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Surgical treatment of Pilon fracture

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Abstract

Introduction: A Pilon fracture, an uncommon but serious injury of lower limb constituting 7.1 % of all tibial fracture, is still unsolved problem & challenge for orthopedic surgeon as far as management is concerned.

Methods: This study covers 33 adult patients out of which 26 were treated by some kind of surgical modalities & followed upto 8 to 24 months. We have divided surgical modalities into three groups.

Results: Average union time is 14-16 weeks. High incidence of local complication is due to poor soft tissue envelop and precarious blood supply. Hence due respect should be given to soft tissues while managing fracture.

Conclusion: These fractures are of high energy trauma. They are frequently open or associated with severe soft tissue injury. These fractures are difficult to reduce and even more to maintain reduction without much disturbing soft tissue condition. [Misahra N NJIRM 2017; 8(3):111-119]

Keywords: Treatment, Pilon Fracture, Orthopedic

Introduction

A Pilon fracture, an uncommon but serious injury of lower limb constituting 7.1 % of all tibial fracture, is still unsolved problem & challenge for orthopedic surgeon as far as management is concerned.

'Pilon' – measure hammer, this term was first coined by Destate ^[1] 1911 to describe explosive injury of talus impacting against tibial plafond to that of hammer striking nail. Pilon fracture is any fracture through tibial plafond (ceiling) that encompasses wide spectrum of injury varying from low energy rotational injury to those caused by high energy trauma resulting from fall from height or motor vehicle accident. Number of these type of high energy increase with advancement. These fractures have frequently significant degree of metaphyseal or intra-articular comminution with varying amount of extension into shaft of tibia & often are open fracture or associated with severe soft tissue injury. However, anatomically this region has inherited precarious blood supply with poor soft tissue coverage. Because of all these, this fracture was considered inoperable and conservative treatment associated with many complication and require often more than one surgery.

In 1968, Reudi & Allgower ^[2-4] classified the fracture & proposed standard management in form of open reduction & internal fixation which initially give encouraging and revolutionary result. But later on, long term study shows that, these method give satisfactory result only in Type I or II (low energy trauma) and associated with many local complication in Type III fracture, those fractures associated with severe soft tissue injury or open wounds.

Hence, in 1993, various orthopedic surgeons from different part of the world recommended external fixation (in form of, delta frame, articulated external fixator, ring fixator or hybrid fixator) of fracture after achieving reduction by indirect method (ligamentotaxis) with or without fixation of fibula. If reduction of tibial articular surface is not achieved by closed means, minimal open osteosynthesis by screw or wire is recommended. This has changed whole scenario of treatment of pilon fracture. Moreover, some innovative idea were proposed for treatment of pilon fracture in the form of unreamed nailing and MIPPO. All have stressed on meticulous handling of soft tissues.

In spite of available various surgical modalities, the treatment of pilon fracture is still in evolution phase and final line of treatment is yet to be answered.

This study aims at evaluating the role of different surgical modalities.

Method

This study covers 33 adult patients out of which 26 were treated by some kind of surgical modalities & followed upto 8 to 24 months. We have divided surgical modalities into three groups.

A-Those patient treated by standard Swiss (AO) method (ORIF)

B-Those patient treated by external fixation following principal of ligamentotaxis with or without minimal internal fixation of tibia and or fibula to maintain articular alignment.

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C-Other methods

Ender +CC + Fibula Fixation

Plating of tibia by MIPPO technique with fibula fixation.

Fibula fixation with minimal tibial fixation only fibula fixation.

Table I

Agein years	Surgical Modalities			
	A	B	C	Total
21-40	3	6	6	15
41-60	-	6	2	8
>60	-	3	-	3
Total	3	15	8	26

60% patient are of middle age group as they are more prone to have accident. Amongst these patients, youngest patient was 20 years old and oldest patient was 66 years old.

Table II

Sex	Surgical Modalities			Total
	A	B	C	
Male	3	12	7	22
Female	-	3	1	4
Total	3	15	8	26

More common in male with prevalence of 5:1

These patients were selected on the basis of following criteria

1. Fracture of distal end of tibia with articular involvement.
2. With or without fibula fracture
3. Skeletally mature patient.

We have followed the classification of Reudii and Allowers & AO. In each patient close reduction is attempted and is treated conservatively it can be reduced to acceptable reduction.

Indication for operation

1. Open fracture
2. Fracture associated with severe closed soft tissue injury.
3. Unacceptable alignment of fracture (defined as a joint space or incongruity of articular surface more than 2 mm)
4. Malreduction.
5. Fracture of both tibia & Fibula.

We have excluded three patients because one of them had undergone BK amputation later on and other two were treated conservatively as acceptable closed reduction was achieved.

Table III

Mechanism of injury	Surgical Modalities			
	A	B	C	Total
Road Traffic Accident	2	6	6	14
Fall	1	9	2	12
Total	3	15	8	26

Majority of fracture (>60%) resulting from road vehicle accidents. Only three patients had other associated injury.

1. Case No. 20 had bilateral Pilon fracture with shaft femur fracture on left side.
 2. In cases of 14 & 15 patient have been associated metacarpal and metatarsal fracture respectively.
- Patient No. 23 & 27 have diabetes mellitus. Hence, operation was delayed for 21 days. One patient was then treated conservatively.
 - On follow up, (18 months) patient No. 6 had fracture shaft tibia from tibial ST pin site which was treated conservatively and successfully.

3. Patient No. 16 had got tibial plateau fracture in another accident after 8 years of first accident when he had pilon fracture.

Table IV

Gustillo Classification	Surgical Modalities			
	A	B	C	Total
Close	3	10	8	21
OG I	-	2	-	2
OG II	-	1	-	1
OG	-	2	-	2
Total	3	15	8	26

In this series, 21 fracture (70%) were closed. All open fracture were treated in emergency by external fixator. Open fracture were usually RA Type III injury.

Table V

Duration of Hospitalisation weeks	Surgical Modalities			
	A	B	C	Total
<2	-	1	-	1
2-3	1	6	7	14
3-4	2	2	1	5
>4	-	6	-	6
Total	3	15	8	26

- Average hospitalization of all surgical modalities is around 3 weeks.
- Duration is comparatively more as compared to international series probably because in our set up patient having closed fracture were operated after 6-7 days when local oedema subsides.
- In type B modality 6 patients had prolonged hospitalisation because of infection. In three patients fracture were open & other three patients develop post operative infection.

Table VI(a)

AO Type	Surgical Modalities			
	A	B	C	Total
B	2	11	6	19
C	1	4	2	7
Total	3	15	8	26

In this series both classification were used to classify each fracture.

Table VI(b)

RA Type	Surgical Modalities			
	A	B	C	Total
I	-	2	5	7
II	3	10	3	16
III	-	3	-	3
Total	3	15	8	26

Method

All patients were reviewed on emergency basis where patients were assessed as a whole and vital function were stabilized. Other associated injuries were treated accordingly. History and thorough examination was carried out. e.g. History of

- Mode of injury
- Smoking, alcoholism, PVD
- Medical / surgical problem
- Open fracture patients – debridement, irrigation and immediate stabilisation.

Examined specially for

1. Sign of vascular injury
2. Open injury
3. Swelling
4. Compartment syndrome
5. Blister
6. Soft tissue crushing
7. Closed degloving.

AK, Slab, Calcaneal ST pin traction, strict elevation on boehler splint were primary line of treatment for all closed fractures.

Open fractures were treated on emergency basis by external fixator or Roger Anderson apparatus (Distractor) with or without fibula fixation and minimal internal fixation of tibial articular surface after primary debridement of open wound.

Plain AP and lateral radio graphs were made preoperatively and postoperatively in each cases.

Other fractures were treated after 4-7 days when oedema get subsides, local condition get settled.

In all, if fibula is fractured, it was fixed first through anterolateral approach by plate or nail / K.wire.

In our study no patients were treated by hybrid fixator or articulated external fixator or ring fixator. In our series, no patients were treated by short term external fixator followed up by internal fixation.

In all mode of external fixator minimal internal fixation were used to achieve and maintain the articular reduction Internal fixation were mainly in the form of 4 mm cannulated cancellous screw, 3.5 mm cortical screw, K wire etc. Primary bone grafting were not done in fracture.

Roger Anderson's Distractor

Technique: For both open & close fracture, first calcaneal 4.5 mm ST pin was introduced and with manual traction fracture were reduced. If articular alignment is not achieved with traction, open reduction and minimal internal fixation with 4 mm

CC screw was done. Then, two 4.5 mm ST pin was inserted in the mid tibia at junction of Ant. 2/3 and post. 1/3 from lateral to medial. Distractor were applied on the both side of ST pin. Fracture were distracted gradually till desired reduction achieved. Fibula was fixed when it was found fractured.

Postoperatively: BK splint and elevation till oedema subside NWBW allowed with crutch support.

Distractor were kept for 6-8 weeks and then it was removed and BK slab applied with intermittent ankle mobilisation. Weight bearing is not allowed till 16-20 weeks. By that time, fracture is usually united.

In one patient secondary bone grafting was carried out after 16-20 week to promote union on an average distractor was kept for 1.5 to 2 month.

External Fixator: It was used mainly for open fracture especially OGII and OGIII. We have used simple half pin ankle spanning delta fixator. Fibula was fixed when it was found fractured.

Foot is fixed to fixator in neutral position or BK splint is given to immobilise ankle in neutral position.

Post operatively, limb is elevated to reduce the oedema. Daily dressing for open fracture. Secondary procedure such as debridement / STG / flap were carried out as per requirement.

Fixator were kept for 1 to 2 months. Patient was kept non weight bearing till fracture get united. Other postoperative protocol is same as distractor. Full weight was allowed when fracture was united both radiologically as well as clinically.

ORIF: Three patients were treated by this method.

These were operated by senior surgeon. Through postero – lateral approach fibula was fixed by 3.5 DCP and by antero – medial approach, tibia is fixed with T plate in one patient and cloverleaf in other two which either acts as buttress or neutralization plates. Primary bone grafting was not done in a single case.

Post operative care for ORIF

- Posterior BK splint & Elevation – for 10 to 14 days
- Stitches removed by 10-14 days.
- Partial weight bearing walking.
- After union – judged by roentographic evidence of Union (also clinical) Implant removal deferred till 12 months.

In 3 patients only fibula was fixed and tibial reduction observed automatically, then, AK cast applied for 2 month and is followed by PTB cast for 1 month with Knee mobilisation. Full weight bearing avoided till union occurs by 16 to 20 weeks.

In one patient, he has bi-lateral pilon fracture, both were fixed with MIPPO technique. In this technique fibula is fixed as a routine through postero-lateral approach with small stab incision, articular reduction is achieved and fixed with 4 mm cancellous screw. T plate was slide subcutaneous without disturbing fracture hematoma upto diaphysis and beyond fracture it was fixed 3 to 4 screws. Proximal calcaneal screws were passed from T plates.

Ender's nailing: In rotation type of injury where spiral fracture of shaft were extended into the ankle. Ankle fracture were fixed with 4 mm calcaneal screw and from above three Ender nail were introduced.

Care of pin site was begun immediately post operatively and consisted of cleaning with splint and application of dry sterile gauze.

Pre operatively and post operatively antibiotics were given to all patients.

To evaluate patient at final follow-up both Burwell Charnley's criteria and ankle functional score system is used.

Ankle Functional Score

Clinical Scoring System (Maximum 100 points) [26]

	No. of paints
Subjective (80 points)	
Pain (54 Points)	
Always after any activity	0
Prolonged after mild activity	10
Transient after mild activity	20
Prolonged after heavy activity	35
Transient after heavy activity	40
None	50
Requires medication regularly	0
Requires medication occasionally	2
Requires no medication	4
Fncion (26 points)	
Unable to climb stairs	0
Uses normal foot first	1
Requires aid of banister	2
Climbs normally	3
Unable to descend stairs	0
Uses normal foot first	1
Requires aid of banister	2
Descends normally	3
Walks < 1 Block	0
Walks < 5 Block	2
Walks <10 Block	3
Walks >10 Block	5
Walks unlimited distance	6
Recreational activities limited	0
No activities limited	3
Requires Walker	0
Requires Crutches	1
Requires One Crutch	2
Requires Cane	4
Requires No Walking aids	8
Dissatisfied	0
Moderately satisfied	2
Very satisfied	3
Objectively (20 points)	
Gait (6 points)	
Antalgic limp	0
External Rotation gait	3
Normal gait	6
Range of motion(difference from contralateral side) (14points)	
Dorsiflexion	
Difference >20°	0
Difference 10° to 20°	2
Difference < 20°	4
No Difference	7
Planter Flexion	
Difference >20°	0
Difference < 20°	2
No Difference	3
Supination	
Difference >0°	0
No differene	2
Pronation	
Difference >0°	0
No difference	2

Burwell & Chamley's Criteria

	Subjective	Objective
Good	- Complete recovery	- ¾ normal foot
	+ slight aching after use	& ankle movement
Fair	Aching during use	- Trival swelling
	Slight stiffness	- Normal gait
	No interference with work Walking ability unimpaired	- ½ normal Foot & ankle movement
Poor	Pain Impairment of Work Impairment of walking	- Mild swelling
		- Normal gait
		- ½ Movement
		- swelling
		- visible deformity
		- Limp

Chapter 6: Observation and Discussion

In this studies, patient's follow up is varying from 8 to 24 months & following points were observed.

Union: Fracture were considered united there was no clinically tenderness and mobility with radiological sign of union.

Table VII: Union Vs Surgical Modalities

Union Time in week	Surgical Modalities			
	A	B	C	Total
10-14	2	3	2	7
15-18	1	7	3	11
19-24	-	3	2	5
>25	-	2	1	3
Total	3	15	8	26

Table VII: Union Vs Fracture Type

Union Time in week	Surgical Modalities			
	A	B	C	Total
10-14	3	4	0	7
15-18	4	6	2	14
19-24	2	3	1	6
>25	0	3	0	5
Total	9	18	3	26

Arrange Union time in different surgical modalities are as follows:

Type A : 14 weeks

Type B : 16 weeks

Type C : 16 weeks

- Average union time was 16 to 14 weeks for all type of surgical modalities.
- Early union occurs in modality A because most of the patients treated by the modality has RA Type 1 of Type II fracture with less metaphyseal comminution. These modalities involve perfect anatomical reduction of fracture without any distraction at fracture site.
- In Type b modality most of the fractures are of RA
- Type III with metaphyseal and articular comminution along with severe soft tissue injury, hence, there will be always some distraction at fracture site.
- In Reudi Allgower Type I fracture is united early as compared to type II and type III probably due to absence of any metaphyseal comminution & articular alignment is maintained.
- Type II fracture usually united between 15-17 weeks because of metaphyseal comminution. In this series it was delayed in three patients due to fraction. The patient

no. 6 have been bone loss who later on required bone grafting to promote union after 20 weeks.

- Type III fracture get united between 17-19 weeks because of significant metaphyseal comminution and articular displacement.

<ul style="list-style-type: none"> Final result of each surgical treatment is evaluated by following two criteria
1. Ankle functional score (AFC)
2. Burwell & Charnley's criteria

Result As PER AFC

Table IX

Type of Surgical Intervention	Excellent	Good	Fair	Poor	
I	1	2	2	0	100%
II	2	8	2	3	80%
III	3	4	1	-	90%
TOTAL	6	14	3	3	

In contrast to international series, in these cases results were 100% good in type A modality because of:

- Inadequate no. of patients.
- All patients have RA type I fracture without much soft tissue injury.
- Patients were operated by senior orthopaedic surgeon.

In type B modality, results were comparable to international series. Here, the fracture are of RA type 3 or associated with severe soft tissue injury. Most of the operations were carried out by junior orthopaedic surgeon. In spite of all this 80% result was obtained.

In type C modality no. of patients treated by different surgical method were inadequate, hence statistically, no valid conclusion can be made.

Table X(a): result vs. type of fracture (RA)

RA TYPE	Result				
	excellent	good	fair	poor	
I	2	4	2	1	75%
II	4	8	3	3	66%
III	1	1	1	1	33%
Total	6	13	6	5	

Table X (b): Result Vs. Type of fracture (AO)

AO TYPE	Result				
	Excellent	good	fair	poor	
B	4	12	2	3	75%
C	2	5	1	1	70%
Total	6	17	3	4	

- In RA type II, results were not so good but better than type III because of metaphyseal comminution.
- In RA type III, results were poor as these fractures are frequently associated with severe soft tissue injury, significant articular displacement and extensive metaphyseal comminution.
- RA classification is proved to be more useful to predict the prognosis of fracture in this series as in other international series.
- Result prediction is better made from RA classification as in international series. In this study, best results were obtained in RA type 1 and poor results in RA type III

Table XI: Reduction Vs. Result

Reduction achieved	Result				% satisfactory result
	Excel lent	good	fair	poor	
Anatomical (P)	4	8	1	0	90
Nonanatomical (P)	2	6	3	2	66
Total	6	14	4	2	

- Encouraging results were obtained where anatomical reduction was achieved. This was stressed in all available international series.
- Anatomical reduction is reduction of fracture with articular displacement with less than 2 mm.

Table XII: Fixation achieved Vs. Final result

fixation	Result				
	excellent	good	fair	Poor	
Anatomical (P)	6	12	1	2	90
Nonanatomical (P)	-	2	12	1	40
total	6	14	13	3	

Complication

Table XIII: Complication Vs. Type of management'

Complication	Type of surgical modalities		
	A	B	C
Infection	2 (70%)	6 (30%)	1 (12%)
Delayed union	-	3 (15%)	2 (20%)
Malunion	-	1 (5%)	-
Stiffness of ankle	-	4 (25%)	-
shortening	-	2 (10%)	-

In RA type I, results were excellent because of less articular displacement and metaphyseal comminution with minimum soft tissue injury.

Acceptable fixation has direct relationship with the final result as shown also in international series. Level of fixation achieved post operatively were judged by operating surgeon and by post operative X-ray.

Delayed union: defined as when fracture does not show any sign of union by 4 month both clinically and radiologically.

Nonunion: when fracture does not show any sign of union by 8 months non clinically and radiologically.

Stiffness of ankle: when ankle movement is less than half of normal movement it is considered as stiff ankle.

Shortening: is measured in comparison to opposite limb.

- Even though fracture were type II with good skin condition in type A management infection is till 70% in this series. Though this much infection is higher than other international series but it shows that local complications are higher in type A management. Incidence of secondary procedure in ORIF is more as here plate were removed in two patients out of three and one patient is undergone for debridement two times.
- In type B patient infection is 30% because
 - C3 patients who got infection had open fracture.
 - C1 patient has DM.
 - C1 patient where fixator has been kept for long time.
 - Condition of soft tissue was poor in all RA type III fracture. Overall result shows that type B management decreases local complication.
- In type C management
 - C1 patient having bilateral pilon fracture has undergone for tibia fixation by MIPPO technique but he got infected

on one side. This stresses that due respect should be given to soft tissues.

2. C Other patient has uncontrolled diabetes mellitus so he get infected and ultimately plate has to be removed.
- Delayed union is more in type B management probably because
 1. C Over distraction of fracture site
 2. C Lack of perfect anatomical reduction.

Malunion: In our series it occurs in one patient, who was treated by distractor without fibula fixation. He has RA type III fracture and is not anesthetically fit for surgery. Surgery

was carried out under local anesthesia. He has valgus deformity. Malunion is directly related to level of reduction achieved.

- Stiffness is more common in type B management probably because prolonged immobilization in ankle spanning fixator/distractor, but results were excellent where it has been kept for short term and patient was young.
- Shortening of 2 cm in only one patient who has RA type III fracture with extensive metaphyseal comminution is observed.

Table XIIV (a): Type of fracture Vs. Complication

Type of fracture	infection	Delayed union	malunion	Stiffness	Shortening
I	1	-	-	1	-
II	6	4	1	-	-
III	2	2	1	-	1

Table XIIV (b): Type of fracture Vs. Complication

Type of fracture	infection	Delayed union	malunion	stiffness	Shortening
B	6	4	-	3	-
C	2	2	1	2	1

Complications are more with type III as compared to type I as in all other international series because of:

1. They are frequently open fracture.
2. Associated with severe soft tissue injury.
3. Having significant articular incongruity and metaphyseal comminution.

Overall rate of complications were less in this series because 23 patients had RA type I and RA type II fracture as it was in Swiss series.

Table XV: ankle motion Vs. Type of management

Ankle movement	Type of management			
	A	B	C	Total
Full	1	1	2	4
¾	1	6	3	10
½	1	5	3	9
< ½	-	3	-	3
Total	3	15	8	26

Normal ankle movement

- Plantar flexion- 55
- Dorsi flexion- 15

Ankle motion are restricted more in type B management because prolonged duration of ankle spanning external fixator in some patients. These patients are old age with post-operative physiotherapy protocol.

Table XVI: ankle motion Vs. type of fracture

RA	Ankle motion			
	Full	¾	½	< ½
I	2	3	1	1
II	2	5	7	1
III	-	2	1	1
Total	4	10	9	3

Ankle movement is best achieved in type I fracture and poor stiffness is maximum in type III fracture because of intraarticular comminution and prolonged immobilization because of delayed union.

Table XVII: Period of ankle mobilization Vs. ankle movement

Period of mobilisation	Ankle motion			
	Full	¾	½	<½
<4 wk.	2	1	-	-
4-8	2	1	-	-
8-12	-	5	6	-
12-16	-	3	-	1
>16	-	-	3	2
Total	4	10	9	3

As period of immobilization increases, there will be more stiffness of ankle joint.

As arthritis takes 12 months to develop and in this study average duration of total follow up is 8-10 months, we have not included it.

Table XVIII: Duration of disability Vs. type of management

Duration of disability in months	Type of management			
	A	B	C	Total
<3	2	5	4	11
3-6	1	7	3	11
>6	-	3	1	4
Total	3	15	8	26

Duration of disability is defined as duration during which patient is unable to carry out his routine work. There is decreased duration of disability in type A management provided that it should not be associated with any other local complication.

Table XIX: ability to walk at final follow-up Vs. type of management

Ability to walk	Type of management			
	A	B	C	Total
>5km	3	6	5	14
1-5km	-	6	2	8
100-100 mtr	-	2	1	3
<100 mtr	-	1	-	1
Total	3	15	8	26

All patients of this series are walking without support at the end of union.

Table XX: level of patient's satisfaction Vs. type of modality

Type of modality	Patient's satisfaction			
	<50%	50-75%	>75%	% satisfactory result
A	-	1	2	66
B	2	3	10	80
C	1	2	6	80
Total	3	6	18	26

Level of patient's satisfaction is nearly equal in all modalities of treatment.

Results were compared with international series of Brad Wyrsh, who has performed a randomized prospective study to compare result of two methods for operative fixation of fractures of tibial plafond.

1. C Group A- those treated by ORIF.
2. Group B- those treated by external fixation.

Table XXI: Comparison of results with international series

	Series I		Series II	
	A modalities	B modalities	A modalities	B modalities
Avg. union time	14 wk.	16 wk.	14 wk.	16 wk.
• Reduction				
• Anatomical	70%	50%	50%	30%
• Near perfect	30%	50%	50%	70%
• Complication				
• Infection	50-60%	30%	40-50%	10%
• Loss of reduction	-	-	-	1
• Reflex				
• Sympathetic dystrophy	-	5%	-	-
• Malunion	-	-	10%	-
• BK amputation				

In this study we have included third type of surgical management regarding which international series are available.

Conclusion & summary

1. These fractures are of high energy trauma.
2. They are frequently open or associated with severe soft tissue injury.
3. These fractures are difficult to reduce and even more to maintain reduction without much disturbing soft tissue condition.
4. Average union time is 14-16 weeks.
5. High incidence of local complication is due to poor soft tissue envelope and precarious blood supply. Hence due respect should be given to soft tissues while managing fractures.
6. Final result depends upon:
 - Type of fracture
 - Severity of soft tissue injury.
 - Type of surgical modality used.
 - Associated fibula fracture or tibia shaft fracture.
7. Type A modality produces excellent result in RA type I fracture associated with minimal soft tissue injury.
8. Type B modality produces good result when fracture is of RA type III or associated soft tissue injury.
9. Biological plating (MIPPO) opens new horizon for treatment of pilon fracture as it minimizes soft tissue trauma and devascularisation of fragments.
10. When fracture of tibia with extension into ankle, it can be treated by Ender's nailing from above with cancellous screw to maintain articular alignment.
11. When fibula is fractured it should be fixed. Type of fixation depends upon:
 - Level of fracture.
 - Extent of comminution.
 - Severity of soft tissue injury.

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