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Research Article

Functional Outcomes of Closed Subtrochanteric Fractures Treated by Proximal Femur Nail and Proximal Femur Locking Plate-A Prospective Study

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Abstract

Subtrochanteric fractures are a variant of per trochanteric fractures of femur extending 5cm distal to the lesser trochanter. Management of subtrochanteric fractures is a major challenge and treatment failure is common for it.

Aim: To compare the functional outcomes of closed subtrochanteric fractures manged by Proximal femur nail and Proximal femur locking plate.

Materials and Methods: This is a prospective study of 20 cases of subtrochanteric fractures admitted in Govt Mohan Kumarmangalam Medical College Hospital, Salem during the period from December 2015 to September 2017.The cases were classified under Russel Taylor classification. Out of the 20 cases 10 cases were managed by Proximal femur nail and 10 cases were managed by Proximal femur locking plate.

Results: In our study, we observed that there were significant reduction in operating time(p-value:0.001) and decrease in blood loss (p value:0.000) in cases managed by PFN when compared to PFLCP. Among the cases managed by PFN closed nailing was done in 50% of cases whereas open reduction was required in all cases managed by PFLCP which was a significant difference (p value:0.033). Among the cases managed by PFN, all cases united except for one case which went for a hypertrophic non-union. One of the cases had breakage of the nail distal to the lag screw and one case had breakage of de-rotation screw. Among the cases managed by PFLCP, 3 cases went for non-union with implant failure, for one among these 3 cases revision surgery was done with PFN.

Conclusion: Even though both PFN and PFLCP are effective in the treatment of subtrochanteric fractures, we observed that PFN was a better implant than PFLCP, because PFN enables more of a biological fixation with less disturbance of fracture haematoma, faster than PFLCP and lesser amount of blood loss.

Keywords: Subtrochanteric Fractures; Proximal Femur Nail; Proximal Femur Locking Compression Plate

Introduction

Sub-trochanteric fractures have evolved as one of the most important causes of morbidity and mortality in elderly patients [1]. They account for approximately 10-30%of per trochanteric fractures. Subtrochanteric region is area below the inferior border of lesser trochanter extending distally 5 cm to the junction of proximal and middle third of femur [2]. These fractures have a bimodal distribution and are seen in two main populations, older osteoporotic patients following low energy falls and younger patients with high energy trauma. This pattern of fracture is associated with higher rates of malunion and non-union than any other femoral fractures because of the anatomical peculiarity of this area.

A number of modalities of management exists for this pattern of fracture. However the main modality of treatment can be divided into two groups, the cephalon-medullary hip nails and the lateral plate screw systems.

Fixed nail plate devices were used for the treatment of these fractures initially. Later sliding hip screw devices became popular in the treatment of subtrochanteric fractures. Other implants used were angular blade plates, dynamic condylar screws and cephalon-medullary nails. All these implants had its own advantages and disadvantages.

Traditionally the medial and posteromedial fracture fragments were considered to be important elements in determining severity

of per-trochanteric hip fractures [3]. Later GOTFRIED emphasized the importance of lateral trochanteric wall in stabilizing subtrochanteric fractures. Locking plates for stabilising subtrochanteric fractures were developed in 21st century as it can act as a buttress for the lateral trochanteric wall and helps in the stabilisation of lateral trochanteric wall.

Materials and Methods

The study was conducted in 20 patients with subtrochanteric fractures admitted in the emergency department. Out of the 20 cases, 10 cases were treated by Proximal femur nail and 10 cases were treated by Proximal femur locking compression plate. The duration of study was from December 2015 to August 2017. The patients were randomly selected into the two groups based on inclusion and exclusion criteria. These patients were managed immediately based on ATLS protocol and after thorough pre-operative evaluation were taken up for surgery.

Inclusion criteria

- Patients admitted in our hospital with subtrochanteric fractures
- Skeletally mature patients.
- Injury within 2 weeks.

Exclusion Criteria

- Patients with pathological subtrochanteric fractures.
- Patients in whom surgery was contraindicated due to systemic diseases.
- Immature Skeleton.
- Open fractures.
- Injury more than 3 weeks.

Operative technique

Patient was positioned in fracture table. After satisfactory reduction and alignment, verified under C arm guidance, in cases of plating a lateral approach was used. If a good satisfactory reduction was obtained and displacement was minimal, a MIPPO technique can be used. Length of the incision varies according to the fracture pattern. A lateral longitudinal incision of about 10-15 cm is made from 2 cm below the tip of the greater trochanter. Fracture is successfully reduced mostly by open reduction, using bone holding forceps and collinear reduction clamps. Plate was temporarily fixed to the shaft using K wires and both alignment of plate is checked. Using C arm guidance,3.2mm guide wires were inserted into the proximal hooded position. The position of guide wires are checked in both AP and lateral views. The most distal screw of the proximal hooded portion was first inserted to maintain the femoral neck shaft angle. After ensuring correct position of the guide wires, they were removed and screws of adequate length inserted in order to ensure that the screws have a satisfactory subchondral purchase. The plate is then fixed to the distal shaft with minimum cortical screws of 4.5mm (6 cortical purchases.).

In cases of proximal femur nailing, after positioning the patient in fracture table, the reduction was verified under C-arm guidance. If reduction could be achieved by closed means, then fracture site was opened by small incision, centred at the fracture site and an anatomic reduction of the fragments is achieved using bone clamps, K wires, collinear reduction clamps, and then the nailing is done. Various reduction techniques were used in achieving closed reduction such as use of Steinmann pins, Schanz screw and mallet externally for correction of the deformity in the proximal fragment. The nail was introduced once the reduction was satisfactory, we used the conventional Proximal femoral nail which had a de-rotation screw and lag screw into the femoral neck. In some cases additional cerclage wiring was done at the fracture site for stability. In all nailing cases long PFN was used and the nail was statically locked.

Postoperatively non weight bearing walking, knee ankle mobilisation and quadriceps strengthening exercises was started from third post-operative day. Sutures were removed after 2 weeks. Initial X rays were taken at 6 weeks and full weight bearing was initiated based on radiological evidence of union and clinical evaluation. All patients were evaluated with Harris Hip Score at the end of 6 months and one year.

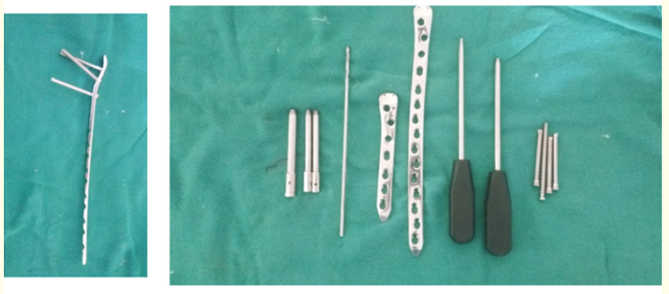

Figure 1: Proximal femur locking plate instrumentation.

Figure 2: Proximal femur nailing instrumentation.

Results

Study population and demographic characteristics

In our study the average age of PFN group patients was 47 and PFLCP group was 58. Among our 20 patients in the study, 18 patients were males and 2 were females. Out of the 10 cases of PFN all patients were males and among the 10 cases of PFLCP only 2 were females. Most of the cases were Russel Taylor Type IB. 3 cases each were classified under Russel Taylor type IIB and 4 cases were classified under type IA.

Operative details

Among the 20 cases,15 cases were treated by closed reduction and 5 cases were treated by open reduction. Among the PFN cases, 50% of cases were reduced by closed reduction whereas in all cases managed by PFLCP open reduction was done. When we analysed the method of reduction in both groups the p value was found to be 0.033 and this is statistically significant . Bone grafting was done in a total of 4 cases out of which 3 cases primary bone grafting was done and for one case secondary bone grafting was done. Out of the 3 cases of primary bone grafting ,2 were done for PFN patients and one for a case treated by PFLCP. Secondary bone grafting was done for a case of PFLCP which had implant failure and later revision surgery was done with PFN and secondary bone grafting. The average operating time in PFN patients 80 min and in PFLCP patients was found to be 104 minutes. P value was found to be 0.001 which was statistically significant. The average blood loss in PFN patients was 78 ml and in PFLCP patients was 152.50 ml, p value was 0.000 which was statistically significant.

Follow-up and fracture union

The average time for union in weeks for cases managed with PFN was 16 weeks and those managed with PFLCP was 18 weeks. P value on comparing the union rate of both groups was 0.453 which was statistically insignificant. The average follows up of patients with PFN was 10 months for PFN and 12 months for PFLCP. In our study of 20 patients ,25% that is 5 patients had an excellent Harris Hip Score. Out of these 5 cases with excellent Harris hip score, 4 cases were managed by PFN and 1 case managed by PFLCP. Two cases, that is 20% of cases had a poor outcome and these 2 cases with poor outcome was managed by PFLCP. Patients with Harris Hip Score was categorised as follows: Excellent :90 - 100, Good :80 - 90, Fair:70-80, Poor: less than 70.

Complications

Out of the 20 cases,4 cases went for non-union, and among these 4 cases, 3 were treated with PFLCP. Among the three cases for one of the case revision surgeries was done with PFN, one case which was managed by PFN went for hypertrophic non-union. In our study screw breakage of proximal locking screws were seen in 2 cases managed by PFLCP, one case of PFLCP there was implant failure with plate breakage and in one case of PFN there was breakage of de-rotation screw. In our study varus collapse was seen and in 3 cases manged by PFLCP. Among the 20 cases in our study, shortening was observed in 8 cases, out of which 3 cases was seen in PFN group and 5 cases belong to PFLCP group.3cm shortening was seen in one case, all other cases had shortening of less than 3cm.No significant association (p 0.316) was observed with shortening in both the group of patients.

In our study on comparing the operating time (p value: 0.001), blood loss (p value: 0.000) and reduction techniques closed/open (p value: 0.033) in PFN and PFLCP groups we observed that the differences were highly significant and the method of reduction when compared to PFN and PLCP group is also of significance. This indicates that there is a highly significant decrease in the average blood loss and operating time in cases treated by PFN when compared to PFLCP group and also closed reduction is seen more with cases managed by PFN when compared to PFLCP.

Discussion

Fixation: Intramedullary or extramedullary

Subtrochanteric fractures are a challenge to treating orthopaedic surgeon. This is mainly due to the multiple deforming forces that act on both the proximal and distal fragments. On the proximal fragment, the gluteus medius and gluteus minimus cause abduction, the iliopsoas causes flexion, and the short external rotators (piriformis, obturator internus, quadratus femoris, and the superior and inferior gemelli) cause external rotation. On the distal fragment, the gracilis and adductor muscles cause an adduction and shortening force. [4]The culmination of these forces results in the characteristic deformity seen in subtrochanteric femur fractures of abduction, external rotation, and flexion of the proximal segment and adduction of the distal segment-overall generating a typical fracture pattern of varus and procurvatum. Operative management of sub-trochanteric fractures can be broadly broken down into two major categories: intramedullary (IM) nailing and extramedullary plating.

Crosstab.					
			Groups		Total
			Long PFN	PFLCP	
Sex	F	Count	0	2	2
		% within Groups	0.00%	20.0%	10.0%
	M	Count	10	8	18
		% within Groups	100.0%	80.0%	90.0%
Total % within Groups		Count	10	10	20
		100.0%	100.0%	100.0%	

Table 1

Crosstab					
			Groups		Total
			Long PFN	PFLCP	
Russeltayl or classification	TYPE IA	Count	3	1	4
		% within Groups	30.0%	10.0%	20.0%
	TYPE IB	Count	5	8	13
		% within Groups	50.0%	80.0%	65.0%
	TYPE IIB	Count	2	1	3
		% within Groups	20.0%	10.0%	15.0%
Total % within Groups		Count	10	10	20
		100.0%	100.0%	100.0%	

Table 2

Crosstab					
			Groups		Total
			Long PFN	PFLCP	
Reduction	Closed	Count	5	0	5
		% within Groups	50.0%	0.0%	25.0%
	Open	Count	5	10	15
		% within Groups	50.0%	100.0%	75.0%
Total		Count	10	10	20
% within Groups		100.0%	100.0%	100.0%	

Table 3

Crosstab					
			Groups		Total
			Long PFN	PFLCP	
Union	Non-Union	Count	1	2	3
		% within Groups	10.0%	20.0%	15.0%
	Union	Count	9	7	16
		% within Groups	90.0%	70.0%	80.0%
	Malunion	Count	0	1	1
		% within Groups	0.0%	10.0%	5.0%
Total		Count	10	10	20
% within Groups		100.0%	100.0%	100.0%	

Table 4

Crosstab					
			Groups		Total
			Long PFN	PFLCP	
HHS	Excellent	Count	4	1	5
		% within Groups	40.0%	10.0%	25.0%
	Fair	Count	2	2	4
		% within Groups	20.0%	20.0%	20.0%
	Good	Count	4	5	9
		% within Groups	40.0%	50.0%	45.0%
	Poor	Count	0	2	2
		% within Groups	0.0%	20.0%	10.0%
Total		Count	10	10	20
% within Groups		100.0%	100.0%	100.0%	

Table 5

Crosstab					
			Groups		Total
			Long PFN	PFLCP	
Shortening	1CM	Count	3	2	5
		% within Groups	30.0%	20.0%	25.0%
	2CM	Count	0	2	2
		% within Groups	0.0%	20.0%	10.0%
	3CM	Count	0	1	1
		% within Groups	0.0%	10.0%	5.0%
	NIL	Count	7	5	12
		% within Groups	70.0%	50.0%	60.0%
Total		Count	10	10	20
% within Groups		100.0%	100.0%	100.0%	

Table 6

Crosstab					
			Groups		Total
			Long PFN	PFLCP	
Implant failure	Screw loosening, plat	Count	0	1	1
		% within Groups	0.0%	10.0%	5.0%
	Nail breakage	Count	1	0	1
		% within Groups	10.0%	0.0%	5.0%
	NIL	Count	9	7	16
		% within Groups	90.0%	70.0%	80.0%
	Plate breakage	Count	0	1	1
		% within Groups	0.0%	10.0%	5.0%
	Plate pulls out	Count	0	1	1
		% within Groups	0.0%	10.0%	5.0%
Total % within Groups		Count	10	10	20
		100.0%	100.0%	100.0%	

Table 7

Groups		Mean	Std Deviation	P Value
Age	PFN	47.20	16.390	0.154
	PFLCP	57.50	14.524	
Union	PFN	15.56	2.404	0.069
	PFLCP	18.00	3.024	
Operating time	PFN	80.00	13.944	.001
	PFLCP	104.00	13.499	
Blood loss	PFN	78.00	13.375	.000
	PFLCP	152.50	32.167	
Follow up (Months)	PFN	9.80	2.440	.301
	PFLCP	11.80	5.412	

Table 8

Intramedullary fixation has advantages over extramedullary implants as it is more of a biological fixation with less devascularisation, less bleeding less surgical duration and early functional recovery. In a study by [5]. Jie Wang., *et al*. where biomechanical evaluation of different implants like PFN and PFLCP was compared it was observed that PFN was superior biomechanically than other implants in terms of its construct. We observed that PFN has more advantages as compared to PFLCP, PFN has shorter bending lever arm, and it can bear more compressive stresses on medial cortex of proximal femur. PFN also prevents varus collapse of the medial cortex of subtrochanteric region thus reducing the incidence of failure rate [6]. Although intramedullary fixation has the advantages of biomechanical stability and less soft tissue damage, most studies have not confirmed the clinical superiority of intramedullary fixation over extramedullary fixation. Initially fixed angle plates and dynamic hip screws were used for fixation of subtrochanteric fractures but with the advent of minimally invasive techniques and principles of relative stability locking plates was introduced. There was a significant difference in blood loss between PFN and PFLCP groups. The blood loss was significantly lower in PFN group [7]. Sadowski., *et al*. observed mean duration of surgery 82 min for PFN, in our study mean duration of surgery was 80 min for PFN. The mean duration of surgery for PFLCP in our study was 104 min. A study by [8]. Lee. W., *et al*. showed an operating time of 163.2 min

for PFLCP. In studies all around the world, the duration of surgery highly varies. The duration of surgery is largely dependent on the skill and experience of the operating surgeon as well as the nature of fracture pattern. In our study we observed that 80% of cases in PFN group had good to excellent Harris Hip Score. In PFLCP group 60 % of cases had good to excellent Harris Hip Score, study by [9]. P.K. Chalise it was observed that 88% of cases had a good to excellent Harris Hip Score whereas in a study by [10]. Kumar. N., *et al*. a good to excellent Harris Hip Score was seen in 77.5% of patients.

Complications related to surgical management of subtrochanteric fractures

[11] Literature suggests that the complication rate in subtrochanteric fractures is high. The major fracture healing-related complications are loss of reduction, non-union, implant failure, and malunion of the fracture. These complications are mostly related to the quality of reduction and its fixation. In a study by [12]. Siva Rama Krishna., *et al*, it was observed that the rate of implant breakage in PFN was 4%. They observed a complication rate of 20%. The inherent instability of the fracture pattern and the difficulty to achieve medial buttressing is considered as a cause of failure in PFN fixation. Studies on subtrochanteric fractures using PFN by [13]. Jiang L., *et al*. showed one case of delayed union on their study [14]. Streubel., *et al*. in their study had 5% non-union. In a study by [15]. Gadegone and Salphale 100 cases treated by PFN, complications like femoral head cut through was seen in 4.8% of patients, implant breakage in 0.8% and intra-operative femoral shaft fractures 0.8%.

Figure 3

Figure 4: Complications of proximal femur nailing.

In one of our cases with PFN, cerclage wiring was done, this patient achieved union by 12 weeks [16]. Codesido., *et al*. in a study compared open reduction and cerclage wiring with closed reduction and found that patients treated with cerclage wiring had better results than open reduction. For this same case bone grafting was also done. A study by [14]. Thapa. P., *et al*. advocated bone graft as a routine procedure in all comminuted subtrochanteric fractures without posteromedial continuity. Bone grafting acts as protection factor for fixation device and prevents the varus deformity.

Figure 5: Cerclage wiring done which resulted in union faster.

Among the patients operated with PFLCP, we had 3 cases of implant failure. Revision surgery using PFN was done for one of the cases,2 other cases no revision procedure was done. One of the patients had plate breakage after 6 months with varus collapse. Plate exit was done and revision surgery with long PFN was with cerclage wiring with bone grafting was done. Patient has not attained complete radiological union till now and has varus collapse. Patient also has a significant shortening of 3cm.Causes for implant failure in this patient was due to varus mal-reduction at the time of surgery, medial comminution and distraction at the fracture site which would have causes high stress at the plate screw interface, eventually leading to plate breakage. We could have avoided this complications by achieving a perfect reduction and earlier bone grafting. Another case where PFLCP fixation was done, had implant failure at 6 months. We had intra operative complication of breakage of drill bit in this case. In this case we had achieved an acceptable reduction of the fracture fragments and posteromedial continuity was also well maintained. Only 2 proximal locking screws was applied to the head. No union was achieved even after 6 months. On weight bearing, patient developed varus collapse with breakage of screws and proximal loosening of screws with plate pull out. In this patient we could have reduced the fragments with interfragmentary screws, which would have further enhanced the stability, as well as secondary bone grafting after no evidence of union would have decreased the risk of implant failure. We should have applied all the three proximal locking screws into the head. These reasons along with the inherent nature of non-union and devascularisation of the fragments could be the cause of failure. Another patient had implant failure at 8 weeks follow up. Patient was not compliant and started weight bearing early in spite of strict advise. In this case failure was due to early weight bearing of the patient even before evidence of callus formation and lack of posteromedial continuity [18]. Glassner and Tejwani reported a 70% failure rate in their studies, 30% of cases developed varus collapse,20% of cases had breakage of plates. In a study by [19]. Asif N., *et al*. union rate was found to be 92%, 3 (12%) patients developed bending or breakage of proximal screws and 3 (12%) cases varus collapse was observed. They observed that the failure was due to early weight bearing before callus formation, and they observed that in all the failure cases there was a lack of posteromedial continuity and patients were unreliable and non-compliant with weight bearing [20]. Wirtz C., *et al.* recently in their study reported 37% complications in their study included important complications such as infection, cut out and varus collapse which required revision surgeries. We observed that the cause of failure in our study among PFLCP patients was due to mechanical stress at the plate screw interface caused due to early weight bearing on the affected leg, before bone healing has been completed.

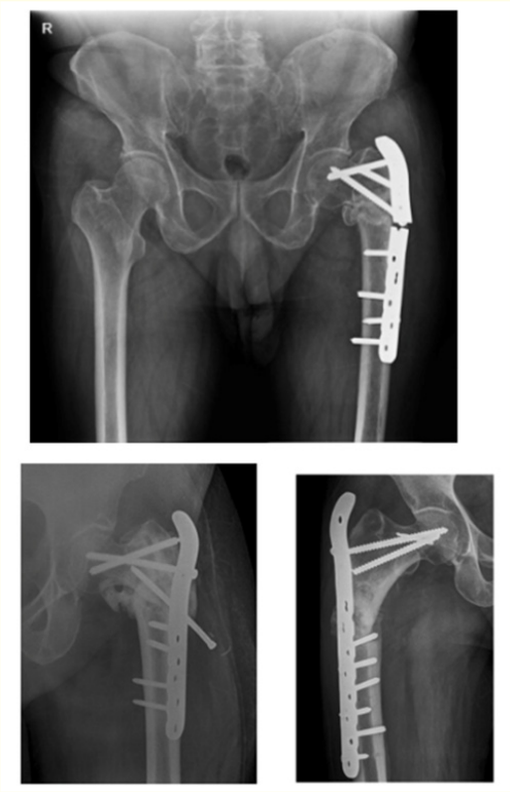

Figure 6: Failed cases of proximal femur locking plate.

Learning points

For better functional outcomes in PFN, an ideal entry point and reduction is crucial. [14]Streubel., *et al*. in their study after analysing 50 x rays of normal hips demonstrated that the ideal entry point was medial to the tip of greater trochanter in 70% of patients and lateral in the remaining patients. In spite of evolution of different implants for subtrochanteric fractures, reduction is considered as isolated crucial factor in prognosis of subtrochanteric fractures [21]. Ekstrom W., *et al*. in their study analysing the results of intramedullary fixation in the treatment of subtrochanteric fractures, observed that in those cases with acceptable reduction, the rate of reoperation was 23% whereas those with good reduction patients were re-operated. The aim should be to restore the cervico-diaphyseal angle, in addition to the correction of rotation and flexion of the proximal fragment with methods that cause minimal biological damage.

Factors important in plate fixation are critical technique and good surgical experience, protected weight bearing until evidence of bony healing is important, good anatomical reduction of the fracture fragments and maintenance of posteromedial continuity. One of the key factures in subtrochanteric fractures is good anatomical reduction, in our study we observed that in a patient where we had done a good anatomical reduction using interfragmentary screws, the bone healing and union was quicker when compared to other cases where we had not used this techniques. We also observed that this patient had an excellent HARRIS hip score and weight bearing was stated earlier, Another case where we had done pri-

mary bone grafting healed well with excellent HARRIS hip score, in this case bone grafting was done in order to maintain the posteromedial continuity.

The concept of lateral trochanteric wall as a stabilising factor in management of subtrochanteric fractures led to the development of concept of locking plates for subtrochanteric fracture management. Following observations which we made in our study while using PFLCP were

- Delayed weight bearing, toe touch weight bearing can be delayed in unstable fractures with limited posteromedial continuity. Earlier weight bearing can be started in fracture with good posteromedial cortical contact.
- Plate once locked in its position does not permit further collapse or does not increase the cortical contact, hence open reduction must be done whenever doubtful about reduction which further adds to blood loss and causes devascularisation of the fragments.
- Avoid distraction while fixing which increases risk of implant breakage as the fracture heals.
- Plate positioning and screw placement is crucial, the proximal tip of the plate should engage with the tip of the greater trochanter and the plate with increased length spanning the whole fracture are more reliable. Proximal screws should be as long as possible and inferior most head screw should engage the calcar.
- We observed that bone grafting must be considered in cases of subtrochanteric fractures both as a primary or secondary procedure.

Figure 7: PFN fixation with ideal entry point.

Figure 8: Proximal femur locking plate cases with good union.

Limitations

The major limitations in our study were the number of patients and the shorter duration of follow up.

Conclusion

Both PFN and PFLCP are effective implants in the management of subtrochanteric fractures. No major differences were noted in the functional outcomes and complication between the PFN and PFLCP. Advantages of PFN over PFLCP are decreased blood loss, decreased duration of surgery. The main factor in better outcome regardless of the implant was the reduction achieved by open or closed means and the principles to be followed in subtrochanteric fractures irrespective of the implant used.

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