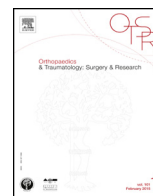




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Original article

Results of the Sugioka transtrochanteric rotational osteotomy for osteonecrosis: Frequency and role of a defect of the quadratus femoris muscle in osteonecrosis progression



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ABSTRACT

Background: During transtrochanteric rotational osteotomy (RO), it is important to preserve the posterior column artery (PCA), which is generally located in the adipose tissue underneath the quadratus femoris muscle (QF). If there is a defect in the QF, the risk of injuring the PCA, subsequently resulting in total necrosis of the femoral head, may increase. Therefore, we investigated: (1) the frequency of defects of the QF at the time of RO, and (2) clinical outcome of RO based upon a defect of the QF.

Hypothesis: The presence of defects of the QF at the time of RO could be detected pre-operatively by magnetic resonance imaging.

Methods: RO was performed in 124 hips between 2001 and 2010. In all, 95 of the hips were in male patients and 29 in female patients. The mean age was 45.4 years (range: 11–61 years) at the time of surgery and MRI was performed before RO in all cases. We retrospectively evaluated the progression of a collapse through 3 years after RO.

Results: MRI showed a defect in the QF in four hips (3.2%) (2 males, 2 females), all of which were confirmed intra-operatively. Among the four patients, one (25%) underwent total hip arthroplasty because of varus deformity of the osteotomy site due to total necrosis of the femoral head 1 year after RO. The 120 hips with a normal QF showed no evidence of total necrosis or progression of necrosis of the femoral head, indicating that the presence of defects of the QF may increase the risk of poor survivorship of this procedure.

Conclusions: Defects of the QF have been reported to occur in 1–2% of all patients, whereas in our study the incidence in ON was approximately 3%. In ON patients with QF defects, pre-operative MRI evaluation of the QF appears to be important when planning RO, followed by a carefully performed surgical procedure.

Level of evidence: IV; retrospective case series without control group.

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1. Introduction

Once subchondral collapse occurs in a patient with osteonecrosis (ON) of the femoral head, surgical treatment is necessary to relieve the pain and to obtain good hip function [1,2]. First developed by Sugioka in 1978 [3], transtrochanteric rotational osteotomy (RO) is a joint-preserving procedure used to treat ON. The procedure involves transposing an intact area to a weight-bearing portion of the joint, resulting in transfer of the necrotic area to a non-weight-bearing area. The survival rate has been reported to be around 80%, while less than 20% of survival rate has also been reported, indicating that this procedure is technically demanding [4–8]. One of the most important aspects in performing RO

is to preserve the posterior column artery (PCA), a branch of the medial femoral circumflex artery, which supplies nutrients to the femoral head [9,10]. The PCA is generally located in the adipose tissue underneath the quadratus femoris muscle (QF), which is a flat, quadrilateral muscle between the gemellus inferior and the proximal margin of the adductor magnus. In order to expose the obturator externus, minimum release of QF is recommended, but if the QF is absent, the adipose tissue is directly exposed, which may increase the risk of injuring the PCA during the procedure, eventually resulting in total necrosis of the femoral head. The QF is thus an important anatomical signpost for performing RO safely.

However the anatomical variations of the QF muscle are not accurately known. In addition, there is no information whether the presence of defects of the QF at the time of RO influences the survivorship of this procedure. Therefore we investigated the frequency of QF defects at the time of RO in ON patients and also assessed their influence on clinical outcomes of RO. The goals of

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Table 1
Clinical findings of the 4 patients with a defect of the quadratus femoris muscle.

Patient number	Gender	Age	Etiology	Defect side	Necrosis side	Pre-operative stage and type	Procedure	Total necrosis of the femoral head (months)
1	Female	47	Corticosteroids	Bilateral	Bilateral	Stage 3A, type C2	Lt. PRO	–
2	Male	49	Alcohol	Left	Left	Stage 3B, type C2	Lt. ARO	–
3	Female	36	Corticosteroids	Bilateral	Bilateral	Stage 3A, type C2	Lt. PRO	–
4	Male	29	Alcohol	Left	Bilateral	Stage 3B, type C2	Lt. ARO	+ (10 months)

ARO: anterior rotational osteotomy; PRO: posterior rotational osteotomy; Rt.: right; Lt.: left.

the current study were to evaluate: (1) the frequency of defects of the QF at the time of RO, and (2) clinical outcome and survival of RO according to the presence of defects of the QF. Our hypothesis was that the presence of defects of the QF at the time of RO could be detected pre-operatively by magnetic resonance imaging.

2. Patients and methods

2.1. Patients

The institutional review board at our university approved this study. Between 2001 and 2010, transtrochanteric RO was performed in 124 hips (95 in males, 29 in females) of 109 patients whose average age was 45.4 years (range: 11–61 years) at the time of surgery. (During the same period, prosthetic hip replacement was performed in 200 ON hips, transtrochanteric varus osteotomy in 34 ON hips, but core decompression was done in none of the ON cases in our hospital [11,12]). RO was indicated and performed in patients who: (1) had a necrotic area in the anterior or posterior portion of the femoral head; (2) had an intact healthy area in the anterior or posterior portion; and, most importantly, (3) were predicted to have a postoperative intact area ratio over 34% after the RO [3,4]. Cases who fulfilled these criteria have been reported to have a low risk of progression of a collapse [4].

Based on the Japanese Investigation Committee Classification System of ON, 77 hips were stage 3A, 43 stage 3B, and 4 stage 4 (3A: collapse less than 2 mm, 3B: collapse over 3 mm), and one hip was categorized as type B, 18 as type C1, and 105 as type C2 [13]. (According to the Ficat and Arlet classification, 121 hips were in stage III and 4 in stage IV, while 121 hips in ARCO stage 3, and 4 in ARCO stage 4.) The etiology of ON was idiopathic in 5 hips, alcohol abuse in 50, post-trauma in 9 (including 11-year-old girl with ON after slipped capital femoral epiphysis), and corticosteroid use in 60. The presence of a QF defect was mainly investigated in all 124 hips based on intra-operative findings. In addition, pre-operative MRI was examined whether only high-signal adipose tissue is observed without any evidence of muscle structure.

2.2. Methods

The basic RO surgical procedure has remained unchanged since it was described by Sugioka [3]. Briefly, it includes three osteotomies: (1) osteotomy of the greater trochanter; (2) intertrochanteric osteotomy, which passes from superolateral to inferomedial on the anteroposterior (AP) view; and (3) an osteotomy that passes from the proximal flare of the lesser trochanter inferolaterally toward the inferomedial extent of the primary osteotomy. During these osteotomies, preservation of the PCA (located in adipose tissue underneath the QF) is the most important procedure, so minimum release of QF in order to expose the obturator externus is recommended. To obtain rigid fixation, the K-MAX Adjustable Angle Hip Screw (K-MAX AA Hip Screw; Japan Medical Materials, Osaka, Japan) as well as two screws are used. Postoperatively, the patients were not allowed to bear weight

for 5 weeks, after which gradual weight-bearing was permitted. Full weight-bearing was permitted after 6 months.

2.3. Methods of assessment

We evaluated radiographic evidence of total necrosis of the femoral head 3 years after the procedure based on AP and frog lateral views of all 124 hips. QF defects were pre-operatively assessed on MRI and checked during surgery.

2.4. Statistical methods

The prevalence of total necrosis of the femoral head in patients with a QF defect and those with a normal QF were statistically assessed using Fisher's exact test. Statistical differences were considered significant when $P < 0.05$.

3. Results

The pre-operative MRI examinations revealed a QF defect in 4 of the 124 hips with ON (3.2%) (2 males, 2 females) (Table 1). The etiology of the ON was alcohol abuse-related in two patients and corticosteroid-related in the other two. All the four cases were categorized as type C2 according the Japanese Investigation Committee Classification System of ON. The QF defects were confirmed intra-operatively in all four patients and no false negative cases were found. Anterior RO was performed in two patients and posterior RO in two.

One of the four (25%) patients with a QF defect showed varus deformity of the osteotomy site resulting from total necrosis of the femoral head 10 months after the RO, resulting in conversion to a hip prosthesis (Fig. 1). The other three patients showed no evidence of total necrosis of the femoral head 3 years after RO. On the other hand, among the 120 RO cases in which the QF was normal, no hips showed progression of a collapse caused by total necrosis of the originally intact area 3 years after RO. This incidence was lower than that for the patients with a QF defect ($P = 0.0323$).

4. Discussion

A QF defect has been observed in 1–2% of general patients in anatomical studies [14,15]. In the present study, the rate was approximately 3% in patients with ON who underwent RO at our institution. In addition, one of four patients with a QF defect underwent total necrosis of the femoral head, whereas cases with normal QF anatomy showed no evidence of total necrosis. This relatively high rate of total necrosis may indicate that when the QF is not observed another type of operation (e.g., transtrochanteric varus osteotomy) should be considered, although the number with a defect of QF muscle was only 4 hips and a defect of QF itself may not have been the direct cause of total necrosis. If the RO is the only joint-preserving procedure that is deemed appropriate, it is necessary to verify the location of the PCA pre-operatively using MR angiography or CT angiography to confirm the location of the PCA. If the PCA is not observed in its normal location, RO is not indicated.

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