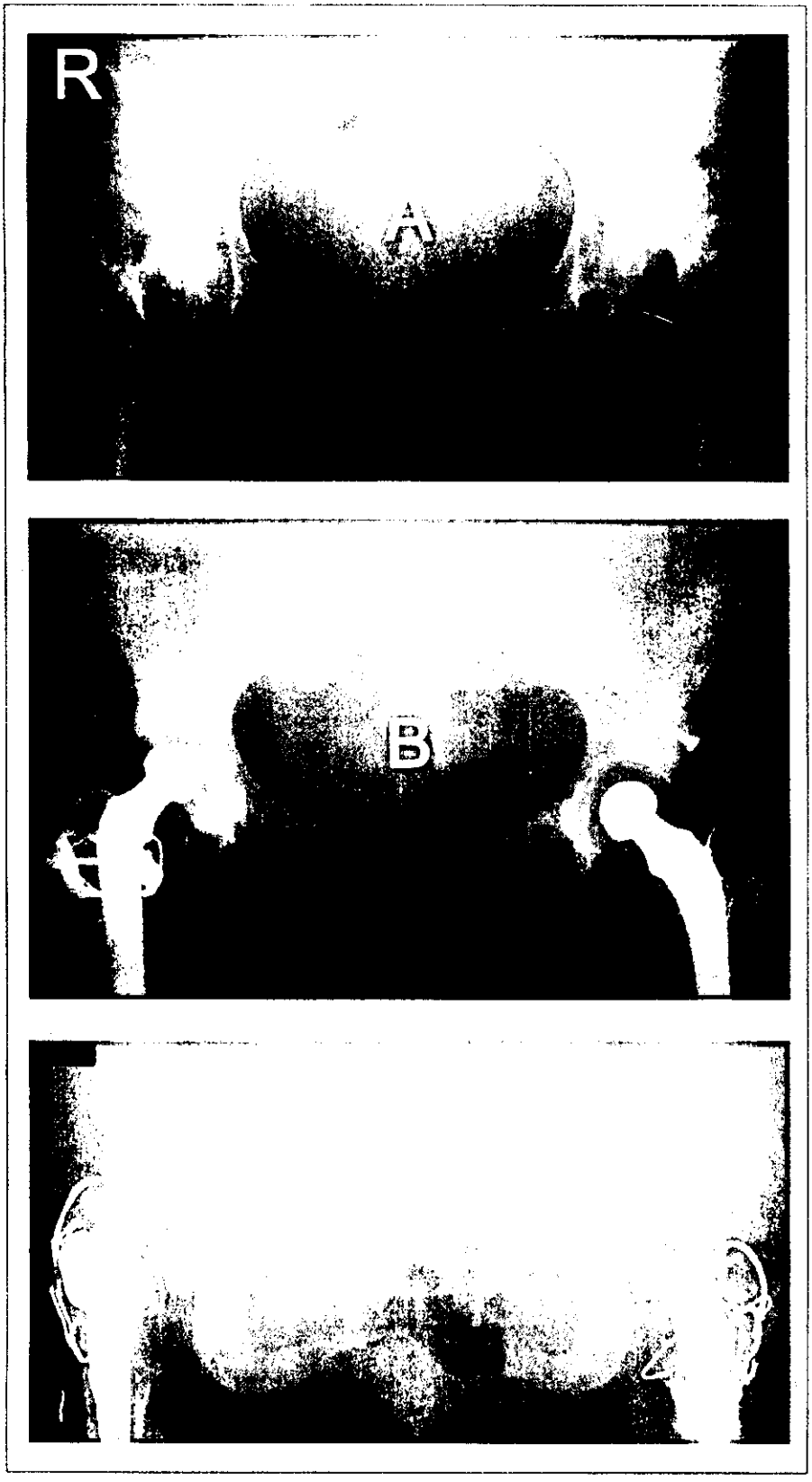

ulum that forms a portion of the false acetabulum) is prepared with surface reaming and drilling of multiple holes (2.8 or 3.2 mm in diameter) to obtain a bleeding bone bed. The cancellous portion of the resected femoral head is then trimmed to be congruent with the bone bed and is fixed with two cortical screws. The graft should be partially supported by the superior lip of the false acetabulum. A final reaming completes the shaping of the inner side of the graft (Fig. 2, *E* and *F*).

Multiple anchor holes are made in the reamed acetabulum but not in the grafted portion. Before 1979, only a few large an-

FIG. 3

A forty-eight-year-old woman underwent bilateral sequential total hip arthroplasty with acetabular bone-grafting (left hip) and without it (right hip) during the same hospitalization in 1983. *A:* Preoperative radiograph showing almost the same pathological findings (Crowe Type-II subluxation and hypertrophic osteoarthrosis) of both hips. *B:* Discharge radiograph showing flanged sockets fixed with bulk autograft (left) and without it (right). The graft coverage of the left socket is 48%, and the center-edge angle of that socket is 1°. The height of the hip center is 22 mm for the right socket and 18 mm for the left. The right socket is placed more proximally, and the bone deficiency of the acetabular roof is filled with cement. *C:* Radiograph made twenty years after the arthroplasties, showing migration of the right socket that requires revision, whereas there is no demarcation around the left socket (Hodgkinson Type 0). Polyethylene wear was measured to be 1.0 mm on the right and 1.3 mm on the left.

CRITICAL CONCEPTS | continued

PITFALLS:

Computed tomography scans of the hip are recommended for planning of this procedure. Computed tomography scans aid in the estimation of the size of the socket and the defects. It is possible that even the smallest off-the-shelf socket cannot be accommodated in an extremely small and deficient acetabulum. Knowledge of the thicknesses of the acetabular walls helps to avoid excessive reaming. Preoperative identification of the location of the external iliac vessels on computed tomography scans can help the surgeon to avoid injuring those vessels during drilling for graft fixation.

As we stated in our original article, the long-term success of the procedure depends on selection of a patient with an age of forty-eight years or older and on graft coverage of the socket of <50%. Younger patients should be educated about appropriate levels of activity. When it is not possible to achieve >50% coverage of the socket by the ilium at the level of the true acetabulum, excessive graft coverage should be avoided by means of additional proximomedial reaming (Fig. 4).

chor holes (12.5 mm in diameter and 1.0 cm deep or less) were bored in the iliac, ischial, and pubic bones (ten hips). Since that

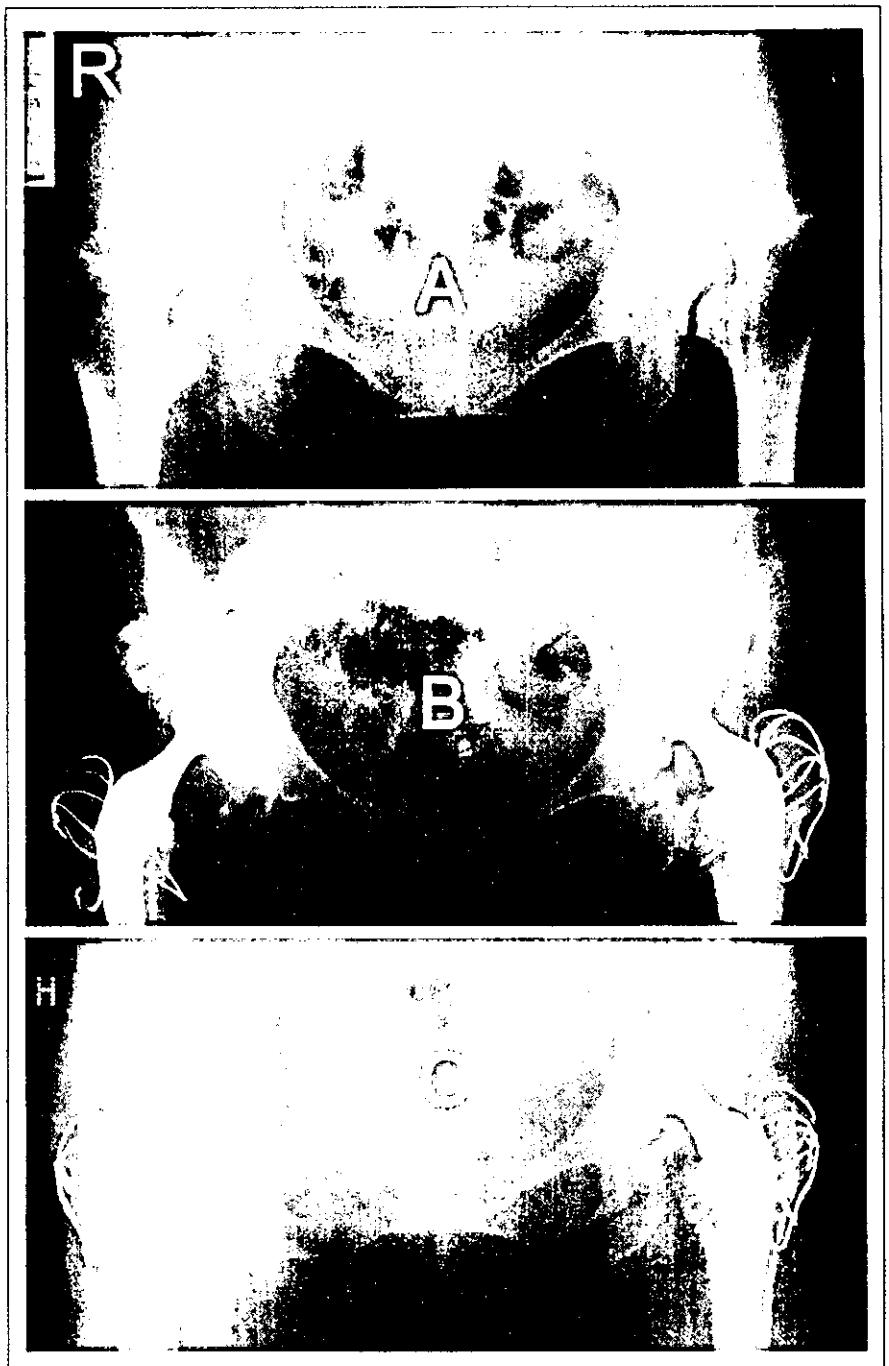

FIG. 4

A fifty-year-old woman underwent bilateral sequential total hip arthroplasty with acetabular bone-grafting. *A:* Preoperative radiograph showing Crowe Type-II subluxation and normotrophic osteoarthrosis of the right hip and Crowe Type-IV dislocation and hypertrophic osteoarthrosis of the left hip. *B:* Discharge radiograph showing sockets fixed with bulk autografts. For the right and left sockets, the graft coverage is 40% and 30%, the socket center-edge angle is 6° and 5°, and the height of the hip center is 25 and 27 mm, respectively. Although both sockets were placed a little proximally, they are nearly within the true acetabulum. *C:* Radiograph made seventeen years after the index procedure, showing no demarcation around the sockets (Hodgkinson Type 0). Polyethylene wear was measured to be 0.2 mm on the right and 0 mm on the left.

time, multiple small anchor holes (6.0 mm in diameter and 6.0 mm deep or less) have been made in addition to the large anchor holes. When a socket with a flange is used, the flange is trimmed to fit the acetabulum. A Charnley socket-holder is used to achieve correct alignment of the socket (inclined at approximately 45° to the transverse plane without anteversion)[4]. The acetabulum is irrigated with saline solution with use of a power-driven rotatory nylon brush and then is packed with hydrogen-peroxide-soaked gauze just before insertion of the cement. The socket is pushed into the cement-filled acetabulum, at first with its face directed more distally. When the inferior part of the rim reaches the full depth, the socket-holder is moved to achieve the final orientation of the socket while pressure is exerted firmly with a pusher on the face of the socket-holder[5]. Full pressure is maintained with the pusher and a thumb on the socket during hardening of the cement.

In the seventeen hips in our series that were treated before 1980, the femoral medullary canal was enlarged by removing weak cancellous bone, and a femoral prosthesis was fixed with cement, without occlusion of the distal part of the medullary canal (the so-called first-generation cementing technique). In the twenty hips treated since 1980, the so-called second-generation cementing technique, which included brushing, insertion of an intramedullary plug, and use of a vent tube, has been employed. With both methods, cement was introduced into the femoral canal in the doughy state by the so-called double-thumb packing technique[4].

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CRITICAL CONCEPTS | continued

AUTHOR UPDATE:

The following modifications were made after the index period.

- As described above, we expanded the indications for the procedure to allow complete osseous containment of the acetabular component and a horizontal cement-bone interface at the acetabular roof.
- We no longer bore the large (12.5-mm-diameter) central pilot hole before reaming or the large anchor hole in the iliac bone after reaming.
- The trimmed surface of the bulk autograft now is coated with a thin (about 1.0-mm-thick) layer of bone debris (obtained during the latter part of acetabular reaming) before it is applied to the prepared bone bed. This technique has been found, on postoperative radiographs, to be effective in eliminating any gap between the graft and the ilium.
- Instead of cortical screws, cancellous screws (4.0 or 6.5 mm, depending on the size of the graft) have been used to fix the bulk autograft since 1996.
- Since 1996, cement has been introduced into the femoral canal with a cement gun, instead of with the so-called double-thumb packing technique[4].
- Although we still use the flanged Charnley socket with cement, we currently use the continuous triple-tapered polished cemented stem (C-stem; DePuy, Leeds, United Kingdom).

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Original articles

Osteonecrosis of the femoral head in Japanese adults after liver transplantation: a preliminary report

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Abstract Patients who are treated with high-dose corticosteroids as an immunosuppressive therapy are at high risk of developing osteonecrosis, especially in the femoral head. We examined whether symptomatic osteonecrosis of the femoral head (ONFH) would be a clinical problem after liver transplantation. From June 1990 to December 2001, a total of 169 patients underwent liver transplantation at the Shinshu University Hospital. Within this group, 65 patients were more than 18 years old at the time of surgery, and all were enrolled in the present study. All patients were referred to the Orthopaedic Department of Shinshu University Hospital when they experienced musculoskeletal symptoms, including hip or groin pain. In addition, they were informed of the potential risk of osteonecrosis associated with immunosuppressive therapy after the liver transplant. As result, the patients were advised to have a magnetic resonance imaging (MRI) check for osteonecrosis after transplant surgery. In terms of outcomes, none of the patients presented with symptomatic hip difficulties due to osteonecrosis. Additional clinical investigation revealed that of the 18 patients who underwent MRI screening, only one was found to have asymptomatic unilateral ONFH. In conclusion, ONFH after liver transplantation has not been a clinical problem for our patients.

Key words Osteonecrosis · Femoral head · Liver transplantation · MRI

Introduction

Liver transplantation has become a common procedure for treating patients in Japan with severe chronic hepatic disorders. However, due to allogeneic transplantation, postoperative immunosuppressive regimens are required for the survival and normal function of the transplanted liver. Corticosteroids are effective immunosuppressants, although it is also well known that the use of these agents can lead to disruption of normal bone function over time and eventually osteonecrosis of the femoral head or other bones. Therefore, liver transplant patients are at potential risk for bone loss.

Surveys to determine the prevalence of osteonecrosis in liver transplant cases are limited, particularly in Japan. The purpose of this preliminary study was to determine the incidence of symptomatic and asymptomatic osteonecrosis of the femoral head in liver transplant patients undergoing treatment with immunosuppressive agents including corticosteroids.

Patients and methods

Between June 1990 and December 2001 a series of 169 patients underwent liver transplantation at Shinshu University Hospital. The age distribution of the recipients was as follows: 104 were younger than 17 years (pediatric patients), and 65 were older than 18 years old (adult patients). The adult patients were the subjects for the present study. Because babies accounted for a large number of our liver transplant patients, infants were excluded from this study.

All patients were examined for or questioned about musculoskeletal symptoms by interviews at hospital visits. If there were complaints of musculoskeletal symptoms, including hip or groin pain, the patients were referred to the orthopedic surgeon. For these patients, roentgen grams and magnetic resonance imaging (MRI) studies were used as needed to confirm the diagnosis of osteonecrosis of the femoral head (ONFH).

Additionally, patients who did not show evidence of symptomatic hips during the posttransplant periods were interviewed by surgeons, who explained the purpose of our prospective study. After the patient agreed

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to participate in the study, MRI was performed to screen for ONFH. For these patients, an MRI apparatus with a 1.5-tesla magnet (Signa Advantage; General Electric Medical System, Milwaukee, WI, USA) was used to obtain both T1- and T2-weighted images in coronal planes. All images were assessed by two orthopedic surgeons (H.H. and K.T.) and a radiologist (O.K.) independently. The MRI diagnosis of osteonecrosis was made on the basis of criteria established in previous studies.[13,16]

Postoperative immunosuppressive regimen

The immunosuppressive regimen for the patients presented here has been described elsewhere.[3,4] Before August 1993, the major immunosuppressants consisted of intravenous or oral cyclosporine to maintain a serum level of 250–300 ng/ml (measured by the fluorescence polarization immunoassay) and corticosteroids. Since September 1993, intravenous tacrolimus at a serum level of 15–20 ng/ml (microparticle enzyme immunoassay) during the first 2 weeks, 10–15 ng/ml on days 15–21, and 5–10 ng/ml thereafter was added to the regimen. Methylprednisolone was started at 20 mg/kg/day the morning of the operation and gradually tapered over 7 days to 0.5 mg/kg/day and then to 0.06 mg/kg/day by 6 months. These protocols for methylprednisolone use were unchanged since Jun 1990.

Acute allograft rejection was monitored histopathologically in most cases by percutanous liver biopsy. Initial treatment consisted of intravenous methylprednisolone at 10–20 mg/kg body weight, tapering over 5 days to the maintenance dose.

Results

Of the 65 adult patients, 2 (2.9%) presented with hip pain and visited the orthopedic clinic of Shinshu University Hospital. One of these patients (1.5%) had stumbled and fallen from a standing position 1 year after the liver transplant procedure. Upon radiographic examination, a right femoral neck fracture was noted, but the patient could not undergo total hip arthroplasty because of her poor general condition. Another patient developed mild left hip pain 4 months after receiving a new liver. On further examination with radiography and MRI, no abnormal findings suggestive of osteonecrosis were defined, and the pain subsided within a few days with no residual functional disability.

Altogether, 18 patients (9 men, 9 women), including the two symptomatic cases described above, underwent MRI (Table 1). These patients had no history of alcohol abuse or other common risk factors for ONFH, except glucocorticoid use. The average age at the time of MRI was 39.6 years. The average follow-up periods after transplantation, at the time of MRI, was 2 years 6 months (range 2 months to 9 years 10 months). Among these patients, only one presented a typical image of osteonecrosis of the femoral head. This patient's postoperative course resembled that of the other cases; there was no severe allograft rejection and no additional high-dose methylprednisolone use. The patient's hip

Table 1. Clinical data for 18 liver transplant patients who underwent MRI

Patient	Interval from LT to MRI (months)	Duration of steroid use (months)	Cumulative dose of steroid (mg)	Additional pulse therapy	Other risk factors
1	23	23	7213	Y	N
2	34	34	8075	Y	N
3	11	11	3781	N	N
4	4	4	6779	Y	N
5	20	20	9321	Y	N
6	4	4	5528	Y	N
7	2	2	3045	N	N
8	2	2	5922	Y	N
9	6	6	5319	N	N
10	3	3	3386	N	N
11	5	5	5835	Y	N
12	14	14	6054	Y	N
13	14	14	6345	Y	N
14	3	3	5612	Y	N
15	110	110	16817	N	N
16	78	78	16452	Y	N
17	48	48	8422	N	N
18*	2	2	3380	N	N

LT, liver transplant; MRI, magnetic resonance imaging; N, no; Y, yes
*Osteonecrosis

was asymptomatic at the time of diagnosis and at the most recent follow-up.

Discussion

Corticosteroids are known to induce osteonecrosis, especially in the femoral head. The compromised vasculature and subsequent ischemic bone necrosis may result from a steroid-induced hypercoagulation state,[6] abnormal lipid metabolism as a result of corticosteroid use,[7,17] or a fat embolism.[5,6] However, the precise pathophysiological mechanism by which steroids cause bone necrosis in patients with immunological disorders such as systemic lupus erythematosus, asthma, or nephritis is yet to be elucidated. In terms of the risk of transplantation-related osteonecrosis, several studies have looked at patients receiving bone marrow or kidney transplants. The prevalence of osteonecrosis of the femoral head in renal[2,8,14] and bone marrow[1,12,15] transplant patients was 3%–23%. Torii et al. reported Japanese patients with osteonecrosis of the femoral head after bone marrow transplantation and indicated that the risk factors for bone necrosis were the patient's age at the time of transplantation, chronic graft-versus-host disease, and pulsatile administration of steroids.[15] In the present study, it was not possible to run this type of analysis because of the low incidence of bone necrosis.

A few studies have reported on the prevalence of osteonecrosis after liver transplantation. Papagelopoulos et al. reported that 23 (8.1%) of 285 liver transplant recipients developed symptomatic osteonecrosis after surgery, and 7 patients required joint arthroplasties (total hip arthroplasty 5, total knee arthroplasty 2).[10] In another report, 4 (2%) of 203 patients were diagnosed with osteonecrosis of the hip; these authors noted that, overall, this condition was rare and would not require MRI screening.[9] In addition, Porayko et al. reported that 12 (8.2%) of 142 patients who underwent liver transplantation developed osteonecrosis of the femoral head.[11] In the current study, despite the use of high-dose corticosteroids for immunosuppression, none of the patients presented with symptomatic ONFH, and only 1 of 36 hips in 18 patients screened by MRI screening developed asymptomatic ONFH.

Because of the delay in the start of organ transplant medicine in Japan, the total number of transplant patients and those with MRI data are limited. However, ONFH after liver transplantation has not been a clinical problem for our patients.

Lieberman et al. also noted the lower prevalence of osteonecrosis after liver transplant surgery.[9] This group proposed that the difference may be explained in part by the underlying metabolic bone disease associated with chronic renal failure. Clearly, the organ-specific incidence of ONFH requires closer examination.

Although this is the first epidemiological report of osteonecrosis associated with liver transplants in Japan, the data presented in this study are retrospective and incomplete. A more accurate estimate of the incidence of ONHF or potential risk for ONFH in liver transplanted patients will be possible when larger numbers of cases with prospective clinical data and long-term follow-up are available.

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Continuous Local Cooling for Pain Relief Following Total Hip Arthroplasty

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Abstract: This study is the first to evaluate whether continuous cryotherapy can relieve pain soon after total hip arthroplasty (THA). Patients who had undergone THA for osteoarthritis were divided into 2 prospective, randomized groups: the cryotherapy group was fitted with a computer-controlled cooling device for 4 days, and the control group was not. The pain scores measured on a visual analog scale between days 1 and 4 following surgery were significantly lower for the cryotherapy group than for the control group. Furthermore, postoperative analgesic use by the cryotherapy group was significantly lower than by the control group. The results of this study support the potential benefit of a cold compressive device for pain reduction during the postoperative recovery of patients undergoing THA. **Key words:** cryotherapy, total hip arthroplasty, pain, visual analog scale, analgesic.

Past studies have shown that local cooling is effective for the relief of postoperative pain following surgery in areas near to the skin, such as the knee joint [1–6]. However, there have been no reports dealing with the efficacy of postoperative cryotherapy for pain relief as applied to the hip joint. This is because it was thought unlikely that the cooling action on the skin surface would extend to the deeper hip joint region [7]. This study is the first to demonstrate directly that postoperative local cooling is extremely effective for relieving postoperative pain after total hip arthroplasty (THA). We believe that the application of cryotherapy in this manner will reduce postoperative pain, relieve stress, and thus result in more rapid ambulatory rehabilitation.

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Materials and Methods

Forty-six patients (37 females, 9 males) underwent primary cementless THA for osteoarthritis and were randomly divided into a cryotherapy group (23 subjects) and a control group (23 subjects). The same prosthesis (S+G Implants, ESKA, Lübeck, Germany) was used for THA via a posterolateral approach with the patient in a lateral position under general anesthesia. Both the socket and the stem implants were fixed without cement. Mepivacaine hydrochloride for pain relief at a dose of 250 mg or less was routinely administered to both groups via a continuous epidural tube for 24 hours after surgery, followed by an additional dose until 72 hours after surgery for patients with continuing complaints of pain. In Japan, postoperative epidural anesthesia is commonly used in THA. As an adjunct analgesic, diclofenac sodium at a daily dose of 50 mg or less was administered. In the cryotherapy group, an adhesive bandage was applied to the suture wound and covered with 10 layers of gauze. A cooling pad (23 × 33 cm) wrapped in a waterproof cover then was applied to the gauze immedi-

ately after surgery, and the surgical wound was fixed with a cloth anchor band (Prepants, Sigmax, Tokyo, Japan). A computer-controlled cooling device (Icing System 2000, Sigmax) was started up in the operating room immediately after surgery and was run continuously for 4 days with the cooling temperature set to a constant 5°C. The same procedure was used for the control group, including fixation of the surgical wound with the cloth anchor band for 4 days, but not the cooling procedure.

Blood loss 12 hours and 24 hours after surgery, as well as the final gross amount of blood loss, were measured. Blood was collected on postoperative days 1, 4, and 7 to determine creatine kinase (CK) and C-reactive protein (CRP) levels. Total doses of mepivacaine hydrochloride and diclofenac sodium used for pain relief also were measured. Postoperative pain of the hip was scored from 0 (no pain) to 10 (worse possible pain) by using a visual analog scale. The patients recorded their pain scores on a visual analog scale questionnaire by themselves on consecutive postoperative days 1 to 7. During this period, all patients remained hospitalized.

The unpaired *t*-test was used for all statistical analyses of the results as well as for comparisons between the cryotherapy and control groups, except for the analysis of analgesic use and pain scores, for which the Mann-Whitney *U* test was used. A 2-tailed *P* value of less than .05 was considered statistically significant.

Results

Of the 23 patients who underwent cryotherapy, cooling was suspended for 1 patient on postoperative day 1 because of discomfort experienced as a result of cooling the surgical site. No other complications such as skin problems or neuroparalysis were observed. As a result, findings for 22 patients in the cryotherapy group and 23 patients in the control group were compared. There were no differences in age (59.3 ± 11.4 years vs 59.0 ± 11.2 years; $P = .989$), body weight (53.7 ± 9.5 kg vs 55.4 ± 11.0 kg; $P = .913$), body height (1.54 ± 0.07 m vs 1.52 ± 0.08 m; $P = .368$), duration of surgery (111 ± 12 minutes vs 118 ± 24 minutes; $P = .144$), or blood loss during surgery (412 ± 130 g vs 444 ± 206 g; $P = .786$) between the cryotherapy and the control group.

There were no significant differences between the 2 groups in the amount of postoperative blood loss, CK levels, or CRP levels. However, the total dose of mepivacaine hydrochloride used as the main analgesic was significantly lower for the cryotherapy than for the control group. On the other hand, the total dose of diclofenac sodium administered as an adjunct analgesic was not significantly different (Table 1).

Table 1. Comparison of Postoperative Blood Loss, CK Level, CRP Level, and Analgesic Use Between Cryotherapy and Control Groups

Variables	Cryotherapy (n = 22)	Control (n = 23)	*P*
Postoperative blood loss (mL)			
Hour 12	611 ± 301	658 ± 333	.633*
Hour 24	733 ± 389	755 ± 334	.812*
Total	1,110 ± 685	1,123 ± 436	.972*
Postoperative CK level (U/L)			
Day 1	556 ± 360	592 ± 342	.510*
Day 4	237 ± 149	254 ± 215	.561*
Day 7	109 ± 65	98 ± 46	.481*
Postoperative CRP level (mg/L)			
Day 1	46.2 ± 20.6	48.9 ± 26.8	.361*
Day 4	59.9 ± 42.4	50.1 ± 24.1	.571*
Day 7	29.0 ± 25.3	24.5 ± 15.3	.347*
Total dose of mepivacaine hydrochloride (mg)	295 ± 99	489 ± 160	<.001†
Total dose of diclofenac sodium (mg)	58 ± 54	60 ± 50	.529†

NOTE. Plus-minus values are means ± SD.
*Unpaired *t*-test.
†Mann-Whitney *U* test.

Pain scores measured postoperatively from day 1 to day 4 were significantly lower for the cryotherapy group than for the control group. On postoperative days 5, 6, and 7, pain scores for the cryotherapy group were lower, but not significantly so (Fig. 1). Pain had disappeared by postoperative day 3 in more than half of the cases of the cryotherapy group, whereas it took up to 5 days for the pain to disappear for more than half of patients in the control group.

Discussion

In recent years, computer-controlled cooling equipment that continuously cools the local region at a constant temperature has been developed and tested for efficacy in an objective manner. However, the pain-relief efficacy of postoperative cryotherapy has been recognized only for regions near the skin, as in knee –surgery [16], but not in cases involving deeper hip surgery, except for one study that found a reduction in hospitalization time for THA patients

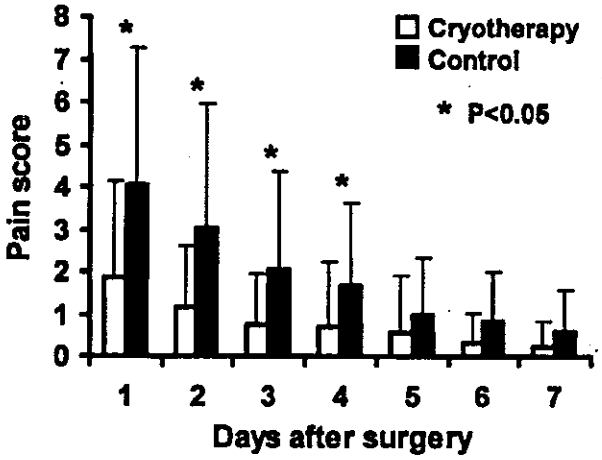

Fig. 1. Comparison of pain relief between cryotherapy and control groups after THA. Pain scores measured postoperatively from day 1 to day 4 were significantly lower for the cryotherapy group than for the control group.

undergoing cryotherapy for undetermined reasons [8]. This is because the effects of cutaneous cooling are thought to penetrate only several centimeters below the skin surface [7]. In fact, our study did not find the reduction in blood loss as a result of cooling observed after total knee arthroplasty [1]. Moreover, cryotherapy for THA has no effect on CK or CRP levels, indicating that it has no inhibitory effect on muscle damage or inflammation. Nevertheless, this study is the first to demonstrate that postoperative pain is substantially relieved even in hip surgery.

The mechanisms by which postoperative local cooling relieves pain are thought to result in large part from 2 sets of coordinate actions [9–13]. The first involves the effects on tissue metabolism. Cryotherapy relieves bleeding and edema by constricting blood vessels. It also reduces the tissue metabolic rate, thus curbing nutrients needed for tissues, and relieves inflammation by suppressing enzymatic activity and preventing secondary tissue damage. For the second set of actions, cryotherapy is thought to exert a local anesthetic action that may elevate the pain threshold and restrain muscle tissue spasms, thereby reducing pain. If the cooling action does not reach the deeper hip regions yet results in pain reduction, this may indicate that the major part of pain experienced following THA is less associated with the deeper joint than with the soft tissues ranging from the skin to the shallow subcutaneous tissues.

Postoperative pain represents a large burden for postoperative ambulatory rehabilitation. If early pain management through cryotherapy is successful, it is clear that early-stage rehabilitation can be performed efficiently. Consequently, the risk of postoperative thromboembolism [14,15] can be expected to decrease.

In this study, the cooling procedure was not used for the control group. Patients in the control group with the cooling pad set at a nontherapeutic temperature could recognize that they were not being cooled and thus were not in the therapeutic group. Therefore, we could not obtain a completely blinded control for the cryotherapy. A placebo effect seems to be unavoidable with this type of trial.

Postoperative continuous cryotherapy is a simple, noninvasive, and effective approach for pain management following THA. Furthermore, diminished stress and accelerated ambulatory rehabilitation suggest that cryotherapy has broad therapeutic benefits. We are confident that the results of this study will lead to the adoption of continuous cryotherapy as a routine procedure after THA.

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CASE REPORT

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Tominaga Shimizu · Hiroyuki Kato**

Locking of the knee caused by localized pigmented villonodular synovitis: a case report

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Abstract Pigmented villonodullar synovitis (PVS) occurs in two forms: diffuse PVS and localized pigmented villonodular synovitis. In this report, a 40-year-old woman presented with a history of recurrent episodes of knee locking and pain. Arthroscopy revealed a nodular pedunculated mass occupying the area anterior to the intercondylar notch of the femur. Histological examination of the tissue confirmed the diagnosis of PVS. After surgery, the patient's symptoms of pain and recurrent locking promptly resolved.

Key words Arthroscopy · Knee · Pigmented villonodular synovitis (PVS)

Introduction

Pigmented villonodullar synovitis (PVS) occurs in two forms: diffuse and localized (LPVS). The knee joint is the site most commonly affected, although lesions have been described in a variety of other joints. Most consider PVS to be a benign inflammatory process, whereas others think that the pathological characteristics of some lesions suggest a neoplastic condition.[1] We present a case of LPVS of the knee that caused it to lock recurrently. Arthroscopic procedures to remove the lesion were performed, and no recurrence was observed.

Case report

A previously healthy 40-year-old woman presented with a 1-year history of pain in her left knee. It began when the patient started to kneel and felt her left knee lock, preventing full extension. She saw her local physician immediately, who manipulated the knee into extension. Approximately 3 months after the initial injury, the patient again experienced locking of her left knee while running. During this second occurrence, the patient was unable to unlock her knee, and she visited her local physician for treatment. One week after her second injury, the patient visited our hospital. She had no history of remarkable swelling or hemarthrosis of the left knee joint.

Examination revealed a slight limp and restricted range of motion in the knee joint. There was no ligamentous abnormality, and she had no typical meniscus tear signs. No biochemical disorders in the blood examinations were seen. Radiographs did not reveal any abnormal shadows. However, magnetic resonance imaging (MRI) did reveal a mass in the anterior intercondylar space near the insertion of the anterior cruciate ligament. She had experienced both medial and lateral knee pain, which was exacerbated by squatting, standing, and walking. Prior to surgery, her symptoms worsened after prolonged standing, and she could not squat or fully extend her left knee because of pain.

Arthroscopy revealed a nodular pedunculated mass occupying the area anterior to the intercondylar notch of the femur (Fig. 1). The mass was round with a smooth surface and yellow-brown pigmentation. The remaining synovium was seen within the joint space, and all structures were noted to be normal. No other similar lesions were detected. The entire lesion was completely removed through the anteromedial portal. Histological examination of the lesion demonstrated the presence of multinucleated giant cells, hypercellularity, fibroconnective tissue, and pigmentation (Fig. 2). These features established the diagnosis of PVS.

The patient's symptoms of pain and recurrent locking promptly resolved. At her 7-month postoperative follow-up, the patient remains symptom-free and has returned to a low level of sports participation.

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Discussion

Pigmented villonodular synovitis occurs in large joints, bursa, or tendon sheaths. The etiology is unknown. It occurs in two forms: a diffuse pigmented villonodular synovitis involving the entire synovium or a localized pigmented villonodular synovitis.

The localized form of PVS is a rare pathological condition. The knee joint is most commonly affected, and the disease is generally characterized by the presence of a single pedunculated nodular lesion. The patient occasionally presents with various symptoms such as pain, swelling, or a palpable mass in the knee.[2,3] There are a few previous case reports of localized PVS lesions producing meniscal symptoms.[4–6] In the present case, prior to surgery the patient had a recurrence of her knee locking, such as might occur with a locking bucket handle tear of the meniscus.

Fig. 1. Localized pigmented villonodular synovitis lesion located anterior to the intercondylar notch

Histologically, PVS is characterized by a fibrous stroma, proliferation of round histiocytic cells or spindle cells, and hemosiderin deposits in macrophages and synovium. The lesions are predominantly villous or nodular in appearance, and in some cases both are seen. The degree of pigmentation ranges from barely yellow to dark brown.[1]

Although radiographic findings are usually normal when examined in localized PVS, a soft tissue mass is occasionally seen. In patients with a diffuse form of PVS, bony changes are observed in a few cases and consist of cyst formations, cortical erosions, and osteopenia.[4,5] The MRI finding of a localized form of PVS is relatively specific, and the signal intensity is similar to that of the diffuse form of PVS, which is characterized by a hypointense area on both T1- and T2-weighted images. This pattern correlates with intralesional deposits of hemosiderin. However, this appearance is not specific for the localized form of PVS and can be confused with synovial chondromatosis or fibroxanthoma.[7]

The localized form of PVS has a good prognosis, in contrast to the diffuse form. Recurrence has been reported but appears to be uncommon.[1,8] Although there is a paucity of literature on localized PVS, arthroscopy can be used as an effective diagnostic method to identify localized PVS in the knee.[9–11]

Conclusions

We described a case of localized PVS of the knee presenting as a recurring locked meniscal tear in a 40-year-old woman. The patient was treated via arthroscopy to remove the mass, and the diagnosis was confirmed by histological findings. At her most recent follow-up, the patient is doing well, is symptom-free, and has returned to low-level sports participation.

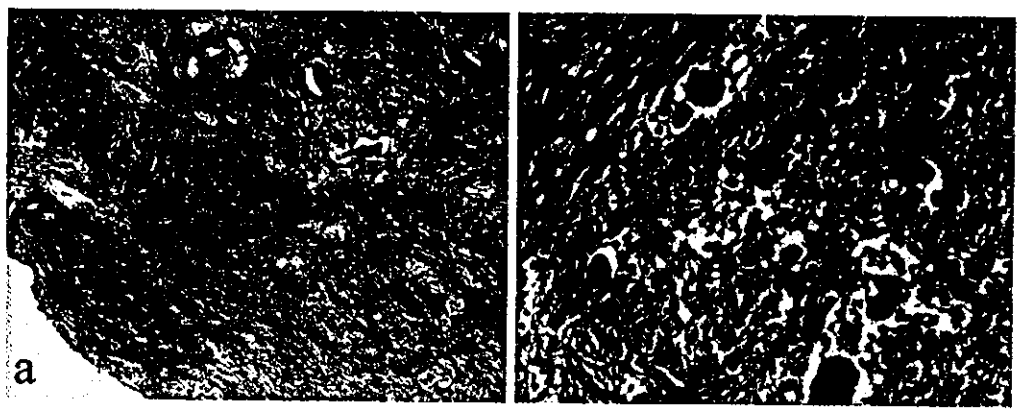

Fig. 2. **a** Pathology of localized pigmented villonodular synovitis demonstrates multinucleated giant cells, hypercellularity, and fibroconnective tissues. **b** At higher magnification, pigmentation (*arrows*) is seen to be present. H&E. **a** ×100, **b** ×200

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特発性大腿骨頭壊死症に対する人工骨頭・人工関節置換術の適応と限界

小林千益　久保俊一　高岡邦夫

Key words：bipolar femoral head replacement, total hip arthroplasty, idiopathic osteonecrosis of the femoral head, hip joint

はじめに

特発性大腿骨頭壊死症(ION)患者は一般的に青壮年期成人で，就労者が多く活動性も高い。したがって，その外科的治療にあたっては骨頭温存手術が望ましいとされている。しかし骨頭壊死範囲が大きい場合やすでに病期が進行し，高度の股関節症変化のある場合はやむなく人工骨頭人工関節置換に至ることも多い。ION患者に行う人工物置換術は患者の年齢，生活環境からみて，とくに長期耐用性が優れているべきである。したがって人工骨頭か人工関節の選択，またその機種の選択については慎重であるべきである。その根拠をえるために厚生労働省難治性疾患克服研究事業：骨・関節系調査研究班：特発性大腿骨頭壊死症調査研究分科会(研究代表者：平成11～15年度は高岡邦夫，平成16年度からは久保俊一)で，IONに対する人工骨頭置換術とTHAの治療成績を12施設共同で調査を行った(表1)[1]。その結果を紹介するとともに，IONに対するこれらの治療法について概説する。

厚労省特発性大腿骨頭壊死症調査研究班での調査研究

1986～1995年に本症で人工骨頭置換術かTHA(再置換術を除く)を行った549関節を対象とした。

手術時年齢は，平均49歳(17～87歳)で，男性が56%を占めた。

本症背景因子は，ステロイド剤使用48%(ステロイド対象疾患は頻度順にSLE：34%，腎移植：7%，ネフローゼ症候群：7%など)，アルコール多飲：29%，両者なし：23%であった。

Charnleyカテゴリーは，A(片側罹患)：26%，B(両側罹患)：71%，C(股関節以外の障害もあり)：3%であった。

術後患者活動性レベルがGustilo Ⅱ(non-

Bipolar femoral head replacements and total hip arthroplasties for idiopathic osteonecrosis of the femoral head

0286-5394/04/¥400/論文/JCLS

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strenuous)：49%，Ⅲ(moderately strenuous)：35%であった。

平均身長：160cm，平均体重：58kg，平均BMI：23であった。

対象股関節の手術既往なし：89%で，回転骨切り術後：7%，その他の手術後：4%であった。

術前X線像上，IONの病期は，Stage Ⅱ：10%，Ⅲ：49%，Ⅳ：36%であった。

IONの病型は，Type Cが80%を占めた。

股関節症(OA)の病期は，前期もしくは早期：57%で，進行期：19%，末期：19%であった。

経過観察期間は，平均7.8年(50日～16年)であった。日本整形外科学会の股関節症判定基準で，術前と比べ，経過観察時には各項目に有意な改善があった(図1)。

人工骨頭置換術とTHAの耐用性に関し，再手術を終点として多変量生存率解析を行った。表2に示す項目に関し生存率への影響を検討した。再手術は，股臼部品に関するものが53例(9.7%)，大腿部品に関するものが47例(8.6%)であった。多変量生存率解析では，インプラントの機種だけが耐用性に有意に影響していた。ユニポーラー人工骨頭は，セラミック骨頭であっても耐用性が不良であった。THAのセメントレスソケッ

表1　厚生労働省特発性大腿骨頭壊死症調査研究班での特発性大腿骨頭壊死症に対する人工骨頭・人工関節置換術の調査研究者名(施設名)(注：敬称略)

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菅野伸彦，西井 孝，吉川秀樹(大阪大学)
山本卓明，野口康男(九州大学)
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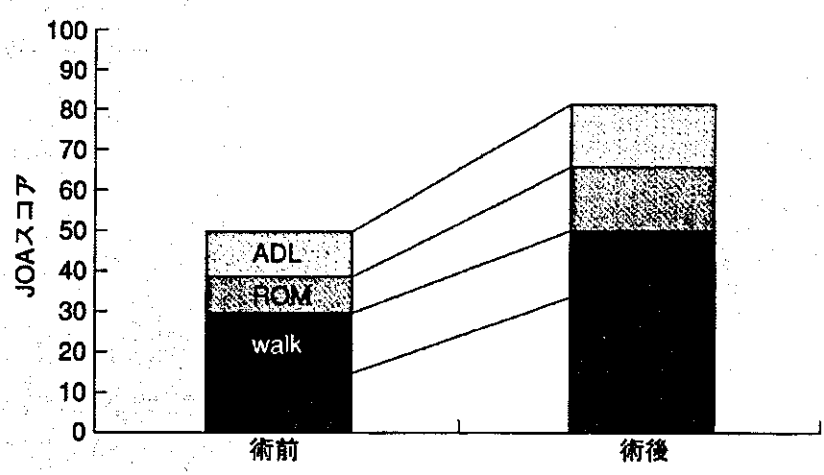
表2　生存率影響因子解析の検討項目

[患者属性]
- 年齢
- 性別
- 背景因子(ステロイド対象疾患も)
- Charnleyカテゴリー
- 活動性
- 身長
- 体重
- BMI
- 以前の股関節手術

[術前X線像]
- ION(特発性大腿骨頭壊死症)-Stage
- ION-Type
- OA(股関節症)-Stage
- Bombelli分類
- Noble's canal flare index

[手術]
- 股臼部品(人工骨頭 vs THA，固定法など)
- 大腿部品

図1　術前と術後経過観察時(平均7.8年)の臨床成績
JOAスコア：各項目で有意な改善あり。



トは，耐用性の良好な機種(81関節)と不良な機種(56関節)に分かれた。

セメントTHA：53関節，耐用性のよいセメントレスソケットを用いたTHA：81関節，バイポーラー人工骨頭置換術(BFR)：331関節の15年生存率は，それぞれ，97%，100%，71%であった。前二者と比べ，BFRの生存率は有意に低かった。

術前X線像上股関節症の徴候がないStage Ⅱ，Ⅲの症例に対してBFRもしくはTHAを行った308関節に絞って検討した。セメントソケットもしくは前記の耐用性のよいセメントレスソケットを用いたTHA(41関節)の15年生存率は100%で，BFR(267関節)の78%より有意に高かった(**図2**)。BFR群の再手術例24例は，19例では骨融解(osteolysis)に対し，5例では人工骨頭の近位移動に対して，THAソケットへの変換手術が行われていた。合併症は，BFR群では深部感染2例，神経麻痺1例で，THA群では術後反復性脱臼が1例あった。

まとめると，IONに対する人工骨頭置換術とTHAの術後成績を調べ，以下の結論を得た。

①ユニポーラー人工骨頭は，セラミック骨頭であっても耐用性が劣るので，用いるべきではない。

②セメントレスソケットは，耐用性がよい機種と不良の機種に分かれた。

③耐用性のよいセメントレスソケット，もしくはセメントソケットを用いたTHAは，BFRより耐用性が優れていた。

④X線像上股関節症性変化を生じる前の症例群でも同様の結果であった。

⑤BFRの15年耐用性(生存率)が，全体で71%，Stage Ⅱ，Ⅲ症例で78%とTHAより低かったことより，二次性股関節症に至る以前のIONに対しても，THAが有用な手術療法となりうる。

ユニポーラー人工骨頭置換術

BFRのポリエチレン摩耗粉による骨融解が問題となり，ポリエチレンを用いないユニポーラー人工骨頭置換術をIONに対して行う可能性が考慮された。骨頭壊死症に対するAustin Moorユニポーラー人工骨頭置換術は，近位・中心性移動が高頻度で，耐用性が不良であることが知られている[2)~4)]。

今回の検討では，ユニポーラー人工骨頭置換術例の78%にセラミック骨頭が用いられていたが，耐用性は劣った。したがって，セラミック骨頭であっても，ユニポーラー人工骨頭置換術はIONに対して行うことは適当ではない。

バイポーラー人工骨頭置換術(BFR)

OAに対して股臼リーミングをして行ったBFRの成績は，疼痛の残存持続，ポリエチレンライナ

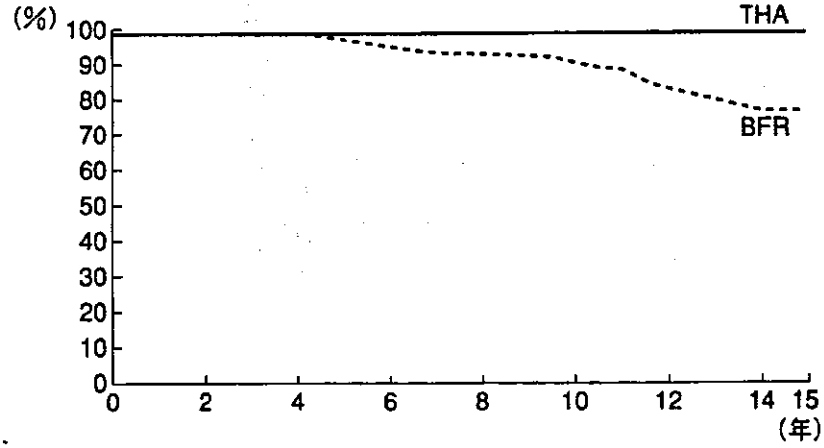


図2　股臼部品の生存(終点＝再手術)
術後5年以降，バイポーラー人工骨頭置換術(BFR)の耐用性は人工関節置換術(THA)に劣る($p<0.05$)。

一摩耗破損，外骨頭の近位・中心性移動などで，THAより劣る[5)~8)]。したがって，二次性OAを生じたStage ⅣのIONに対しては，BFRよりTHAを行うことが推奨される(下記「THA」の項を参照)。

OAを生じる前のStage Ⅲ以前のIONに対しては，BFRとTHAのどちらを行うか論争がある。OAを生じる以前の対象症例が比較的多いIONに対するBFRの臨床成績は，術後短期では良好であるが[9), 10)]，中・長期ではポリエチレン摩耗とそれに伴う骨融解と，外骨頭の近位・中心性移動，術後疼痛などが問題となる。Nishiiらは，Stage Ⅲ(OA変化なし)の27関節と，Ⅳ(OA変化あり)の8関節に行ったBFRで，術後3～7年(平均5年)の経過で，再置換術を行った8例にポリエチレン摩耗粉に対する異物性肉芽があり，ポリエチレンライナー摩耗が摺動面より縁で著しかったので，BFRは構造上問題があると述べている[11)]。

Itoらは，Steinberg Stage Ⅲ，Ⅳ(OA変化なし)の31関節とStage Ⅴ(初期OA変化あり)の7関節に対するBFRの術後7～18年(平均11.4年)で，12関節(25%)に再置換術を行い，15年生存率は70%であった[12)]。これは，今回の班研究の結果とほぼ一致する。再置換術時に得た肉芽内のポリエチレン摩耗粉量は，BFRよりTHAソケットのほうが多く[13)]，約2倍であることが示されている[14)]。ポリエチレンライナーに対する内骨頭の可動性がTHAの約1/2であるBFRは，人工骨頭頚部とポリエチレンライナー縁のインピンジメントを生じやすく，ポリエチレン摩耗量が約2倍となり，それに伴う骨融解の問題もBFRのほうが多くなるようである[11), 12), 15), 16)]。さらに，人工骨頭に相対する股臼関節軟骨は，術後経過とともに変性消失することが示されており[17)]，X線像上OA変化のないStage ⅢのIONでも，股臼軟骨変性が大部分の症例で生じていることが知られている[18), 19)]。

その結果，外骨頭の近位・中心性移動や[11), 12)]，術後の疼痛残存持続[12), 20)]などの問題を生じている可能性がある。今回の班研究では，Stage Ⅱ，Ⅲに絞った検討で，BFRよりTHAのほうが術後5年以降，耐用性が優れていた(**図2**)。

大腿骨頭壊死症例でのBFRとTHAの比較では，少数例の対象でBFRがTHAに劣ることを示唆した研究と[20)]，28人の両側例で片側BFRと対側THAを行い術後平均6.4年で比較し，有意差を認めなかった研究[21)]がある。後者では，Stage Ⅲの片側にBFRを，Stage Ⅳの対側にTHAを行っており，症例数不足と経過観察期間が短かったために有意差を見出せなかったものと思われる。

今回の研究結果より，二次性OAを生じる以前の病期のIONに対しても，THAが有用な手術療法となりうると考える。二次性関節症を生じる前の大腿骨頭壊死症に対する人工骨頭置換術とTHAに関しては，さらに詳しい班研究を予定している。

人工股関節置換術(THA)

IONに対するTHAの耐用性を制限する主な危険因子は，比較的低い患者年齢(40もしくは50歳以下)，セメント手技やセメントレスTHAの機種の不良，ポリエチレン摩耗(それに伴う骨融解)である。第一世代セメント手技によるION例でのTHAは，OA例に比べ耐用性が劣った[22), 23)]。とくに，50歳未満のION患者に第一世代セメント手技で行ったTHAの耐用性が不良であった[24)]。セメント手技が第一世代から第二世代になったことで，50歳以下の高リスクION患者でのTHA破綻率が有意に低下した[25)]。

また，IONに対するTHAでは，年齢が比較的低い患者が多く，術後の患者活動性が高く，ポリエチレン摩耗が高度で，骨融解の頻度が高いことが問題となっている[26), 27)]。さらに，診断がIONであることは，THA脱臼の危険因子の1つであり[24), 28)]，適応決定や術後生活指導に注意を要する。ION患者に対するTHAでは，以上の点にとくに注意することが重要である。

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1 骨粗鬆症

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■サマリー

骨粗鬆症の予防もしくは治療のゴールは，骨折の予防である。そのためには，骨折の危険因子を患者で同定し，是正する必要がある。脆弱性骨折（転倒などの軽度の外傷で生じる骨の脆弱性に伴う骨折）の既往，低骨密度，骨代謝マーカー高値，転倒しやすさなどが骨折危険因子として知られている。

特に脆弱性骨折の既往のある場合は，新たな骨折発生の危険が高いので注意を要する。それに骨密度低下や，骨代謝マーカーの高値を合併した場合は，さらに骨折危険度が高い。骨代謝マーカーの是正，骨密度維持または増加によって，新骨折発生予防の目的で薬剤を使用することが勧められる。

転倒予防策も大切であり，近年開発された大腿骨頚部骨折予防用のヒッププロテクターの使用も考慮するべきである。疼痛が持続する脊椎圧迫骨折偽関節症例には，比較的侵襲が少ない"骨セメント注入＋後方固定術"も行われている。

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骨粗鬆症の予防もしくは治療のゴールは，骨折の予防である[1]。そのためには，骨折危険因子を同定し，是正する必要がある。各患者の危険因子に応じて，薬物療法，転倒予防，殿部プロテクターなどの保存的療法を行う。以下に，その概要を記し，外科療法にも言及する。

I 骨粗鬆症診断と骨折危険因子同定

骨粗鬆症の診断は，日本骨代謝学会の診断基準によって行っている[1]。骨粗鬆症患者の骨折予防のために，患者の骨折危険因子を同定し，是正することが必要である。脆弱性骨折（転倒などの軽度の外傷で生じる骨の脆弱性に伴う骨折）の既往，低骨密度，骨代謝マーカー高値，転倒しやすさなどが，骨折の危険因子として認められている[2]。

1. 既存脆弱性骨折

骨粗鬆症に伴う骨折の危険因子の中で，脆弱性骨折の既往が最も重要であることが知られている。骨折の既往とその後の骨折発生の関連性は椎体骨折で最も高く，椎体骨折の既往のある患者は，ない患者の約4倍のリスクであり，四肢の骨折については約2倍のリスクである[3]。

既存椎体骨折の数が増すと，新椎体骨折発生リスクが高くなる。ハワイのDavisらは，閉経後骨粗鬆症の日系アメリカ人721人で，新椎体骨折発生のオッズ比を調べた[4]。その結果，既存骨折がない例に比べ，椎体骨折が1個の場合は2～5のオッズ比で，椎体骨折が2～3個の場合は7～9となっていた。