A Comparison of Surgical Outcomes of Hip Fractures with Mini-open Screw Fixation and with Closed Screw Fixation in Young Adults

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Background: *Most femoral neck fractures in young adults (patients under 60) are caused by severe trauma and lead to complications such as nonunion and avascular necrosis. Two types of operations, mini-open reduction and screw fixation and closed reduction and screw fixation are commonly performed. However, the relative merits of these two techniques are still controversial.*
Objectives: *To investigate the characteristics of young adult patients with femoral neck fractures and to compare surgical outcomes with mini-open reduction and screw fixation (mini open group) and patients undergoing closed reduction and screw fixation (CRSF group).*
Materials and Methods: *The medical records of 77 young adult patients with hip fractures treated at Roi-Et Hospital in northeast Thailand from 2011 to 2016 were reviewed. The data, including patient characteristics and surgical outcomes, were statistically analyzed.*
Results: *The mean age of the patients was 36.19±9.95 years. The main cause of hip fracture was motor vehicle accidents. Most of the injuries were basicervical fractures with no difference between males and females. There were no significant differences between patients in the mini open and the CRIF groups for screw placement, operative time, successful reduction of fracture, incidence of failure of fixation, achievement of bone union, and occurrence of avascular necrosis. The mini-open group, however, did have statistically significantly higher intraoperative blood loss and lower overall treatment costs than the mini open group.*
Conclusions: *In clinical practice, mini-open reduction and internal fixation with cancellous non cannulated screws using the Watson-Jones approach and with a normal operating table is appropriate for treatment of young adults with hip fractures, especially when the cost of treatment is a major consideration.*

Keywords: *hip fractures, young adult patients*

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Introduction

The incidence of hip fractures world-wide in the 1990s was not less than 1.3 million, and is expected to rise to 2.6 million by the year 2025 and 4.5 million in 2050[(1)]. Among Asian people, the incidence of hip fracture is expected to increase 50% by 2050[(4)]. In 2003, there were 345,000 hip fracture patients in the United States alone[(2)]. More than 90% of hip fracture patients are age 60 or older (older adults)[(3)]. That percentage is expected to increase as the world population continues to age[(1)]. In 2004, more than 320,000 workers in all countries were admitted to hospital for hip fractures. Although the incidence of hip fracture is high in the elderly, it is also increasing for adults under 60 who are at high risk of developing avascular necrosis of the femoral head as well[(5)].

Hip fractures in adults under 60 are often caused by blunt force trauma. In evaluating and treating hip fractures in young adults, physicians need to be aware of the differences between young and older adults. Major differences include the anatomy of the bones and blood vessels, mechanisms of injury, associated injuries, and the goals of treatment. Data indicate that hip fractures in adults under 60 are associated with avascular necrosis and nonunion in 12-86% of cases. Those complications can require revision surgery and have high failure rates[(6)]. Injuries in young adults need to be treated promptly and appropriately.

There are two major methods for the management of hip fractures: hip prosthesis, which is most frequently used in elderly patients, and reduction and internal fixation which is appropriate for young adult patients. Fracture reduction can be achieved either by closed reduction using a fracture table or by open reduction to restore the anatomical position. When bone union has been achieved, there are no prosthesis complications, although a risk of avascular necrosis persists[(7,8)]. Closed reduction is preferred where possible because it does not damage the blood supply; however, if reduction cannot be achieved by the closed method, open reduction should be performed. In both cases,

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internal fixation is recommended using three cannulated, fixed in an inverted triangle configuration. A fluoroscope can be used to check the fracture reduction and screw placement[7,8].

This study compared the surgical outcomes of femoral neck fracture treatment with mini open reduction and screw fixation (mini-open) and with closed reduction and screw fixation (CRSF) in young adults.

Materials and Methods

This study was conducted with the approval of the Ethical Committee of Roi-et Hospital. Inclusion criteria for femoral neck fracture cases were: young adults age less than 60 who were treated for a closed displaced femoral neck fracture by the inpatient department (IPD) at Roi-et Hospital between 2011 and 2016. Patients with multiple trauma were excluded. All of the 77 patients included in the study were operated on with mini-open reduction and cancellous non-cannulated screw fixation via the Watson-Jones approach (mini-open group) or with closed reduction and cannulated screw fixation using a fracture table (CRSF group). Patient data obtained included sex, age, occupation, underlying diseases, cause of the injury, location of the fracture, degree of displacement, tilt of the fracture, intraoperative blood loss, placement of screws, operative time, success in reduction of fracture, cost of treatment, incidence of failure of fixation, avascular necrosis and achievement of final union.

Primary outcomes assessed in this study were union rate. Secondary outcomes were intraoperative blood loss, operative time, length of hospital stay, screw placement, fracture reduction, fixation failure and avascular necrosis.

Statistical methods

All continuous data were compared between the treatment groups using the independent t-test. Non-normally distributed data cancellous screws, either cannulated or non and categorical data were analyzed using non-parametric tests. Comparison ratios between the two treatment groups were reported as odds ratios. The 95% confidence interval (CI) was also calculated.

Demographics of the femoral neck fracture patients were analyzed using descriptive statistics. Comparison of outcomes of femoral neck fracture treatment between mini-open reduction and screw fixation (mini-open) and closed reduction and screw fixation (CRSF) in young adults was done using the chi-square test and the independent t-test. Statistical significance was set at $p < 0.05$ and 95 percent confidence intervals for factors affecting outcomes were calculated.

Results

Patient characteristics

The mean age of all patients was 36.19±9.95 years, and most were male (75.32%). Basicervical was the most common type of fracture (80.52%). Of the 77 patients who were operated on, 42 were in the CRSF group and 35 were in the mini-open group (Table 2). There were no statistically significant differences in patient characteristics between the two groups ($p > 0.05$) (Table 1).

Surgical outcomes

The union rate was 80.52% overall, and 55.84%, of the patients had more than 200 ml intraoperative blood loss (Table 3). The union rate, operative time, hospital stay, rate of appropriate screw placement, fixation failure rate and incidence of avascular necrosis were not statistically significantly different between the two groups ($p > 0.05$). Intraoperative blood loss in the mini-open group, however, was significantly greater than in the CRSF group (mean difference 1.02 ml, 95% CI 0.09 to 2.14) (Tables 4 and 5).

Table 1 Demographic data of patients

General characteristics	Number (n = 77)	Percentage
Sex		
Female	19	24.68
Male	58	75.32
Occupation		
Agriculture	30	38.96
Employed	42	54.55
Student	5	6.49
Underlying disease		
No Underlying disease	57	74.03
Underlying disease	20	25.97
Causes		
Fall / fall from height	17	22.08
Traffic accident / other accident	60	77.92

General characteristics	Number (n = 77)	Percentage
Location of fracture		
Basicervical	62	80.52
Transcervical	11	14.29
Subcapital	4	5.19
Degree of displacement		
Garden type 3	54	70.13
Garden type 4	23	29.87
Tilt of fracture		
Pauwels Type 1	40	51.95
Pauwels Type 2	29	37.66
Pauwels Type 3	8	10.39

Table 2 Patient characteristics in the mini-open and CRSF groups

General characteristics	Operation		OR	95% CI	p-value
	Mini-open	CRSF			
Sex					
Male	25	33	0.68	0.24 - 1.88	0.46
Female	10	9			
Occupation					
Employed/Student	21	26	0.92	0.37 - 1.29	0.86
Agriculture	14	16			
Underlying disease					
Underlying disease	10	10	1.28	0.46 - 3.48	0.635
No Underlying disease	25	32			
Causes					
Traffic accident/other	30	30	2.24	0.77 - 7.34	0.132
Fall/fall from height	5	12			
Location of fracture					
Basicervical	28	34	0.94	0.31 - 2.82	0.91
Transcervical/Subcapital	7	8			
Degree of displacement					
Garden type 3	22	32	0.52	0.20 - 1.39	0.20
Garden type 4	13	10			
The tilt of the fracture					
Pauwels Type 1	19	22	1.07	0.44 - 2.63	0.86
Pauwels Type 2/3	16	20			

Table 3 Results of patients with femoral neck fractures

Outcome	Number (n = 77)	Percentage
Union		
Nonunion	15	19.48
Union	62	80.52
Intraoperative blood loss		
≤ 200 ml	34	44.16
> 200 ml	43	55.84

Outcome	Number (n = 77)	Percentage
Placement of Screw		
Appropriate	47	61.04
Inappropriate	30	38.96
Operative time		
1- 2 hours	44	57.14
> 2 hours	33	42.86
Reduction of fracture		
Acceptable	61	79.22
Unacceptable	16	20.78
Cost		
Inexpensive	53	68.83
Expensive	24	31.17
Failure of fixation		
No	68	88.31
Yes	9	11.69
Avascular necrosis		
Yes	13	12.99
No	64	83.12

Table 4 Comparison of treatment outcomes for hip fracture patients by mini open reduction group and closed reduction group

Outcome	Number	Mean $(\overline{X})$	Mean Difference $(\overline{d})$	95% CI	p-value
Intraoperative blood loss					
Mini Open	42	259.57	83.35	56.94 - 109.77	< 0.001
CRSF	35	176.21			
Operative time					
Mini Open	42	107.14	10.35	-1.22 - 21.93	0.07
CRSF	35	107.50			
Hospital day					
Mini Open	42	10.14	1.04	0.38 - 3.48	0.39
CRSF	35	9.10			

Table 5 Comparison of treatment outcomes for hip fracture patients by mini open reduction group and closed reduction group

Outcome	Number		OR	95% CI	p-value
	Mini Open Reduction	Closed Reduction			
Union					
Union	28	34	0.94	0.30 - 2.96	0.57
Nonunion	7	8			
Placement of Screw					
Appropriate	19	28	0.59	0.23 - 1.48	0.26
Inappropriate	16	14			

Outcome	Number		OR	95% CI	p-value
	Mini Open Reduction	Closed Reduction			
Reduction of fracture					
Acceptable	28	33	1.09	0.36 - 3.20	0.87
Unacceptable	7	9			
Failure of fixation					
No	32	36	1.77	0.44 - 7.01	0.43
Yes	3	6			
Avascular necrosis					
No	29	35	0.96	0.30 - 3.06	0.95
Yes	6	7			

Discussion

Most patients in both groups had basicervical fractures and most were Pauwels Type 1. Only the intraoperative blood loss and treatment cost were statistically significantly different between the mini-open and CRSF groups. With mini-open, the skin was incised to expose the fracture site which can result in more blood loss than closed reduction. The cost of each 6.5 mm non cannulated cancellous screws used in the mini-open group was 300 baht (900 baht for the 3 screws) compared with 3,000 baht per screw for 7.3 mm cannulated screws used in the CRSF group (9,000 baht for the 3 screws). Thuan & Marc[8] introduced the Watson-Jones approach to the management of hip fracture in young adult hip fracture patients. It has been suggested that fixation of fractures can be achieved with three screws, either cancellous cannulated or non cannulated, as the quality of bone is sufficient. An advantage of the Watson-Jones approach is reduced intraoperative bleeding.

Limitations of this study include the small sample size which was insufficient to detect differences between the treatment groups related to rare events[11-13] such as avascular necrosis. Because femoral neck fractures in young adults are usually caused by blunt force trauma, e.g., vehicle accidents or falls from height, which can injure major blood vessels to the femoral head resulting in avascular osteonecrosis. A study by Marti et al.[9] reported that 43 of 50 patients developed avascular osteonecrosis. Anglen[10] reported that 13 patients treated with valgus intertrochanteric osteotomy had a reduction failure. All 13 were under the age of 60. Follow-up of 11 patients for a mean of 25 months found 2 deaths. Thierry et al.[7] proposed that urgent management of hip fractures in young adults should include surgery. The key elements in the treatment of thigh bone fractures is rapid diagnosis of the disease, immediate surgery, anatomical reduction and stable fixation[5-7,14-18]. Treatment of femoral neck fractures in young adults should focus on reducing complications of nonunion and avascular necrosis through appropriate management. Diagnosis of fractures should be made immediately, operations should be a matter of urgency and patient rehabilitation should begin early.

Conclusions

The mini-open group had greater intraoperative blood loss, while CRSF group had a higher operative cost. These factors should be considered when dealing with femoral neck fractures in young adult patients. Mini-open reduction and internal fixation with cancellous non cannulated screws following the Watson-Jones approach and using a normal operating bed is appropriate for clinical practice in the care of young adult hip fractures, especially when the cost of treatment is a main consideration.

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Potential conflicts of interest

The authors declare no conflicts of interest.

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ผลการรักษาเชิงเปรียบเทียบการรักษากระดูกสะโพกหักในผู้ป่วยที่ไม่ใช่ผู้สูงอายุระหว่างวิธีผ่าตัดเปิดแผลขนาดเล็กแบบวัตสัน โจนส์ จัดกระดูกเข้าที่ ใส่สกรูยึดตรึงกระดูกภายใน กับการผ่าตัดจัดกระดูกเข้าที่แบบปิด ใส่สกรูยึดตรึงกระดูกภายใน

ชินวัฒน์ ศรีใส,พบ, สุรชัย แซ่จึง, พบ

วัตถุประสงค์: เพื่อศึกษาคุณลักษณะของผู้ป่วยกระดูกสะโพกหักในกลุ่มผู้ป่วยที่ไม่ได้เป็นผู้สูงอายุและเปรียบเทียบผลการผ่าตัดระหว่างวิธีเปิดแผลขนาดเล็กแบบวัตสัน โจนส์ จัดกระดูกเข้าที่ ใส่สกรูยึดตรึงกระดูกภายใน (mini open group) กับวิธีการผ่าตัดจัดกระดูกเข้าที่แบบปิด ใส่สกรูยึดตรึงกระดูกภายใน (CRSF group)

วัสดุและวิธีการ: ทำการศึกษาแบบเชิงวิเคราะห์ โดยเก็บรวบรวมข้อมูลแบบย้อนหลังจากเวชระเบียนของผู้ป่วยที่ไม่ได้เป็นผู้สูงอายุที่กระดูกสะโพกหักและได้รับการรักษาที่โรงพยาบาลร้อยเอ็ดตั้งแต่ปี 2554 ถึง พ.ศ. 2559 ถึงคุณลักษณะของผู้ป่วยและผลการผ่าตัดรักษา

ผลการศึกษา: จากการสืบค้นได้กลุ่มผู้ป่วย 77 คน อายุเฉลี่ย 36.19 ± 9.95 ปี (± SD) สาเหตุหลักของกระดูกสะโพกหักเป็นอุบัติเหตุทางถนน ส่วนใหญ่การหักเกิดที่ตำแหน่ง Basicervical ไม่มีความแตกต่างระหว่างเพศชายกับเพศหญิง สำหรับผลการผ่าตัด ค่าใช้จ่ายในการผ่าตัด การสูญเลือดในระหว่างผ่าตัดและค่าใช้จ่ายในการรักษามีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติระหว่างกลุ่มที่ผ่าตัดโดยวิธีเปิดแผลขนาดเล็กแบบวัตสัน โจนส์ จัดกระดูกเข้าที่ ใส่สกรูยึดตรึงกระดูกภายใน และกลุ่มวิธีผ่าตัดจัดกระดูกเข้าที่แบบปิด ใส่สกรูยึดตรึงกระดูกภายใน และยังพบว่าไม่มีความแตกต่างกันระหว่าง 2 กลุ่มในตำแหน่งของการใส่ Screw ระยะเวลาในการผ่าตัด ภาวะเหล็กถอนเหล็กหัก และภาวะกระดูกสะโพกขาดเลือด

สรุป: วิธีผ่าตัดเปิดแผลขนาดเล็กแบบวัตสัน โจนส์ จัดกระดูกเข้าที่ ใส่สกรูยึดตรึงกระดูกภายในสามารถใช้ในการดูแลผู้ป่วยที่มีภาวะกระดูกสะโพกที่ไม่ใช่ผู้สูงอายุ ให้ผลการรักษาเป็นดี โดยเฉพาะอย่างยิ่งสามารถประหยัดค่าใช้จ่ายในการรักษา