

SINGLE LATERAL PLATE VERSUS DOUBLE PLATING OF COMMINUTED SUPRACONDYLAR FEMORAL FRACTURES

By

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ABSTRACT

Background: Fractures of the distal femur are rare and severe. For an extra-articular fracture, all therapeutic options are possible and mini-invasive surgery can be performed. In case of an intra-articular fracture, open reduction and internal plate fixation should be performed.

Objective: To evaluate the functional and radiological outcomes of 20 patients with comminuted supracondylar fractures managed by either single or double plating.

Patients and Methods: A prospective randomized clinical study was done in the period between November 2019 and September 2020 involving 20 cases with distal femoral fractures. All patients were operated at Al-Azhar University Hospitals and Al-Helal Hospital. Patients were divided into two groups/ preoperatively. The patients were randomly allocated for treatment with either: Group I managed by single lateral plate ,or group II managed by double plating.

Results: There were insignificant differences between the two groups regarding range of movement, pain, knee society score and complications.

Conclusion: Although both lateral and double plating fixation using dual approach for type C2 and C3 distal femoral fractures were efficient and safe methods of management, double plating recommended in these cases, i.e. medial supracondylar bone loss, low transcondylar bicondylar fracture, medial Hoffa fracture, per prosthetic distal femur fractures, nonunion after failed fixation with single lateral plate, poor bone quality and comminuted distal femur fractures C3.

Keywords: Supracondylar femoral fractures, lateral locking plate, double plating.

INTRODUCTION

Fractures of the distal femur are rare and severe. The estimated frequency is 0.4% of all fractures and 3% of femoral fractures (*Elose et al., 2018*). A classic bimodal distribution is found with a peak in frequency in young men (in their 30s) and elderly women (in their 70s). The usual context is a high energy trauma in a

young patient and a domestic accident in an elderly person (*Elose et al., 2018*). The gender ratio has changed and today there is a majority of women (1 man/2 women). Sufficient stabilization to withstand static loading forces on bone and dynamic muscular forces can only be obtained with surgery. An orthopedic treatment is rare: it is proposed in bedridden patients and/or in patients with reduced autonomy in

fractures with little or no displacement (*Elose et al., 2018*). Distal femoral fractures are classified according to AO classification into (A, B, C) A type is simple extra articular fracture, B type is partial articular and C type is completely intra articular and each of them is sub classified in 1, 2, 3 according to the pattern of the fracture (*Meinberg et al., 2018*). For an extra-articular fracture, all therapeutic options are possible and minimally invasive surgery can be performed. In case of an intra-articular fracture, open reduction and internal plate fixation should be performed with the patient on a standard operating table (*Steinberg et al., 2017*). External fixation is indicated for local monitoring of an open fracture and in case of associated vascular injury, the fracture must be stabilized rapidly. Three main problems are commonly observed in these fractures; First, adequate exposure of articular surface, particularly of medial femoral condyle and coronal plane fractures is exhausting. Second, the standard implants used for other types of distal femoral fracture such as the condylar nails are not helpful for articular surface reduction and fixation (*Khalil et al., 2012*). Third, in setting of medial comminution and short distal segment, there is high incidence of loss of fixation and varus collapse (*Imam et al., 2018*). Double plating: double plating is complete and anatomical reconstruction of these severe injuries, facilitation of preliminary k-wire fixation from all directions around the distal end of femur, comfortable application of the medial plate, ideal fixation of medial and lateral Hoffa fractures, complete grafting of bony defects at all locations with good impaction, addressing associated internal

knee derangement whenever possible, lower incidence of suprapatellar area adhesions, and uncomplicated wound healing (*Zhang et al., 2018*). The norm has been surgical management for these fractures, encouraging early joint motion and avoiding joint stiffness (*Gwathmey et al., 2010*).

Unfortunately, there is no less evidence in the literature of problems such as loss of alignment, delayed/ non-union, and implant failure (*Henderson et al., 2011*). Some reports, focused on comminuted C-type fractures, suggest that better recovery may result from double plating. There is, however, no literature on the outcome distinction between single lateral plate and double plating in comminuted A- or C-type fractures (*Khalil et al., 2012*).

The present work aimed to evaluate the functional and radiological outcomes of 20 patients with comminuted supracondylar fractures managed by either single or double plating.

PATIENTS AND METHODS

The current study was conducted as a prospective randomized-controlled trial at Al-Azhar University Hospitals and Al-Helal Hospital during the period from November 2019 to September 2020 including 20 cases with types C2 and C3 distal femoral fractures, and a follow up period of 6 months. Ethical approval was obtained prior to the initiation of the study. All fulfilled our selection criteria of both genders, above the age of 18 years, presenting with types A2, A3, C2 and C3 distal femoral fractures, with no absolute medical contraindications to surgery, without associated neurovascular compromise prior to surgery. Patients with

preoperative neuromuscular compromise in the symptomatic extremity, and those presenting with other types of distal femoral fractures or pathological fractures were excluded. The patients were divided into two equal groups: Group I were managed with single lateral plate, and Group II were managed with double plating.

All displaced supracondylar fractures were admitted, and injured distal femur was immobilized in splint with knee in 5 to 20 degrees of flexion. Elevation and ice compression were advised. Surgery was planned and technique was selected according to random number generated by computer, and was enveloped securely so as to be opened at surgery time. All patients were operated under spinal anesthesia.

Surgical techniques were the principles of management to achieve anatomical articular reduction and preserve the blood supply while providing rigid stable fixation that was strong enough to withstand early functional mobilization. After anatomical reduction of the condyles with lag screws, fixation of the condyles to the shaft with either:

Group I: Single lateral plate (Fig 1)

It was done through lateral approach and fixation using lateral locked distal femoral plate. The placement of locked cancellous bone screws into the distal portion of the lateral locked plate was highly variable and based on the pattern of

the fracture, the location of the lag-screws, and the adequacy of the bone stock. At least, three screws were placed into the condyles, and more were placed if technically feasible. After fixation of the locked plate to the proximal and distal fragments, stability was tested intraoperative.

Group II: Double plating technique (Fig 2)

It was done through dual separate approach (medial and lateral) and fixation is done using lateral locked distal femoral plate and medial buttress plate. A medial plate was applied through separate medial approach. At least two cancellous screws were used distally and two cortical screws were used proximally for fixation of the medial plate. The operative approach that was used for the medial plating consisted of a longitudinal ten to fifteen-centimeter incision, extending from a point five centimeters distal to the adductor tubercle up to the medial aspect of the thigh. The medial cortex of the femur was exposed by dissection of the plane anterior to the adductor magnus and posterior to the vastus medialis. The geniculate arteries were identified and were ligated as necessary. Because the dissection was anterior to the adductor canal and always remained distal to the mid-part of the thigh, the superficial femoral artery was not encountered.

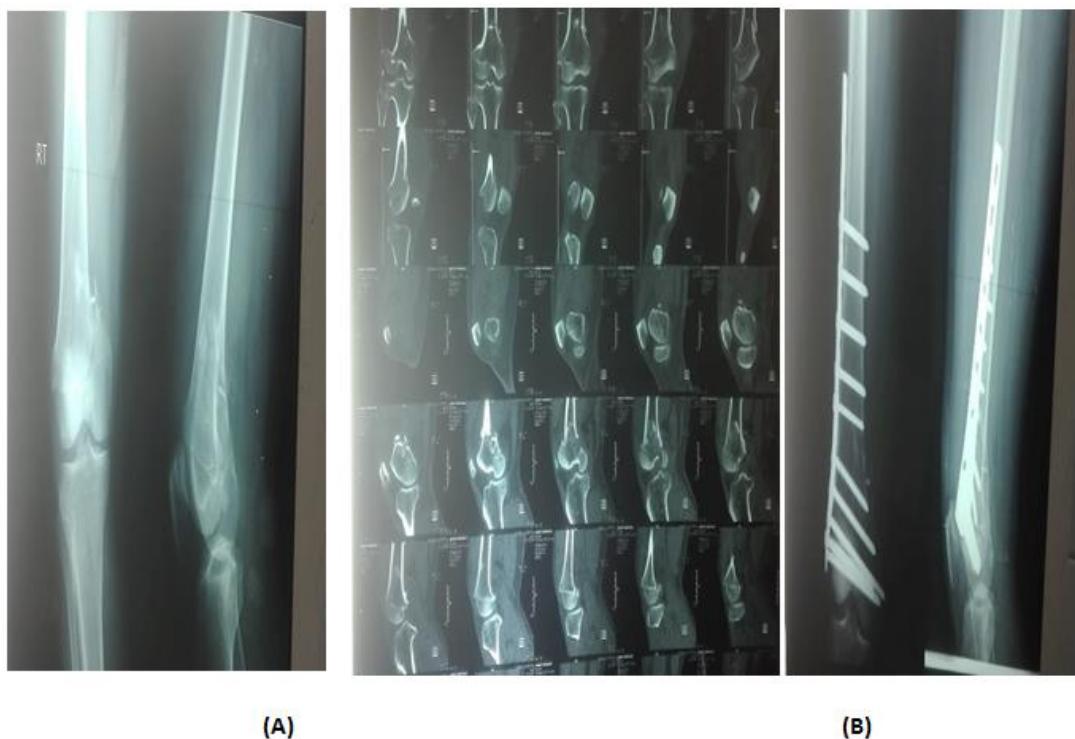


Figure (1): Male patient 40 years old with right supracondylar femur fracture type A2, single lateral technique (a) preoperative x-ray& CT, (b) postoperative x-ray



Figure (2): Female patient 53 years old with right supracondylar femur fracture C2, double plating technique (a) preoperative x-ray &CT, (b) postoperative x-ray

Postoperatively, the limb was placed in an above knee brace with knee-hinges. The range of motion started at 30 degrees and was then advanced on a daily basis. The patients were followed up for at least six months. Every two weeks for the first month, then every month thereafter. Every time the patient was examined clinically and radiologically and encouraged to continue active exercises to reach normal range of motion and to resume the activity again.

Assessment was done using The Knee Society Score which evaluates the clinical profile with regards to pain intensity, range of motion and stability in the anteroposterior and mediolateral planes, flexion deformities, contractures and poor alignment.

Knee society score (100 Points Total)

Pain

- None.....50

Total ROM

ROM	Points given	ROM	Points given	ROM	Points given	ROM	Pointsgiven	ROM	Points given
0-5	1	6-10	2	11-15	3	16-20	4	21-25	8
26-30	6	31-35	7	36-40	8	41-45	9	46-50	10
51-55	11	56-60	12	61-65	13	66-70	14	71-75	15
76-80	16	81-85	17	86-90	18	91-95	19	96-100	20
101-105	21	106-110	22	111-115	23	116-120	24	121-125	25

Alignment (varus& valgus)

- 0.....-15
- 1.....-12
- 2.....-9
- 3.....-6
- 4.....-3
- 5-10.....0
- 11.....-3
- 12.....-6
- 13.....-9
- 14.....-12
- 15.....-15
- Over 15.....-20

- Mild, occasional.....45
- Mild (stairs only).....40
- Mild walking and stairs.....30
- Moderate, occasiona.....20
- Moderate, continual.....10
- Severe.....0

Flexion contracture (if present)

- 5-10.....-2
- 10-15.....-5
- 16-20.....-10
- >20.....-15

Extension lag

- <10.....-5
- 10-20.....-10
- >20.....-15

Stability (maximum movement in any position)

- Antero-posterior
- <5mm 10
- 5-10mm 5
- +10mm 0
- Medio-lateral
- <5 15
- 6-9 10
- 10-14 5
- 15 0

Grading for the Knee Society Score

- Excellent 80-100

- Good 70-79
- Fair 60-69
- Poor below 60

Statistical analysis:

Statistical presentation and analysis of the present study were conducted using the mean and standard Deviation. Unpaired student t-test was used to compare between the two groups in quantitative data. chi-square test was computed for qualitative data and Linear Correlation coefficient was used for detection of correlation between two quantitative variables in one group [r] by SPSS V20. Significant level was at ≤ 0.05 .

RESULTS

The mean age at presentation was about 40.70 ± 14.06 years (range: 22-70 years). The study included both sexes: 15 (75%) were females and 5 (25%) were males (Fig.2). The mode of trauma was road traffic accidents in 15 (75%) cases with 9 cases in group I and 6 cases in

group II, while Falling from height in 5 cases (25%) with 1 cases in group I and 4 cases in group II. 15 patients (75%) had isolated distal femur fractures while with 8 cases in group I and 7 cases in group II (**Table 1**).

Table(1): Demographic data

Demographic data \ Groups	Group I	Group II	Test value*	P-value	Sig.
Age (years)					
Range	22-70	18-63	0.213	0.792	NS
Mean±SD	40.70 ± 14.06	40.90 ± 16.05			
Sex					
Male	1 (10%)	4 (40%)	2.40	0.121	NS
Female	9 (90%)	6 (60%)			

The type of fracture according to AO classification of fractures of long bones was type "33". All patients of this study

were type C fracture except one case A2 (**Table 2**).

Table (2): Classifications of fractures

Classifications \ Groups	Group I		Group II		P-value
	No.	%	No.	%	
A2	1	10.0%	0	0.0%	0.329
C2	8	80.0%	10	100.0%	
C3	1	10.0%	0	0.0%	
Total	10	100.0%	10	100.0%	

The mean range of time in weeks till partial weight bearing was allowed in group I was 8.00 ± 2.31 ranging from 6w to 14w, while in group II the mean was

8.00 ± 1.63 with the range from 6w to 10w. The P-value was 0.962 insignificant differences between two groups (**Table 3**).

Table (3): Time till Partial weight bearing

Groups	Part weight bearing					T-test		
	Range		Mean	\pm	SD	T	P-value	
Group I	6	-	14	8.00	\pm	2.31	0.007	0.962
Group II	6	-	10	8.00	\pm	1.63		

The mean range of time in weeks till full weight bearing was allowed in group I was 14 ± 3.65 w ranging from 12w to 24w, while in group II the mean was 15 ± 2.16 w

with the range from 12w to 18w. The P-value was 0.466 indicating that group I time to full weight bearing is highly significant less than group II (**Table 4**).

Table (4): Time till Full weight bearing

Groups	Full weight bearing					T-test		
	Range		Mean	\pm	SD	T	P-value	
Group I	12	-	24	14.00	\pm	3.65	0.556	0.466
Group II	12	-	18	15.00	\pm	2.16		

The mean range of time in weeks till radiological healing group I was 15.60 ± 2.46 w ranging from 12w to 20w, while in group II the mean was

13.80 ± 1.93 w with the range from 10w to 16w. The P-value was 0.291 insignificant differences between two groups (**Table 5**).

Table (5): Time till radiological healing

Groups	Healing					T-test		
	Range		Mean	\pm	SD	T	P-value	
Group I	12	-	20	15.60	\pm	2.46	1.386	0.291
Group II	10	-	16	13.80	\pm	1.93		

The mean total ROM in group I was 98.20 ± 4.94 , while in group II was 104.50 ± 6.77 . The P-value was 0.217

insignificant differences between two groups (**Table 6**).

Table (6): Total ROM

Groups	Flexion Rom					T-test	
	Range		Mean	±	SD	t	P-value
Group I	90	-	106	98.20	± 4.94	1.053	0.217
Group II	100	-	125	104.50	± 6.77		

60% of all patients experienced mild occasional pain after union and during follow up period (**Table 7**).

Table (7): Pain

Pain	Groups					
	Group I		Group II		Total	
	N	%	N	%	N	%
Mild Walking and Stairs	1	10.0%	1	10.0%	2	10.0%
Mild Occasional	5	50.0%	7	70.0%	12	60.0%
Mod Occasional	1	10.0%	0	0.0%	1	5.0%
None	3	30.0%	2	20.0%	5	25.0%
Total	10	100.0%	10	100.0%	20	100.0%
Chi-square	χ^2		2.291			
	P-value		0.682			

No significant difference between the 2 groups regarding stability or alignment (**Table 8**).

Table (8): Alignment, A-P stability and medial lateral stability

Groups Parameters	Chi-square							
	Group I N	Group I %	Group II N	Group II %	Total N	Total %		
Flexion contracture								
5-10	8	80%	6	60%	14	70%	0.952	0.329
10-15	2	20%	4	40%	6	30%		
Extensor lag							0.220	0.639
<10	7	70%	6	60%	13	65%		
10-20	3	30%	4	40%	7	35%		
Alignment							2.400	0.494
5=10	7	70.0%	8	80.0%	15	75.0%		
15 varus	1	10.0%	2	20.0%	3	15.0%		
15 valgus	1	10.0%	0	0.0%	1	5.0%		
5=20	1	10.0%	0	0.0%	1	5.0%		
Ant. Posterior							0.000	1.000
<5mm	10	100.0	10	100.0	20	100.0		
5-10	0	0.00	0	0.00	0	0.00		
Medial lateral							0.000	1.000
<5	10	100.0	10	100.0	20	100.0		
10-14	0	0.00	0	0.00	0	0.00		

The overall knee society score showed no significant difference between the 2 groups. The mean for group I was

75.90 ± 6.06 and for group II was 78.80 ± 10.67 (**Table 9**).

Table (9): Knee society score grading

Knee society score	Groups		Group I		Group II		Total	
	N	%	N	%	N	%	N	%
Poor	0	0%	1	10%	1	5%		
Fair	2	20%	0	0%	2	10%		
Good	4	40%	3	30%	7	35%		
Excellent	4	40%	6	60%	10	50%		
Total	10	100%	10	100%	20	100%		
Mean \pm SD	75.90 ± 6.06		78.80 ± 10.67					
P-value	0.465							

Negative correlation between age and knee society score with part weight bearing, full weight bearing when P-value was <0.05 and R was (-0.514, -0.535, -

0.485). Positive correlation between age and knee society score, the younger the age the better knee society score (**Table 10**).

Table (10): Correlation between Knee society score and others items

Parameters	Knee society score	
	R	P-value
Age	-0.205	0.186
Partial weight bearing	-0.514	$<0.001^{**}$
Healing	-0.535	$<0.001^{**}$
Full weight bearing	-0.485	0.006*

Negative correlation between age and knee society score with part weight bearing, full weight bearing when P-value was <0.05 and R was (-0.514, -0.535, -0.485). Positive correlation between age and knee society score, the younger the age the better knee society score.

Overall complications in group I was 20% while in group II was 30% with the P-value of 0.547 which indicates non significance of complication rate between the 2 groups (**Table 11**).

Table (11): Complications

Complication	Groups		Group I		Group II		Total	
	N	%	N	%	N	%	N	%
No	8	80.0%	7	70.0%	15	75.0%		
DVT	1	10.0%	1	10.0%	2	10.0%		
Failure Revision through Double Plating	1	10.0%	0	0.0%	1	5.0%		
Medial plate infection	0	0.0%	1	10.0%	1	5.0%		
Superficial wound infection	0	0.0%	1	10.0%	1	5.0%		
Total	10	100.0%	10	100.0%	20	100.0%		
Chi-square	χ^2		3.067					

DISCUSSION

In our clinical study we managed 20 cases with distal femoral fractures AO classification type A2, A3, C2 or C3. 10 cases were surgically managed by open reduction internal fixation through single lateral plate, 10 cases were surgically managed by open reduction internal fixation through double plating technique. 18 cases were AO C2 while 1 case was AO C3 and 1 case A2.

The purpose of this study was to assess the clinical results, time to union and complications of 2 groups of patients with distal metaphyseal femoral fractures.

The most important finding in this study was the overall satisfactory outcome of the both methods and paucity of severe complications in both groups. In group I, 4 cases (40%) had good results, 2 cases (10%) had fair results while 0 cases (0%) had poor results. In group II, 6 cases (60%) had excellent results, 3 cases (30%) had good results, 0 cases (0%) had fair results while 1 case (10%) had poor results. The overall knee society score showed no significant difference between the 2 groups. The follow up period for the cases range from (8–24) weeks and with the mean (14.56 ± 4.85) weeks. Several studies reported that double plating is an advantageous solution for Type C3 distal femoral fractures (*Khalil et al., 2012*).

Our clinical study showed that the fractures became united within 12 weeks. One patient (10%) from group II experienced lateral wound superficial infection in the form of erythema and serous discharge 1 week post-operative. It was controlled by daily dressing with antibiotics. One case of group II (10%) developed DVT another one case of group

I (10%), although being on prophylactic anticoagulant. Vascular consultation was done and therapeutic dose of anticoagulant then was initiated. 1 case (10%) in group II developed medial plate infection and medial wound dehiscence 3 weeks after the operation. The plate was T buttress and the patient was so skinny, so that revision of the medial plate was done by a reconstruction plate. One case (10%) of group I needed revision after 3 months due to plate failure with screw pull out. This may be due to technical error of too much lower positioning of the lateral plate during surgery and had medial metaphyseal communication. Revision was done by double plating technique. Chronic pain may be due to superficial cutaneous nerves damage, the development of scar tissue, or an aggravation of underlying arthritis. Most of the published studies on lateral locking plates reported a union rate ranging between 81%-95% (*Meneghini et al., 2014, Ricci et al., 2014* and *Rodriguez et al., 2014*), The union rate for patients treated by retrograde nails was reported to be 91% (*Meneghini et al., 2014*). Complications related to the implants, such as loosening, breakage, and rotational malposition, were reported as being between 5% to 7%, with a revision rate ranging between 19% to 23% (*Ricci et al., 2014* and *Rodriguez et al., 2014*). Other potential complications, such as hardware malposition and plate located too ventral, too proximal or too short for adequate fixation (*Ricci et al., 2014*), may weaken mechanical stability of the implant followed by early loosening and failure. The double-plating technique may overcome these complications by its properties that provide increased stability

by compensating for some of the intraoperative technical errors to permit complete healing.

Khalil and Ayoub (2012) used a double-plating technique through a modified Olerud extensile approach where the mean radiologic healing time was reported to be 18.3 weeks.

A potential vascular injury to the distal part of the medial thigh and femur aspects may be expected during the procedure. Computerized tomographic angiography studies demonstrated that this area was supplied by two vessels, the medial superior genicular artery and the third perforating artery to the vastus medialis muscle. However, neither artery is adjacent to the bone, so vessel injury can be prevented by meticulous dissection.

Limitations of this study included its retrospective nature, and the relative small group of patients studied. The treatment of all patients by senior surgeons and in two institutions represented strengths of this work.

CONCLUSION

Although both lateral and Double plating fixation using dual approach for type C2 and C3 distal femoral fractures were efficient and safe methods of management, double plating recommended in these cases (medial supracondylar bone loss, low trans condylar bicondylar fractures, medial Hoffa fracture, periprosthetic distal femur fractures, non-union after failed fixation with single lateral plate, poor bone quality and comminuted distal femur fractures C3).

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مقارنة بين التثبيت بواسطه شريحة خارجية و شريحتين داخلية و خارجية لكسور المفتة فوق لقمة عظمة الفخذ
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خلفية البحث: علاج كسور اسفل عظمة الفخذ هو من أكثر الجراحات تعقيداً. وعادة ما تكون كسور اسفل الفخذ متضمنة السطح المفصلي لاسفل الفخذ مما يتطلب اعاده البناء والتثبيت الجيد لاعادة بناء السطح المفصلي منعاً لحدوث المضاعفات.

الهدف من البحث: مقارنة بين التثبيت بواسطه شريحة خارجية و شريحتين داخلية و خارجية لكسور المفتة فوق لقمة عظمة الفخذ

المرضى وطرق البحث: تم إجراء دراسة مستقبلية ذات عينة عشوائية للمرضى في قسم الطوارئ في مستشفيات الأزهر الجامعي في الفترة من نوفمبر 2019 إلى سبتمبر 2020، وفيها تم علاج 20 مريضاً يعانون من كسر أسفل عظمة الفخذ بتقنيتين: استخدام طريقة التثبيت الخارجي فقط بواسطه شريحة خارجية فقط (10 مريضاً)، وإستخدام طريقة التثبيت الداخلي والخارجي بواسطه شريحتين(10 مريضاً)، وقد تم تقييم النتائج بواسطه مجال الحركة للركبة.

نتائج البحث: في خلال فترة الدراسة تم علاج 20 مريض يعانون من كسر أسفل عظمة الفخذ كان منهم 15 إناث و 5 ذكور، وكان متوسط العمر 40.7 سنة، ومتوسط مدة المتابعة 3 أشهر، ولا يوجد إختلاف واضح بين المجموعتين من حيث مجال الحركة للركبة والالم والمضاعفات.

الاستنتاج: لا يوجد فرق إحصائي بين استخدام الطريقتين في تثبيت الكسر أسفل عظمة الفخذ، وكلتا الطريقتين أعطت نتائج مرضية لكلا المرضى؛ ولكن يفضل استخدام طريقة التبيث الداخلي والخارجي بواسطة شريحتين في حالات الكسور المفتته من الناحيـة الداخلية فوق لقمة عظمة الفخذ والكسر الغير ملائم بعد فشل التثبيـت الخارجي بواسطة شريحة خارجية فقط كما تستخدم في المرضى الذين يعانون من هشاشة العظام و الكسور المفتـه حسب التصـنيف السويسـرى للكـسور لـاسـفل الفـخذ من النوع (سـى 3).

الكلمات الدالة: كسور فوق لقمة عظمة الفخذ و شريحة خارجية ذاتية الغلق و شريحتين جانبـيتـين.