Screw fixation for treatment of femoral head fractures

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Background
Fractures of the femoral head (Pipkin fractures) are relatively uncommon. In cases of immediate, gentle reposition, and considerate soft tissue handling during operative treatment, Pipkin 1 and 2 fractures can heal with good long-term results. However, some long-term problems regularly occur. Conservative therapy is possible in cases of anatomic articulation or in the presence of only very small fragments that do not compromise articulation after closed reduction.

Objective
The aim of this study was to evaluate the results of open reduction and internal fixation of femoral head fractures.

Design
All patients were treated with open reduction and screw fixation of the fracture with counter sinking of the screw head.

Patients and methods
Sixteen patients were treated using the anterior Smith-Petersen approach for fixation of femoral head fractures after attempting closed reduction; the average age was 43 years (32–52 years). Postoperative follow-up was for 2 years.

Results
Six patients (37.5%) showed excellent results, four patients (25%) showed good, and six patients (37.5%) showed fair/poor results.

Conclusion
A wide controversy exists in the treatment of femoral head fractures; however, advances in treatment options and rehabilitation protocols make the outcome better by decreasing the incidence of late complications including avascular necrosis, post-traumatic arthritis, and heterotopic ossification.

Keywords:
femoral head fracture, hip fracture dislocation, Pipkin

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Introduction

The vast majority of femoral head fractures present with posterior hip dislocations and most commonly result from a high-energy trauma due to a motor vehicle accident [1,2]. Infrequently, a fractured femoral head fragment may be presented either as a consequence of an anterior hip dislocation [3] or as an isolated injury without accompanying dislocations [4]. The hip position, in terms of flexion, abduction or adduction, and rotation, combined with the amount and direction of the forces applied at the time of the accident, determines the pattern and the severity of the fracture [2].

A first classification of these fracture dislocations was proposed by Pipkin [5], who gave the eponym to this fracture classification. It is classified according to the location of the head fracture in relation to the fovea and additional lesion on the femoral neck or acetabulum (Fig. 1). This classification only applies to femoral head fractures associated with posterior hip dislocations.

Being high-energy intra-articular injuries, femoral head fractures always presented difficulties for every surgeon in terms of their management. Treatment of these fractures may range from a simple closed reduction to a prosthetic replacement, with intermediate options such as open reduction and internal fixation or excision of the fractured segment [6]. Prerequisites for conservative treatment irrespective of the fracture type are anatomic reduction of the hip dislocation and femoral head fracture, absence of intra-articular loose osteochondral fragments, and joint stability [7].

Open reduction and internal fixation (ORIF) is indicated for all fractures with a residual displacement of 1 mm or more, for those of the femoral neck or acetabulum, and for those with large femoral head fragments [8,9]. Fragment excision is mainly carried out for Pipkin type I fractures, whereas ORIF is favored by surgeons for Pipkin fractures of types II and IV. Joint replacement surgery is performed only in the Pipkin type III subgroup [10]. For most Pipkin type I and II fractures, the anterior Smith-Petersen approach can be used [8,9].

Regardless of the type of treatment, serious long-term consequences, such as post-traumatic arthritis, avascular necrosis, and heterotopic ossification, may complicate the

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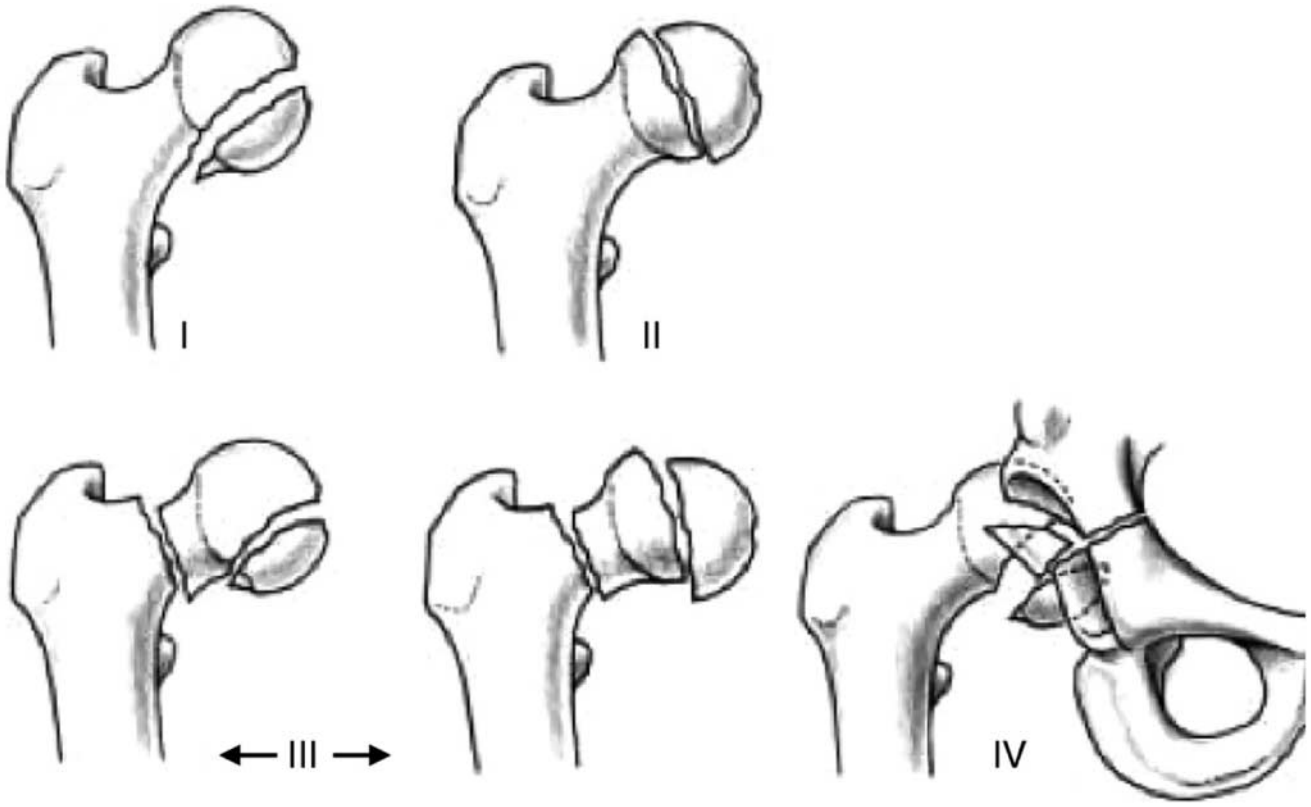
Figure 1



Pipkin classification of femoral head fractures with posterior hip dislocations. Types I and II are distinguished by the position of the fracture in relation to the fovea. Type I is below the fovea with the fracture outside of the weight-bearing joint parts, whereas type II fractures involve the more cranial, weight-bearing parts. Type III is any fracture of the head in combination with a femoral neck fracture. Additional fractures of the acetabulum are classified as type IV [1].

natural course of postinjury healing and rehabilitation, leading to unsatisfactory clinical results and a variable degree of disability [2].

Patients and methods

A prospective multicenter study was conducted on 16 patients with a femoral head fracture that had been treated at the Zagazig University and Health Insurance Hospitals between March 2007 and July 2009. Open reduction and screw fixation using the anterior Smith-Petersen approach was performed in all cases. Each fracture was classified according to the Pipkin classification [5] (Fig. 1).

All results were based on the latest radiographs and the functional outcome, determined using the system developed by Brumback *et al.* [11] (Table 1).

The age of the patients at the time of the accident was between 32 and 52 years with an average age of 43 years; 12 patients were men (75%) and four patients were women (25%). Motor vehicle accident was the cause of injury in 12 patients (75%) and falling from a height in four patients (25%). An associated injury was present in three patients (12.5%), one patient had a sciatic nerve injury, the other had an ipsilateral fracture of the tibia, and the third had a stable wedged dorsal 10 vertebral fracture. The fracture patterns in the 16 patients were as follows: Pipkin type I fracture in four patients (25%) and Pipkin type II fracture in 12 patients (75%). Patient demographics and results are summarized in Table 2. The incidence of complications, such as heterotopic ossification and avascular necrosis, and the need for additional surgery was documented. After admission, immediate closed reduction of a fracture dislocation of the hip was attempted under general anesthesia. Following the reduction, radiographs in two planes and a high resolution pelvic computed tomography (CT) scan were mandatory to evaluate the quality of reduction and to detect intra-articular fragments. If the fracture gap within the joint shows a displacement of 1 mm or more, operative treatment is indicated to improve reduction. If an anatomic reduction can be confirmed by CT scan,

Table 1 Evaluation system for a fractured femoral head [11]

Result	Description
Excellent	Normal hip motion, no significant radiographic changes
Good	Seventy-five percent of normal hip motion, no pain, minimum degenerative changes of the hip joint on radiographic evaluation
Fair/ poor	Painful hip with moderate or severe restriction of hip motion, moderate or severe radiographic joint incongruity, or degenerative joint disease

Table 2 Clinical and operative data of our eight patients

Case number	Age (years)	Sex	Side	Trauma type	Associated injury	Type of head fracture	Result of closed reduction	Results	Complications
1	40	M	Right	MVA	–	Pipkin II	Unstable	Excellent	–
2	32	M	Right	MVA	–	Pipkin II	Unstable	Good	–
3	50	F	Left	MVA	Sciatic nerve injury	Pipkin I	Nonconcentric	Fair/poor	Drop foot
4	48	M	Right	MVA	–	Pipkin II	Unstable	Excellent	–
5	33	M	Right	Falling	Ipsilateral fracture tibia	Pipkin II	Nonconcentric	Fair/poor	Secondary OA
6	45	M	Right	MVA	–	Pipkin I	Unstable	Fair/poor	AVN
7	52	M	Left	Falling	Wedged D10 fracture	Pipkin II	Unstable	Excellent	–
8	48	F	Right	MVA	–	Pipkin II	Unstable	Good	–
9		F		MVA	–	Pipkin II	Unstable	Fair/poor	–
10		M		MVA	–	Pipkin I	Nonconcentric	Excellent	–
11		M		MVA	–	Pipkin II	Unstable	Good	–
12		M		MVA	–	Pipkin II	Unstable	Excellent	–
13		M		Falling	–	Pipkin I	Nonconcentric	Good	–
14		F		MVA	–	Pipkin II	Unstable	Excellent	–
15		M		Falling	–	Pipkin II	Unstable	Fair/poor	–
16		M		MVA	–	Pipkin II	Unstable	Fair/poor	–

AVN; avascular necrosis; MVA, motor vehicle accident; OA, osteoarthritis.

patients are treated nonoperatively. An unstable closed reduction was observed in 12 patients (75%) and a nonconcentric reduction in four patients (25%) on postreduction radiographic and CT studies. An anterior Smith-Petersen approach was used in all patients, navicular screws were used for compression at the fracture site and the heads of the screws were counter sunken (Figs 2 and 3).

Surgical technique

All patients under general/spinal anesthesia were operated upon using the anterior Smith-Petersen approach. The blood supply to the femoral head from the anterior capsule is negligible and, thus, the anterior approach is favored in treatment of fractures of the femoral head [12]. After reduction of the fragment, a 2.7 mm drill was inserted perpendicular to fracture surface and the region near the articular surface was enlarged using a counter sinking tool to enlarge the hole for the head of the navicular screw. In all patients, a minimum of two screws were used to fix the fragment and prevent any rotation. The wound was closed in layers after placement of a drain, and sterile dressing was applied.

Follow-up care and rehabilitation

Depending on any additional injuries, the patients were mobilized out of bed the day after the surgery. Perioperative intravenous antibiotics were administered until removal of the drain (1.5 g cefuroxime three times a day), usually for 48 h, and oral antibiotics were administered until stitch removal. All patients in the study were administered 25 mg indomethacin orally for 6 weeks. Patients were discharged from the hospital after safe mobilization and after draining from the wounds stopped. During the first 8 weeks, only toe-touch weight bearing was allowed and active muscle exercises were prohibited. Radiographs were obtained immediately postoperatively and at 8 and 12 weeks, as well as 6 and 12 months after surgery. When the radiographs at 8 weeks showed fracture healing, progressive weight-bearing and active exercises for strengthening of the abductor muscles were initiated.

Results

According to the criteria of Brumback *et al.* [11], six patient had excellent results (37.5%), four patients had good results (25%), and six patients had fair/poor results (37.5%). One patient had irreversible sciatic nerve injury (12.5%) and was managed with an orthotic brace, another developed post-traumatic osteoarthritis (12.5%) and was managed with hip arthrodesis, and a third patient developed avascular necrosis (12.5%) and was managed with bipolar arthroplasty (Table 3). No patient showed clear signs of heterotopic ossification.

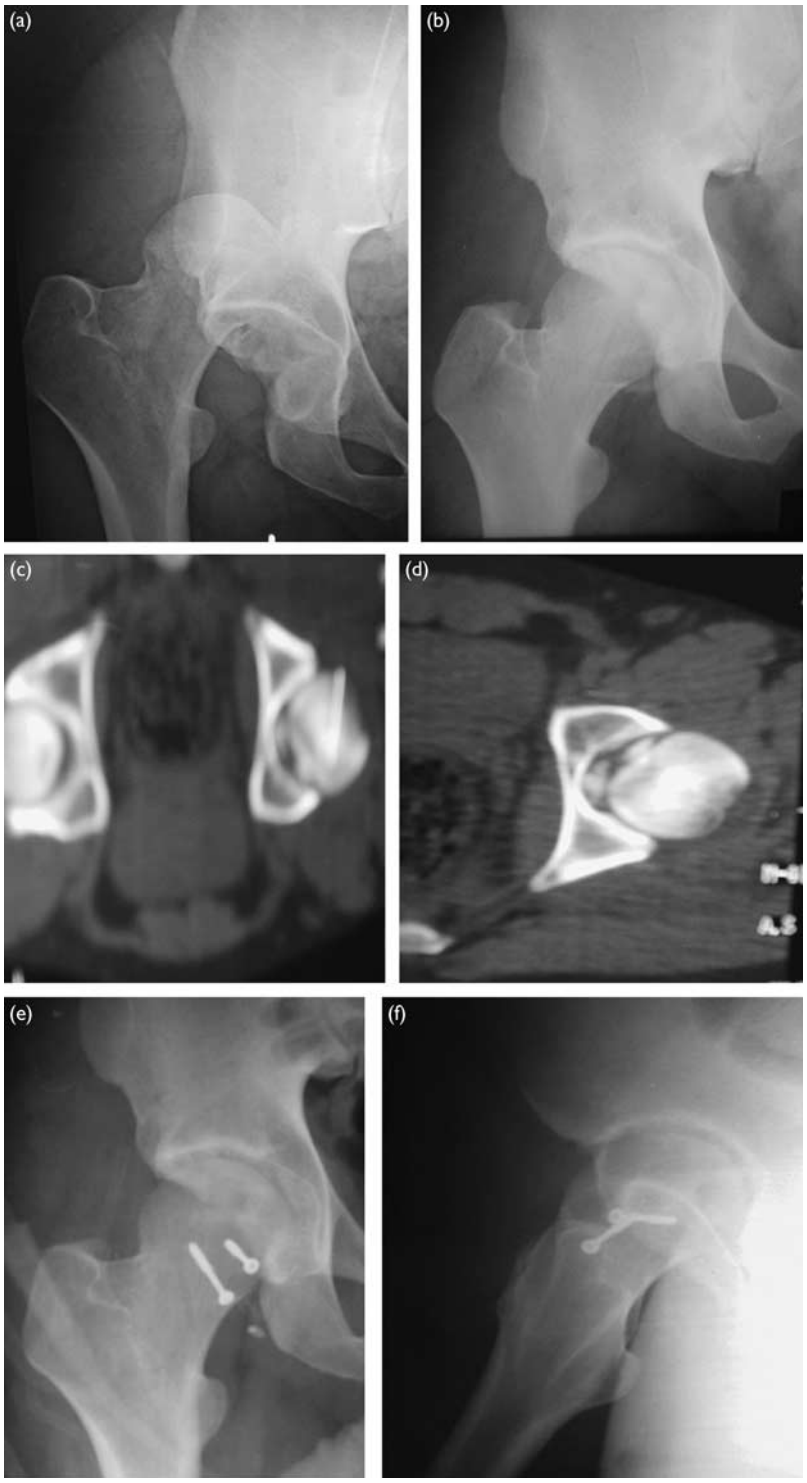
Discussion

Although a significant number of studies have been published on femoral head fractures over the past decades, a good or excellent outcome was reported only in 40–70% of all patients [13–15]. Analyzing our own series of eight patients treated for this injury between 2007 and 2009 showed excellent results in 37.5%, good results 25%, and fair/poor results in 37.5% of the patients.

Mowery *et al.* [16] treated 17 patients with a fractured femoral head of type I, II, or IV Pipkin injury by ORIF; 10 patients (58%) showed excellent/good results in comparison with eight patients (62.5%) in our study, and seven patients (42%) showed fair/poor results in comparison with six patients (37.5%) in our study.

Advantages and disadvantages of the different approaches have been the subject of previous studies. Comparison between anterior and posterior approaches for treatment of Pipkin type I and II fractures showed that operations using the anterior approach were associated with less estimated blood loss, shorter operating times, and better visualization and fixation. The drawback in patients treated with an anterior approach was the development heterotopic ossification [8]. Another, at least theoretical, disadvantage of anterior access to the hip joint might be a possible deterioration in the remaining blood supply to the femoral head after posterior dislocation and associated damage to the posterior blood vessels [12]. However anatomical and clinical studies do not support this theory [17].

Figure 2

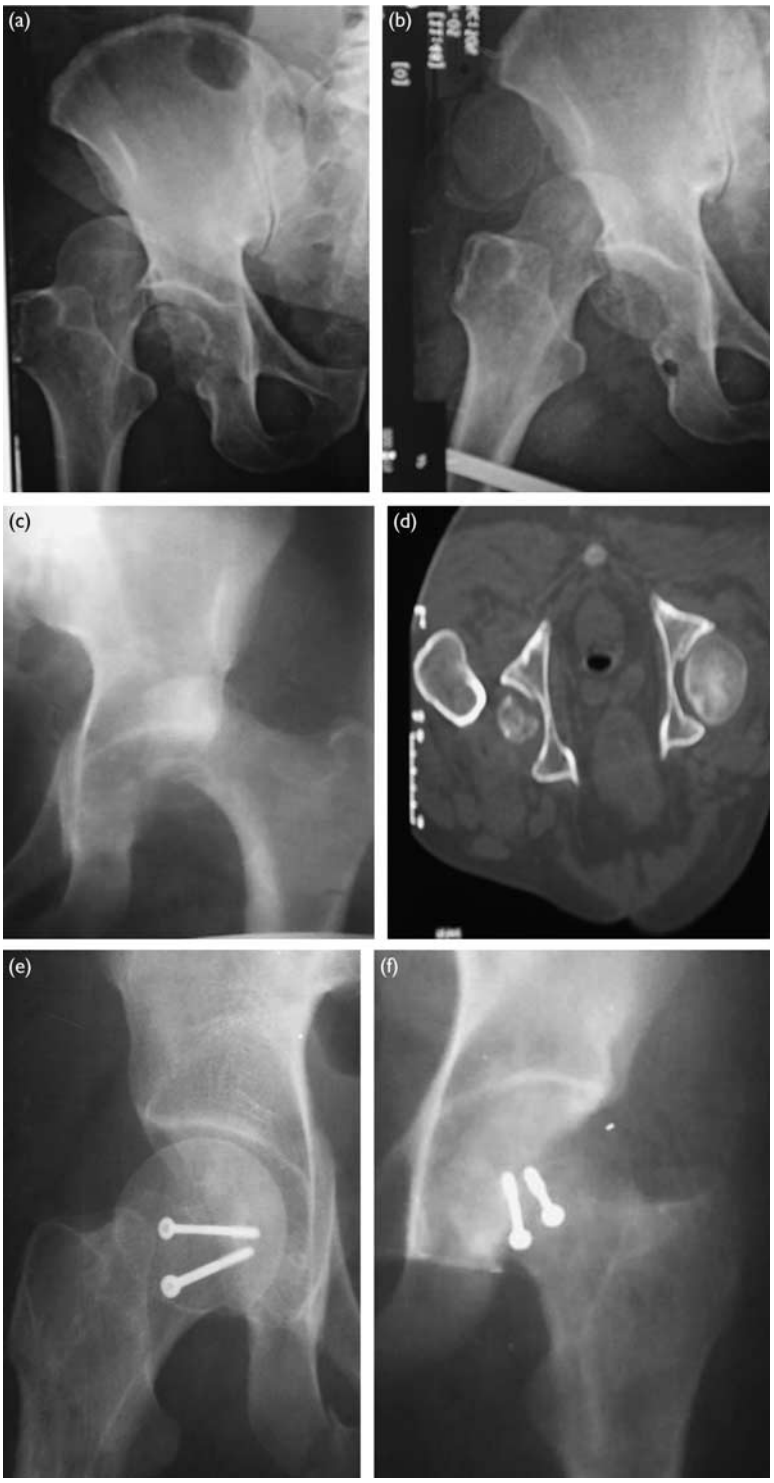


Case 1: a 40-year-old male patient with excellent results after open reduction and internal fixation. (a) Before reduction, (b) after closed reduction, (c) computed tomographic (CT) image before reduction, (d) CT image after closed reduction, (e, f) after fixation with excellent results.

Stannard *et al.* [7] were able to show that in comparison with an anterior approach, the Kocher–Langenbeck approach was associated with a 3.2-times higher risk for avascular head necrosis. It can be concluded that even after a posterior dislocation, a posterior approach to the hip joint causes more damage to the blood supply of the femoral head than an anterior approach [18].

Stannard and Swiontkowski *et al.* [7,8] reported in their retrospective study on 24 patients with Pipkin type I and Pipkin II femoral head fractures that using the anterior Smith-Petersen approach simplified the reduction and maintained blood supply of the femoral head; however, they reported a high incidence of heterotopic ossification. This complication did not occur in any of our patients as

Figure 3



Case 4: a 48-year-old male patient with fracture dislocation of the hip. (a) Anteroposterior view before reduction, (b) iliac view before reduction, (c) failed reduction, (d) computed tomographic image with intra-articular fragments, (e) anteroposterior view after fixation, (f) oblique view after fixation.

prophylactic indomethacin was administered to all the patients for 6 weeks postoperatively.

Complications and a poor outcome in patients with femoral head fractures are mostly attributed to one of the four major complications reported in the literature, which are avascular necrosis of the femoral head in 0–24%, post-traumatic osteoarthritis in 0–72%, peripheral nerve damage in 7–27%, and heterotopic ossification in 2–54% [19–21].

Standard radiographic follow-up of our patients showed signs of osteoarthritis in one patient.

Avascular necrosis developed in 12.5% of our patients in comparison with that reported by Sean *et al.* [22], which

Table 3 The overall results

Result	*N* (%)
Excellent	6 (37.5%)
Good	4 (25%)
Fair/poor	6 (37.5%)

was 10%. Swiontkowski *et al.* [8] reported on 37 patients with femoral head fractures with two cases of avascular necrosis (7.4%), in comparison with 12.5% in our study, and two cases of heterotopic ossification (7.4%), in comparison with none in our study.

Avascular necrosis may be caused by damage to the blood supply at the time of injury or may be iatrogenic. Whereas initial damage to vascular structures is certainly beyond the surgeon's control, care has to be taken during reduction maneuvers and surgery to avoid further damage to the blood supply [18].

Early reduction has been proven to be the most effective means of preventing avascular necrosis by shortening the time period for which the circulation to the femoral head is compromised. The diagnosis of avascular necrosis of the femoral head does not depend on a single finding and the following criteria should be fulfilled to establish a diagnosis of avascular necrosis: collapse of the femoral head, anterolateral sequestrum or the crescent sign, a double line on T2-weighted MRI images, increased uptake surrounding a photopenic area called cold-in-hot on radionuclide scintigraphy, or positive findings on bone biopsy [23,24].

Conclusion

Age of the patient, associated injury, amount of femoral head involvement, and type of fracture are important factors in decision making for femoral head fractures.

The anterior Smith-Petersen approach in femoral head fractures improves the ease of anatomic reduction.

Conservative treatment is only justifiable if the post-reduction CT demonstrates an anatomic reduction in the head fragments.

Herbert screws, small cancellous screws, or navicular screws are usually adequate to maintain the reduction until union.

Long-term results for femoral head fractures remain unknown because most series include a small number of patients and combine different injury patterns and multiple surgical exposures, which make arriving at a useful conclusion challenging.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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