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Sugioka's osteotomy for femoral-head necrosis in young Caucasians

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Abstract The transtrochanteric rotational osteotomy described by Sugioka is used to preserve the femoral head and to prevent secondary osteoarthritis in young patients with osteonecrosis of the femoral head. Several Japanese studies have shown favourable results, but European and American studies were disappointing. An explanation for these outcomes may be that the original protocol was not followed exactly. The objective of our study was to investigate this trans-trochanteric rotational osteotomy in Caucasian patients with osteonecrosis in which we followed the original method of Sugioka as closely as possible, including a 6-month period of non-weight bearing. We included 26 hips in 22 consecutive patients who were followed up for 8.7 (range 6.6–10) years. At review, 17 hips had been converted to total hip arthroplasty. The clinical survival rate was 56% after 7 years (95% CI 36–76%). The radiological survival rate was 54% after one year (95% CI 35–73%). Even after excluding the failures due to problems with osteosynthesis and infection, the results were not satisfactory and the osteoarthritic process was not delayed. Based on our results, we cannot recommend this technique as an alternative for total hip arthroplasty in Caucasians.

Résumé L'ostéotomie rotationelle transtrochantérienne de Sugioka est utilisée pour conserver la tête fémorale et prévenir l'arthrose secondaire chez les jeunes patients avec une ostéonécrose de la tête fémorale. Plusieurs études Japonaises ont montré des résultats favorables, mais des études européennes et américaines étaient décevantes. Une explication pour ces résultats peut être que le protocole original n'avait pas été suivi parfaitement. L'objectif de notre travail était d'étudier cette ostéotomie transtrochantérienne chez des malades caucasiens avec une ostéonécrose en suivant la méthode originale de Sugioka d'aussi prés que possible y compris avec une période de 6 mois sans appui. Nous avons inclus 26 hanches chez 22 malades consécutifs qui ont été suivis pendant 8,7 ans (6,6–10). à la révision 17 hanches avaient été converties par arthroplastie totale. Le taux de survie clinique était 56% après 7 années (IC 95%: 36–76%). Le taux de survie radiologique était 54% après 1 année (IC 95%: 35–73%). Même après exclusion des échecs dû à des problèmes d'ostéosynthèse et d'infection, les résultats n'étaient pas satisfaisants et le processus arthrosique n'a pas été différé. D'aprés nos résultats nous ne pouvons pas recommander cette technique comme une alternative à l'arthroplastie totale chez les Caucasiens.

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Introduction

In view of the poor long-term survival of prosthetic hip replacement in younger patients with avascular necrosis of the femoral head [6], an operation that preserves the femoral head is still highly desirable. In 1972, Sugioka introduced the transtrochanteric rotational osteotomy [20]. Although promising clinical results were achieved by Sugioka et al. [23], these could not be reproduced in American and European studies [1, 3, 4, 9, 11, 13–15, 17, 24]. A serious drawback of most of these studies is, however, that the original protocol of Sugioka was not followed precisely. Therefore, we decided to perform the Sugioka osteotomy in a limited number of young patients using a prospective, single-surgeon study. The purpose was to investigate the outcome of the Sugioka osteotomy in Caucasian patients with osteonecrosis of the hip strictly following the original surgical procedure and post-operative protocol. The performing surgeon (JWMG) was instructed in the procedure by Sugioka in 1992. In the operation, we tried to achieve an intact ratio of the femoral head in the weight-bearing area of at least one third [22] and followed the original post-operative protocol [20].

Patients and methods

From September 1992 to February 1997, a transtrochanteric rotational osteotomy was performed in 22 consecutive patients (26 hips) (Table 1). We were able to follow-up all patients for a mean of 8.7 (6.6–10) years. All patients were treated by the same surgeon (JWMG). The diagnosis of osteonecrosis of the femoral head was based on plain X-rays, 99 mTc scanning and MRI scanning. The hips were graded using the staging system of ARCO [5]. However, according to Steinberg et al. [18], stage 3 was subdivided into "early," without collapse of the femoral head and "late," with collapse of the femoral head. One hip was classified as stage 2BC, six as stage 2CC, two as early stage 3CC, 16 as late stage 3CC, and one as late stage 3CB.

Surgical technique

The modified Ollier's skin incision and posterior approach were used to expose the hip joint. The greater trochanter was osteotomized and the quadratus femoris muscle was partially split to locate and secure the medial circumflex femoral artery. The femoral head was subluxed and inspected to ensure that the intended rotation and varus positioning was sufficient to place the necrotic lesion out of the weight-bearing area. The osteotomies were made perpendicular to the femoral neck, carefully preserving the vascular pedicle. After internal fixation of the osteotomy, the capsule was loosely approximated with a few sutures.

Rehabilitation

Postoperatively, all patients were kept in bed for six weeks, and rotation in the hip was not allowed. Walking with crutches, non-weight bearing was started eight weeks postoperatively, and full weight bearing was permitted after six months.

Table 1 Patient characteristics

	Total (n=22)
Male:female	15:7
Number of hips	26 hips (four patients bilateral)
Left:right	14:12
Age at time of Sugioka	31.5 years (range, 22–49 years)
Rotation	
Anterior	22 hips
Rotation	94° (range, 90–118°)
Varisation	11° (range 0–30°)
Posterior	4 hips
Rotation	118° (range, 90–130°)
Varisation	16° (range, 10–20°)
Cause of osteonecrosis	
Corticosteroids	13 hips
Posttraumatic	5 hips
Idiopathic	8 hips
Length	1.78 m (range, 1.67–1.87 m)
Weight	77 kg (range, 57–110 kg)

Follow-up

All patients were followed up clinically and with serial radiographs. Pre- and post-operative range of motion, Harris hip score (HHS) [7], and plain radiography (antero-posterior and true lateral) were assessed. The ratio of the intact area of the femoral head in the weight-bearing area was measured according to Sugioka et al. [21] (Fig. 1). Any collapse and progressive degenerative changes in the new weight-bearing area were registered. We used the Kellgren system [12] for assessment of osteoarthritic changes.

A result was considered clinical satisfactorily if the HHS was greater than 70. If the HHS was below 70 or if the patient had a total hip replacement (THR), we considered the result as a clinical failure. Radiographic failure was defined as progression of collapse, progressive degenerative osteoarthritic changes, or conversion to a THR.

Statistical analysis

The time to clinical and radiological progression was studied using the Kaplan–Meier estimators. Patients who underwent re-operation because of implant failure or infection, finally resulting in conversion to a THR, were considered as failures at the time of re-operation. The generalized Wilcoxon test was used to test differences in progression between the groups for statistical significance. The 7-years' progression after index surgery for clinical failure and the 1-year's progression after index surgery of radiological failure, with 95% confidence interval, is presented. At that time, at least half of the subjects were still under study. Fisher's exact test was used to test differences between the groups for statistical significance in case of 2×2 tables.

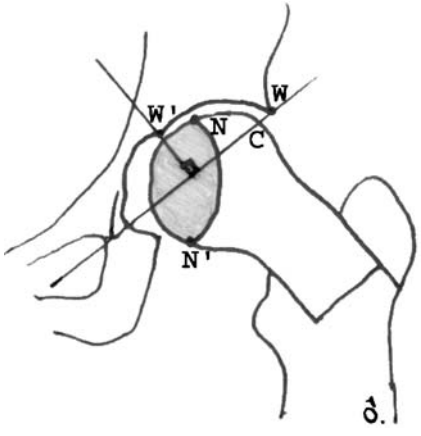

Fig. 1 Measurement of the postoperative, intact ratio in the weight-bearing area: intact ratio = $C–N/W–W'$.

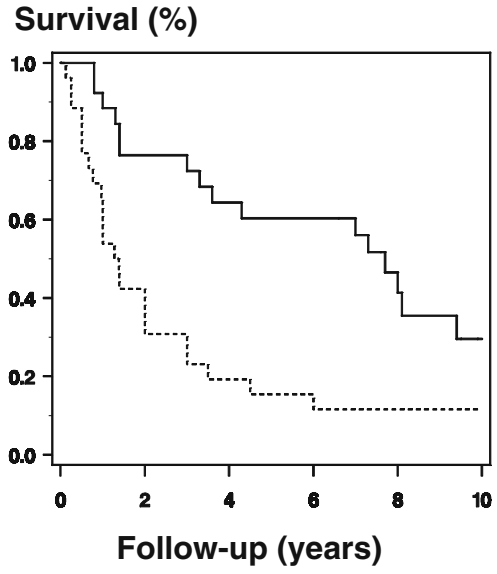

Fig. 2 Kaplan–Meier curve shows the clinical survival rate (*solid line*) and the radiological survival rate (*dashed line*).

Results

Clinical results

The average operating time was 3.9 (3.3–5) h; the average blood loss was 1,528 (750–3,000) cc, and the average hospital stay was 24 (12–53) days. At review, the Sugioka osteotomy was still intact in only nine hips. Seventeen hips were converted to a THR; two of these hips failed because of culture-proven infections. In 15 hips, a THR was performed at an average of 4.5 (0.8–10.1) years. The conversion was due to failure of the internal fixation in two cases, non-union of the osteotomy in one, and progressive secondary osteoarthritis in 12. The mean follow-up of the nine hips that were still intact at review was 8.7 (6.6–10) years. Seven hips were rated clinically as excellent or good, and two were rated as fair. Their average preoperative HHS was 60 (32–93) points and postoperatively 87 (76–97) points. The total preoperative range of motion of the treated hips was 223°; the postoperative range of motion was 210°.

Taking conversion to THR for any reason or HHS below 70 as endpoints, the clinical survival rate using the Kaplan–Meier analysis was 56% after 7 years (95% CI 36–76%) (Fig. 2). With increasing patient age at time of surgery, we found a tendency to increasing clinical survival (p=0.09, Wilcoxon test). The patients' use of corticosteroids considered as a possible risk factor for development of osteonecrosis did not significantly influence the clinical survival (p=0.50, Wilcoxon test).

Radiological results

All patients had a complete radiological follow-up. In 17 hips, we saw a pre-operative collapse. In 25 hips, the postoperative ratio of intact articular surface according to Sugioka was larger than one in three. After exclusion of two cases that failed due to infection, a progressive collapse of the femoral head was seen in 13/24 hips (54%) after a mean follow-up of 28 months. Pre-operatively, osteoarthritic changes were found in 19/24 hips, and progression at follow-up was seen in 19/24 hips; only one hip showed no signs of osteoarthritis (Fig. 3). The overall radiographic failure rate was 88%. Taking conversion to THR, progression of collapse of the femoral head, or progression of osteoarthritis as endpoints, the radiological survival rate for patients without pre-operative collapse was 89% after 1 year (95% CI 68–100%). For patients with pre-operative collapse, the survival rate was 35% after 1 year (95% CI 13–58%), and they had a significantly higher probability of developing radiological failure (p=0.01, Wilcoxon test).

Patients with pre-operative collapse had a significantly higher probability (p=0.028, Fisher's exact test) of developing a Kellgren score of 3 or 4. A pre-operative collapse existed in 15 of 24 hips, of which seven were converted. The remaining eight had narrowing of the joint space, and their mean Kellgren score was 3.6. Of nine hips without preoperative collapse, five were converted due to progres-

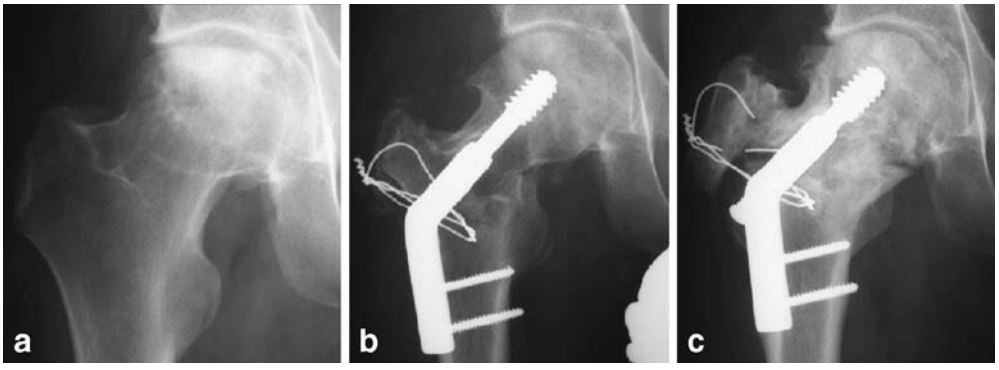

Fig. 3 **a** A 30-year-old man with a late ARCO stage 3CC and preoperative osteoarthritis (Kellgren stage 3). **b** Correct alignment 6 weeks postoperatively; a dynamic hip screw was used for osteosynthesis. Large osteophytes as a sign of progressive secondary osteoarthritis are already visible. **c** At 3 years and 7 months postoperatively, a collapse of the femoral neck was seen, with loosening of the osteonecrotic area that was rotated anteriorly, a large osteophyte in the weight-bearing area, and severe secondary osteoarthritis (Kellgren stage 4).

sive osteoarthritis. However, the four remaining hips had no joint-space narrowing and their mean Kellgren score was 1.3.

Complications

There were eight re-operations due to problems with internal fixation. In the first seven, we used stainless steel cannulated screws, with one re-operation for screw breakage. In the next ten hips, we used titanium screws. We saw one hip with screw breakage and one with varus displacement. In the last nine, we used a special dynamic hip screw. One failed due to infection, two had non-union of the greater trochanter necessitating surgical repair and one suffered a traumatic femoral fracture located distal to the consolidated osteotomy.

Discussion

The purpose of our study was to prove that the Sugioka osteotomy would give satisfactory results in young Caucasian patients with osteonecrosis of the femoral head if surgical technique and after-treatment with a period of at least six months of non-weight bearing were followed very accurately. Therefore, the surgeon who performed the operations was trained and instructed in Japan by the originator of the technique. However, despite this, the clinical outcome after 8.7 years was only acceptable in one third of the patients. We were thus unable to reproduce the promising clinical results achieved by Sugioka et al. [23] (Table 2).

A part of our disappointing results might be explained by patient selection. Sugano et al. [19] stated that the procedure should be performed only in stages before a collapse of the femoral head had become evident. In our study, 17 hips already had a collapse. Indeed, the radiological survival rate was significantly better in patients without a preoperative collapse. The technique in Caucasian patients was found more demanding, probably due to the different dimensions of the hip and the larger body size and weight of the patients compared to Japanese patients. Screw fixation proved to be not strong enough. We started out with cannulated screws but experienced breakage. We also tried both stainless steel and titanium screws. In two cases using titanium screws, progressive varus deformity and breakage occurred. This problem has also been observed by others [3, 11, 13, 24]. Next, we tried fixation with a dynamic hip screw preoperatively bent from 135° to 120°. Although we had the impression that the fixation was solid, it was very difficult to achieve the required varus positioning. Recently, Chen et al. [2] demonstrated that fixation only with screws resulted in higher stress values in the proximal femur compared with the dynamic hip screw. Maybe dynamic hip screws specially designed to allow a varisation of the osteotomy can solve some of these problems.

Radiographically, the deterioration of the hip joints was neither prevented nor delayed, which was a disappointing observation. At an average follow up of 8.7 years, 88% of our cases showed radiographic signs of degeneration.

Some authors attributed the disappointing results to a large area of osteonecrosis in the weight-bearing area. Miyanischi et al. [16] stated that to prevent progressive collapse over a period of ten years, a postoperative, intact ratio of the femoral head in the weight-bearing area of at least 34% is needed. This was, however, not a prognostic factor for our patients. In 25 hips, the post-operative intact ratio was above 33%. Excluding the two cases that failed due to infection, 15 of 24 (63%) needed prosthetic hip replacement. This result does not match the result of Miyanishi et al. [16]. Inao et al. [9] and Hisatome et al. [8] stated that in the presence of preoperative collapse, optimal postoperative joint alignment never seems to be achieved, resulting in early secondary osteoarthritis. In hips without

Table 2 Results of transtrochanteric rotational osteotomy according to the literature

Reference	Year of publication	Number of hips	Follow-up in months	Excellent or good result (%)	Time until full weight bearing in months
Sugioka	1978	41	30	88	6
Kotz	1981	17	25	59	4–6
Sugioka	1982	128	24–108	77	6
Sugioka	1984	158	24–132	77	6
Tooke	1986	18	18–63	22	6
Saito	1988	15	24	33	4–6
Kinnard	1988	10	21–36	70	1.5
Eyb	1990	46	103	26	2–4
Sugano	1992	41	76	56	12
Sugioka	1992	195	36–192	78	6
Dean	1993	18	57	18	Until consolidation
Belal	1996	7	80	0	Until consolidation
Langlais	1997	18	60	56	1.5–3 (if pain free)
Iwasada	1997	48	55	62	4
Inao	1999	14	131	43	6
Hisatome	2003	25	77	80	?
This study	2004	26	104	27	6

THR at follow-up, we found a post-operative osteoarthritis score of 1.3 in hips without pre-operative collapse and of 3.6 in those with pre-operative collapse. This is in agreement with the assertion of Inao et al. [9] and Hisatome et al. [8].

The prevalence of hip osteoarthritis differs in Japanese and Western populations, possibly because of different acetabular shape [10, 25]. From all our THRs, 71% were for secondary osteoarthritis. Progression of osteoarthritis was also observed in Japanese studies [8, 9, 11, 17, 23] but was more limited than in studies with Caucasian patients and did not lead to THR. Despite instruction by the original author, following his principal of having at least one-third of the femoral head intact in the weight-bearing area, and carefully abiding by the original after-treatment protocol of non-weight bearing for 6 months, we did not achieve the same results as Sugioka, and we were not able to delay secondary osteoarthritis. Furthermore, we should add that THR in a patient with a previous Sugioka osteotomy is more difficult and influences the outcome.

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