Impact of surgical approach on postoperative heterotopic ossification and avascular necrosis in femoral head fractures: a systematic review

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Abstract Heterotopic ossification (HO) and avascular necrosis (AVN) have been identified as post-traumatic complications of femoral head fractures and may lead to a restriction in hip function and permanent disability. The question of which surgical approach is the best for the femoral head fracture and its relationship with HO and AVN remains controversial. We conducted a systematic review in which all published studies were evaluated. We performed a literature search in MEDLINE, PubMed, EMBASE, MD Consult, and the Cochrane Controlled Trial Register from 1980 to April 2009. We found ten appropriate studies, describing 176 patients. A lower percentage of patients treated with a trochanteric flip approach was reported with HO than patients treated with anterior or posterior approach (33.3% versus 42.1% and 36.9%, respectively), although the difference was not statistically significant. The incidence of AVN was highest in the posterior approach group (16.9%), and subsequently with the trochanteric flip approach (12.5%) and the anterior group (7.9%). The investigators concluded that the use of the anterior approach may result in a higher risk for HO and the posterior approach may result in a higher risk for AVN. A new, posterior-based approach of trochanteric flip seems to be a better approach for femoral

head fractures. A further case-control study would be appropriate to confirm the findings in our systematic review.

Introduction

Femoral head fracture, which was first reported by Birkett in 1869 [2], occurs with relative infrequency and almost exclusively with hip dislocations. Management of these injuries is complex. Surgical intervention is usual for most femoral head fractures. The operations on femoral head fractures are, however, associated with heterotopic ossification (HO) and avascular necrosis (AVN) [1, 4–9, 11–13, 16, 17]. A variety of surgical approaches have been advocated for the treatment of femoral head fractures, including the anterolateral (Watson-Jones), lateral, medial (Ludloff), anterior (Smith-Peterson, Stoppa), and posterior (Kocher-Langenbeck, trochanteric flip) approaches [1, 4–9, 11–13, 16, 17]. The effect of the surgical approach on postoperative HO or AVN is unclear. Orthopaedic surgeons continue to discuss which approach is better for femoral head fractures because each has merits and limitations. A previous review by Asghar and Karunakar recommended the anterior or lateral approach for open reduction and internal fixation [1].

HO has been noted to occur with a higher incidence in some cases of patients who undergo an anterior surgical approach [8, 16]. AVN is usually considered to be related to reduced blood flow as a consequence of a surgical approach [1, 14]. Since the reported incidence of postoperative HO and AVN in different series varied greatly, we performed a systematic review of the existing literature with the intent of performing an analysis of pooled data to ascertain whether there is any relationship between approach and HO or AVN in patients with operatively treated femoral head fractures.

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Materials and methods

In May 2009, we searched MEDLINE, PubMed, EMBASE, MD Consult, and the Cochrane Controlled Trial Register from 1980 to April 2009. The decision to use the database from 1980 was made because CT was commonly used for orthopaedic diagnosis after the early 1980s and MRI in the late 1980s. Plain radiography does not provide definite diagnosis of some nondisplaced fractures. MRI is also more valuable in evaluation of AVN [1]. Search terms included “femoral head fracture” or “Pipkin fracture” and “heterotopic ossification” or “avascular necrosis”. Search results were screened independently by two reviewers (GJJ, YHL) as relevant, irrelevant, or uncertain according to study eligibility criteria (Table 1), and conflicts were resolved by consensus discussions; full-text articles were obtained for studies deemed relevant or of uncertain relevance for additional full-text screening to determine relevance. References of the obtained articles were also screened and relevant references were retrieved. Additional articles identified from these references that contained relevant supporting information were then included. If the articles were reported by the same authors or from the same institute, the most up-to-date paper with detailed and complete clinical data was included [6, 7].

One person performed the initial search (GJJ), which was followed by two authors (GJJ, YHL) who independently reviewed the results and selected the appropriate studies. These selection procedures identified 25 articles, which were reviewed carefully by two orthopaedic surgeons (GJJ, YHL). Any information about surgical approach and outcome for HO and AVN were extracted from these articles. Fifteen articles were excluded because their descriptions were too general to extract the valid information about the correlation of approach and complications. Finally, a total of ten studies were eligible for the evaluations reported in this study.

Table 1 Inclusion/exclusion criteria used for identifying studies eligible for analysis

Inclusion criteria	Exclusion criteria
Articles with a clear and radiographic diagnosis	Case report/series with no data about follow-up
General adult population	Related only to subchondral insufficiency fracture of the femoral head
Original journal publications in English	Only observational or descriptive studies without follow-up
Published from January 1980 to April 2009	
Level I, II, III, or IV study design by JBJS criteria and case reports [18]	

The selected studies reported data from 164 patients (Table 2). We compared the incidence of HO and AVN of the three main approach groups (anterior, posterior and trochanteric flip) using the chi-square test. SPSS version 13.0 for Windows (SPSS, Inc., Chicago, IL) was used for the analysis.

Results

A total of ten studies were eligible for inclusion into further analysis in which the surgical approach and complication for HO and AVN were described in Tables 2 and 3. All of them were case series. Useful information was extracted from each paper independently by two reviewers (GJJ, YHL). The surgical procedures such as anterior, posterior, lateral, anterolateral and combined anterior–posterior approach were recorded respectively. The postoperative incidence of HO and AVN in each study was also calculated.

There were a total of 176 cases from these ten studies, including 144 who received operative treatment and 32 who had conservative treatment. Five cases with the trochanteric flip approach in Kloen et al.’s study were excluded because these cases were included in another study from the same authors [6, 7]. A lower percentage of patients treated with the trochanteric flip approach had HO than patients treated with anterior or posterior (33.3% versus 42.1% and 36.9%), although the difference was not statistically significant. The incidence of AVN was highest in the posterior approach group (16.9%), and subsequently the trochanteric flip approach (12.5%) and the anterior group (7.9%). There was no significant difference in the incidence of AVN in each group.

Discussion

HO and AVN have been identified as post-traumatic complications of femoral head fractures and may lead to a restriction in hip function and permanent disability [1, 4–9, 11–13, 16, 17]. The question of which surgical approach would be the better one to treat femoral head fracture and its relationship with HO and AVN was controversial in the past. Only a few series have been reported in the literature and the objective of this review was to identify eligible studies to determine better surgical approaches using clinically applicable criteria for evaluations. However, as the eligible studies were all case series, meta-analysis was not possible.

The main advantage of the anterior approach is the provision of good exposure of the femoral head and is associated with a decreased incidence of AVN [1, 6, 7, 16].

Table 2 Characteristics of the included studies

Author	Year	Study design / class of evidence	Population	Treatment	Approach (number of cases)	Number of HO cases (%)	Number of AVN cases (%)
Butler [4]	1981	Case series / IV	10	OP + NOP	Lateral (5)	0	1 (20%)
Vermeiren and Hoye [17]	1991	Case series / IV	3	OP	Posterior (3)	1 (33.3%)	0
Swiontkowski et al. [16]	1992	Case control study / III	24/41	OP + NOP	S-P (12)	7 (58.3%)	0
					K-L (12)	3 (25%)	2 (16.7%)
Marchetti et al. [8]	1996	Case series / IV	33	OP + NOP	Anterior (10)	7 (70%)	1 (10%)
					Posterior (21)	13 (62%)	2 (11%)
Stannard et al. [12]	2000	Case series / IV	22	OP	S-P (9)	0	1 (11.1%)
					K-L (12)	0	4 (33.3%)
					A + P (1)	0	0
Mostafa [9]	2001	Case series / IV	6	OP + NOP	Lateral (4)	0	0
					Posterior (1)	0	1
Kloen et al. [7]	2002	Case series / IV	33	OP + NOP	A-L (5)	3 (60%)	0
					K-L (9)	4 (44.4%)	1 (11.1%)
					S-P (7)	2 (28.6%)	0
					[TOF 5]*	[4 (80%)]*	0
				NOP (7)		0	1 (14.3%)
Prokop et al. [11]	2005	Case series / IV	9	OP	K-L (9)	3 (33.3%)	1 (11.1%)
Henle et al. [6]	2007	Case series / IV	12	OP	TOF (12)	4 (33.3%)	2 (16.7%)
Solberg et al. [15]	2009	Case series / IV	12	OP	TOF (12)	4 (33.3%)	1 (8.3%)

HO heterotopic ossification, AVN avascular necrosis, TOF trochanteric flip, S-P Smith-Peterson, K-L Kocher-Langenbeck, A + P anterior and posterior, A-L anterolateral, OP operative, NOP nonoperative

There are apparent drawbacks as well. The higher incidence of HO was indeed seen in these cases. The relationship between HO and the surgical approach is unclear, although some authors state the more extensile the approach, the higher incidence of HO [3]. In some studies, HO was found to be more frequent in male and elderly patients, and in patients with primary osteoarthritis, a high body mass index, low preoperative range of motion, length of operative time and large osteophytes [10]. Our review suggested that nearly all the incidences of HO in the anterior approach were higher than others. We deduced that extensive disruption of the soft tissue, which includes hip capsule and tenotomy of gluteus fibres, may be a contributor.

Table 3 The incidence of HO and AVN in different approaches

Approach	Total cases	HO (%)	AVN (%)
Anterior	38	16 (42.1%)	3 (7.9%)
Posterior	67	24 (35.8%)	11 (16.4%)
Trochanter flip	24	8 (33.3%)	3 (12.5%)
Lateral	9	0 (0%)	1
Anterolateral	5	3 (60%)	0
Anterior-posterior	1	0	0

HO heterotopic ossification, AVN avascular necrosis

The posterior approach has the benefit of preserving the anterior vascular supply to the femoral head and abductor function. Epstein et al. strongly recommended that femoral head fractures be exposed from a posterior approach to avoid further disruption of the vascular supply [5]. Our review showed the incidence of postoperative HO was not decreased in the posterior approach group, while the incidence of AVN was higher than other approach groups, but this did not reach statistical significance. Henle et al. concluded that even after a posterior dislocation a posterior approach to the hip joint causes more additional damage to the blood supply of the femoral head than an anterior approach [6]. The trochanteric flip approach has been recently described for management of femoral head fractures [6, 15]. Although this is still a posterior-based approach, it allows accelerated access to the femur head, simultaneous direct exposure and repair of fracture fragments without compromising the femoral head vasculature. Steffen et al. measured oxygen concentration during hip resurfacing through the trochanteric flip approach and compared this approach with previous data for the posterior and anterolateral approaches. Preservation of oxygenation with the trochanteric flip was similar to that observed with the anterolateral approach, but with less variation during the procedure. Both of these approaches were superior in terms of oxygenation preservation to the posterior approach

which resulted in a dramatic reduction in oxygenation [13, 14]. In our review, we also observed the decreased incidence of postoperative HO and AVN than other approaches.

Summary

This review may indicate that the use of the anterior approach may result in a higher risk for HO and the posterior approach may result in a higher risk for AVN. A new, posterior-based approach of trochanteric flip would seem to be a more appropriate approach for femoral head fractures. In addition, we should remember that the most important reasons to choose a certain approach are the type of fracture and its location, concomitant injuries and preference of the surgeon. A good case-control study would be appropriate to confirm the findings in our systematic review.

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