Core Decompression and Concentrated Autologous Bone Marrow Injection for Treatment of Osteonecrosis of the Femoral Head

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Background: *Osteonecrosis of the femoral head is a deficiency of blood supply resulting in femoral head collapse and joint destruction. This usually found in young adults as the leading cause of hip arthroplasty. Core decompression has been reported to reduce the bone marrow pressure for treatment of stage I and II of disease. Later, addition of concentrated bone marrow injection was proposed and reported good result. The purpose of the present study was to report the result of core decompression and concentrated bone marrow injection.*

Material and Method: *Twelve patients with osteonecrosis of femoral head underwent a core decompression and concentrated autologous bone marrow injection. Data of age, sex, underlying disease, risk of osteonecrosis were collected. Patients were followed at 3 months, 6 months, 1 year and then yearly. Radiographic data were recorded.*

Results: *Thirteen hips in 12 patients underwent the procedure. Two cases were excluded due to loss of follow-up. Mean age was 36.2 (12-56). One hip were in stage I, five in stage II and five in stage III. Risk factor included steroid usage in 6 hips and alcohol consumption in 3 hips. Underlying diseases were SLE (5), dermatitis (1), post-traumatic (1). Average nucleated cell from marrow was 91.58 x 10^6/ml ($\pm$ 55.9). CD34 was 17.25 x 10^6/ml cells and percentage of recovery of mononuclear cell was 70.4%. Mean follow-up time was 3.6 years (range 1-7 years). All cases had good pain relief initially. At the last follow-up 8 hips (72%) had progression and 2 underwent surgery. No infection occurred. No adverse effect detected.*

Conclusion: *This report showed low success rate of core decompression with concentrated autologous bone marrow grafting. The effect of delayed progression is not clear. However, the procedure appeared to be safe without immediate complication.*

Keywords: *Osteonecrosis, Core decompression, Autologous bone marrow, Femoral head*

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Osteonecrosis (avascular necrosis, aseptic necrosis) of the femoral head is a condition with deficiency of blood supply resulting in femoral head collapse, irregularity of joint space and joint destruction[1-3]. Patients present with pain, decreased motion and disability. This condition usually found in young adults as the leading cause of total hip arthroplasty in Thailand.

Etiology of osteonecrosis of femoral head can be traumatic and non-traumatic causes[4]. The risk of non-traumatic osteonecrosis included steroid usage, alcohol consumption, immunosuppressive drugs, autoimmune disease such as SLE and rheumatoid arthritis, coagulation disorder such as protein C, protein S deficiency, hyperlipidemia, radiation, malignancy and organ transplantation[5-12]. However some patients had no identified risk factor. Incidence of osteonecrosis was estimated to be 1.4-6 per 100,000 populations per year[13].

Ficat[14] described the 4 stages of this condition, subsequently was modified to 5 stages and reported a series of the patients. They described the technique of core decompression in 1985 in order to reduce the bone marrow pressure in the femoral head. From the literature including the meta-analysis, the core decompression is recommended in stage I and II disease only[14,15]. The procedure had success rate in prevention of the disease of 84% in stage I and 65% in stage II[14,15]. The procedure appears to be unpredictable and not recommended if the disease is beyond stage II.

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In 2002, Hernigou[16] reported a large series of 145 hips with stage I and II of the disease underwent the core decompression with autologous concentrated bone marrow grafting. The bone marrow cells were concentrated by cell separator. There were only 9 hips underwent total hip replacement at 5-10 years follow-up period. Other literature showed the same good results[17,18].

The purpose of the present study was to report the result of core decompression and concentrated autologous bone marrow injection in our institute.

Material and Method

From October 2005 to September 2006, 12 patients with the diagnosis of osteonecrosis of femoral head underwent a core decompression and concentrated autologous bone marrow injection. Data of age, sex, underlying disease, risk of osteonecrosis were collected. In the procedure, one hundred ml of bone marrow was aspirated from posterior superior iliac spine both sides two hours before the core decompression operation. The bone marrow was centrifuged to collect buffy-coat by using cell separator at Hematology Department Laboratory. During that time, the patients were sent to recovery room. After the concentrated marrow was sent back to the operating room, the authors performed core decompression by drilling into the femoral head with a 3.5 mm drill bit. The technique used only one entrance hole and spreaded out to 3 holes inside the necrotic lesion of the femoral head. Then patients were injected with concentrated bone marrow aspiration through the drill hole. After the injection, the entrance hole is obliterated by directing the core needle tangentially in order to collapse the core hole by cancellous bone therefore preventing leakage of the marrow. Six weeks of non weight bearing with bilateral crutches was adviced to all the patients. The patients were followed at 3 months, 6 months, 1 year, and then yearly. Radiographic data of the femoral head were observed in each visit.

Table 1. Risk factor and average number of mononuclear cell derived from aspirated bone marrow

Risk Factors	Concentration of Mononuclear Cell (millions per milliliter)
Steroid usage	58.23 ± 24.2
Alcohol consumption	114.67 ± 68.8
Non-steroid usage	131.60 ± 58.5

Results

There were 13 hips in 12 patients underwent core decompression and concentrated autologous bone marrow injection. Two cases were loss to follow-up at 3 months after the surgery. Therefore 11 hips in 10 patients were included for analysis. There were 3 men and 7 women. Mean age at the index procedure was 36.18 years (range 12-56). One hip was classified in stage I, 5 in stage II and 5 in stage III according to Ficat and Arlet classification. Risk factor of osteonecrosis included steroid user in 6 hips and alcohol consumption in 3 hips. Underlying diseases of patients were SLE (5), dermatitis (1), post-traumatic (1). Average amount of nucleated cell derived from bone marrow aspiration was 91.58 (± 55.9) million cells per ml. The number of CD34 was average 17.25 million cells and percentage of recovery of mononuclear cell was 70.4%. Average amount of nucleated cell in steroid use patients was 58.23 (± 24.2)million cells per ml while in non-steroid use patients was 131.6 (± 58.5) million cells per ml (Table 1). Mean follow-up time was 3.55 years (range 1-7 years). All cases had good pain relief initially.

At the last follow-up 8 hips (72%) had radiographic progression and 2 out of these underwent other surgical procedure (1 free vascularized fibular graft and 1 total hip arthroplasty) (Table 2).

One patient was classified in stage I of disease. She was SLE patient with bilateral osteonecrosis of femoral head. Core decompression was performed at one side, another side was injected with concentrated bone marrow. After follow-up, the simple core decompression side was collapsed at 3 years while

Table 2. Number of patients, staging and progression

Stage	Number of Hips	Radiographic Progression	Femoral Head Collapse	Surgery
I	1	1	0	0
II	5	5	3	2
III	5	5	4	0

another side showed cystic and sclerotic change of femoral head with minimal collapse and sclerosis of acetabulum (stage IV) at 5 years. She was free from pain (VAS 0/10) (Fig. 1).

There were 5 patients in stage II. Three of these had oral steroid as a risk factor (2 SLE and 1dermatitis). One patient was a heavy alcohol drinker and another one was idiopathic. All the patients had radiographic progression of stage. Three out of 5 had radiographic progression without femoral head collapse while the other 2 had femoral head collapse and need further surgical procedures mentioned above. One patient was SLE with steroid usage. She had total hip arthroplasty on the right side 3 years earlier and developed new symptoms on the other side. She underwent core decompression and concentrated autologous bone marrow injection. After 4 years follow-up, the x-ray shows progression but no collapse of femoral head and the patient was pain free (Fig. 2). One patient with history of heavy alcohol drinking had femoral head osteonecrosis on both sides, but he refused to perform core decompression on the other side. On the non-surgical side, the femoral head collapsed 5 months later and needed total hip arthroplasty 3 years later. On the decompression side, collapse still occurred but conversion to total hip arthroplasty was at 5 years later (Fig. 3). One was SLE patient taking oral steroid and immunosuppressive drug. She had femoral head collapse 3 year after the procedure and underwent free vascularized fibular graft. She was also performed non-vascularized fibular graft on another side due to osteonecrosis 2 years earlier (Fig. 4). She had good pain relief. One case was a bilateral idiopathic osteonecrosis, procedure was done only one side. At 4 years both sides were all progress in stage but collapsed femoral head occurred at non-surgical side.

Five patients in stage III were all progressed and 4 out 5 femoral heads were collapsed. No data of further surgery because all patients loss to follow-up at 2 years (Table 3).

Discussion

Core decompression is considered a treatment of choice in stage I and II of disease. Other proposed

Fig. 1 (A) A 21-year-old female, underlying SLE with nephritis with oral steroid and immunosuppressive drug, developed bilateral femoral head osteonecrosis stage I in the right side, stage II in the left side. She underwent core decompression on both sides, only the right side was injected with concentrated bone marrow. (B) Six years later both femoral heads had radiographic progressed. More collapse occurred only on left side

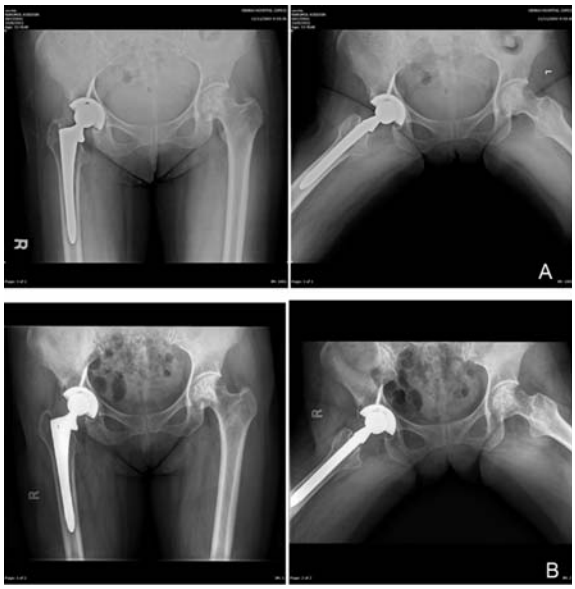

Fig. 2 A 53 years old female with steroid uses for SLE treatment. She had total hip arthroplasty on the right side 3years ago, developed new symptom on the other side. (A) Preoperative film show osteonecrosis stage II of left femoral head and right total hip arthroplasty. She underwent core decompression and concentrated autologous bone marrow injection. (B) After 4 years follow-up, the x-ray shows progression but no collapse of femoral head. The patient was pain free

Fig. 3 (A) 56 years old man, with history of alcohol drinking, had femoral head osteonecrosis on both sides, but he refused to perform core decompression on the other side. On the non-surgical side, the femoral head was collapsed. (B) He underwent total hip arthroplasty 3 years later while the decompression side hip arthroplasty can be delayed to 5 years after core decompression

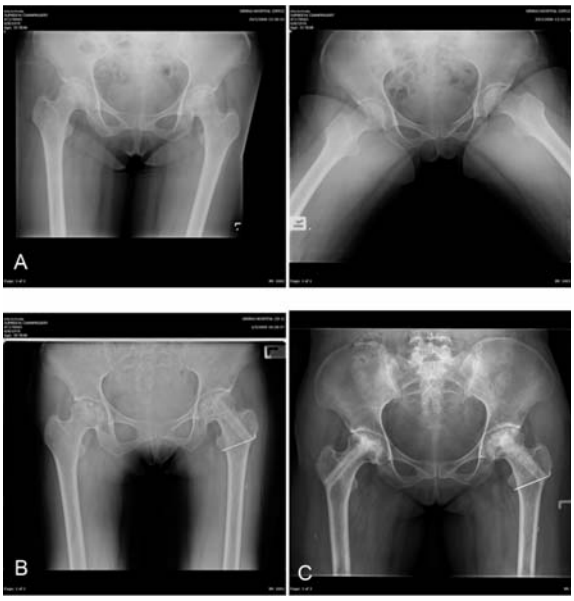

Fig. 4 A 35-year-old female with SLE and thrombocytopenia had oral steroid and immunosuppressive drug as a treatment. She developed bilateral osteonecrosis of femoral head. (A) Preoperative film showed Ficat and Arlet stage II. She underwent core decompression and concentrated autologous bone marrow injection on right side. (B) 2 years later she underwent free vascularized fibular graft on left side due to progressive pain. (C) 2 years after first vascularized graft, she underwent free vascularized fibular graft on another side

additional treatment such as bone marrow grafting, bisphosphonate, bone morphogenic protein, angiogenic bone cement also had reported good results[19-21].

The result of the present study was different from others studies[17,18,22]. Eight out of 11 patients (72%) had radiographic progression of staging. In patients with stage I and II, all 6 patients had progression. Surgical treatment required in 2 patients (33%). Failure of treatment in the present study was higher than in the literatures which reported 6-25%[16-18]. It is possible that the patients had risk factor such as steroid usage and alcohol consumption and still continued to have. The delayed clinical progression to a total hip replacement was observed in 4 patients (stage I and II) as in the literature[18]. Two hips in stage II had radiographic progression but no head collapsed as observed in the others. This might be the result of increasing bone formation in the femoral head, but the secondary osteoarthritis still occurred.

Number of mononuclear cell derived from the separation process was lower in steroid group than the others. This observation is the same as in the other study[16].

Limitations of the present study are the numbers of patients were small and with short term follow-up. All of the stage III patients were loss follow-up at 2 years after surgery.

Conclusion

This preliminary report showed lower success rate of core decompression and concentrated autologous bone marrow grafting. The effect of delayed progression is not clear but the technique might help to preserve the bone in the femoral head at the early stage. Study with larger number of patients and long term follow-up with functional outcome should be

Table 3. Details of the patients

Patient No.	Age	Sex	Side	Underlying	Risk	Staging		Follow up time (year)	Surgery
						Pre-op stage	Post-op Stage		
1	21	F	R	SLE	Steroid, immunosuppressive drug	I	IV	6	-
2	50	F	L	Dermatitis	Steroid stop 3 years	II	IV	7	-
3	53	F	L	SLE	Steroid stop 3 years	II	III	4	-
4	36	F	R	SLE Thrombocytopenia	Steroid, immunosuppressive drug	II	III	5	Free vascularized fibular graft
5	26	M	R	-	-	II	IV	4	-
6	56	M	R	-	Alcohol	II	IV	5	THR
7	40	F	R	SLE	Steroid, immunosuppressive drug	III	IV	2	-*
8	37	M	R	-	Alcohol	III	III	1	-*
			L			III	III	1	-*
9	37	M	L	-	Alcohol	III	III	2	-*
10	12	F	R	-	Trauma	III	IV	2	- *

* Patient loss follows-up

conducted. However, the procedure appeared to be safe without immediate complication in the present study.

Potential conflicts of interest

None.

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การรักษาภาวะหัวกระดูกสะโพกตายโดยวิธีการเจาะแกนกลางกระดูกเพื่อลดความดันในหัวกระดูกสะโพกร่วมกับการฉีดไขกระดูกเข้มข้น

อารีศักดิ์ โชติวิจิตร, เอกพจน์ ก่อวุฒิกุลรังษี, จิรายุ เอื้อวรากุล, สรฤทธิ์ สรีระศรีฤทธิ์

ภูมิหลัง: *ภาวะหัวกระดูกสะโพกตายเกิดจากการขาดเลือดไปเลี้ยง ทำให้เกิดหัวกระดูกสะโพกยุบและการทำลายของข้อสะโพก ภาวะนี้มักพบในผู้ใหญ่อายุน้อย ซึ่งเป็นสาเหตุสำคัญที่นำไปสู่การเปลี่ยนข้อสะโพกเทียม การรักษาโดยการเจาะแกนกลางกระดูก เพื่อลดความดันในหัวกระดูกเป็นวิธีที่ใช้ในการรักษาโรคที่อยู่ใน stage I และ stage II ต่อมาได้มีการฉีดไขกระดูกเข้มข้นร่วมด้วย ซึ่งรายงานว่าได้ผลดีในการรักษา*

วัตถุประสงค์: *เพื่อรายงานผลของการรักษาหัวกระดูกสะโพกตายโดยวิธีการเจาะแกนกลางกระดูกเพื่อลดความดันในหัวกระดูกสะโพก ร่วมกับการฉีดไขกระดูก*

วัสดุและวิธีการ: *ผู้นิพนธ์รวบรวมผู้ป่วย 12 ราย ที่ได้รับการรักษาหัวกระดูกสะโพกตายโดยวิธี การเจาะแกนกลางกระดูกเพื่อลดความดันในหัวกระดูกสะโพกร่วมกับการฉีดไขกระดูก โดยเก็บข้อมูลอายุ, เพศ, โรคประจำตัว, ภาวะเสี่ยงของการเกิด หัวกระดูกสะโพกตาย ผู้ป่วยได้รับการติดตามที่ 3 เดือน, 6 เดือน, 1 ปี และ ทุกปีหลังจากนั้นโดยการตรวจภาพถ่ายรังสี*

ผลการศึกษา: *ผู้ป่วย 12 ราย ได้รับการผ่าตัดเจาะแกนกลางกระดูก 13 ข้าง ผู้ป่วย 2 ราย ไม่มาติดตามผลการรักษา ผู้ป่วยมีอายุเฉลี่ย 36.18 ปี แบ่งเป็น stage I 1 ข้าง, stage II 5 ข้าง, และ stage III 5 ข้าง ปัจจัยเสี่ยงของผู้ป่วยได้แก่ การใช้ยาสเตียรอยด์ การดื่มเครื่องดื่มแอลกอฮอล์ ผู้ป่วยมีโรคประจำตัวเป็น SLE 5 ราย, dermatitis 1 ราย, และจากอุบัติเหตุ 1 ราย จำนวนnucleated cell เฉลี่ยจากไขกระดูก 91.58 x 10^6/ml (± 55.9) CD34 17.25 x10^6/ml และเปอร์เซ็นต์ของ mononuclear cell เฉลี่ย 70.4% ผู้ป่วยทุกรายสามารถบรรเทาอาการปวดได้ในช่วงแรก*

การติดตามผู้ป่วยล่าสุด สะโพก 8 ข้าง(72%) มีการเปลี่ยนแปลงแย่ลง และ 2 รายต้องรักษาด้วยการผ่าตัด ไม่พบมีการติดเชื้อ หรือผลข้างเคียงที่รุนแรง

สรุป: *จากการศึกษาพบว่าผลการรักษาหัวกระดูกสะโพกตายโดยวิธีการเจาะแกนกลางกระดูกเพื่อลดความดันในหัวกระดูกสะโพก ร่วมกับการฉีดไขกระดูกนั้นประสบความสำเร็จน้อย และผลของการชะลอการเปลี่ยนแปลงของหัวกระดูกสะโพกยังไม่ชัดเจน อย่างไรก็ตามหัตถการนี้มีความปลอดภัยและไม่พบภาวะแทรกซ้อน*