserving operations for idiopathic avascular necrosis of the femoral head. *J Bone Joint Surg [Br]* 70:78–84
- Schneider W, Breitensteher M, Engel A, Knahr K, Plenk H Jr, Hofmann S (2000) The value of core decompression in treatment of femur head necrosis. *Orthopaede* 29:420–429
- Simank HG, Brocai DRC, Strauch K, Lukoschek M (1999) Core decompression in osteonecrosis of the femoral head: Risk factor-dependent outcome evaluation using survivorship analysis. *Int Orthop* 23:154–159
- Steinberg ME, Larcom PG, Stafford BB, Hosick WB, Corces A, Bands RE, Hartmann KM (1997) Treatment of osteonecrosis of the femoral head by core decompression, bone grafting, and electrical stimulation. In: Urbaniak JR, Jones JP Jr, (eds) *Osteonecrosis – etiology, diagnosis, and treatment*. American Academy of Orthopedic Surgeons: 293–299
- Stulberg BN, Bauer TW, Belhobek GH, Levine M, Davis A (1989) A diagnostic algorithm for osteonecrosis of the femoral head. *Clin Orthop* 249:176–182
- Stulberg BN, Davis AW, Bauer TW, Levine M, Easley K (1991) Osteonecrosis of the femoral head. A prospective randomized treatment protocol. *Clin Orthop* 268: 140–151
- Tooke MT, Nugent PJ, Basseit LW, Nottingham P, Mirra J, Jinnah R (1988) Results of core decompressions for femoral head osteonecrosis. *Clin Orthop* 228:99–104
- Wirtz C, Zilkens KW, Adam G, Niethard FU (1998) MRI-controlled outcome after core decompression of the femur head in aseptic osteonecrosis and transient bone marrow edema. *Z Orthop* 136:138–146.
- Yoon TR, Song EK, Rowe SM, Park CH (2001) Failure after core decompression in osteonecrosis of the femoral head. *Int Orthop* 24:316–318