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Comparison of radiological and clinical outcomes of patients treated with plating versus IMIL nailing in distal tibia fractures: A prospective study

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Abstract

Background: Distal tibia fractures account for less than 10% of all lower extremity fractures. Tibial fractures are frequently accompanied by soft tissue damage, thus if they are not correctly treated, they can significantly impair the patient. Various surgical modalities used for these fractures include closed intramedullary nailing, plating by open or closed methods, and several types of external fixators. Our study's objective was to evaluate the effectiveness of locking plates (LP) versus intramedullary interlocking (IMIL) nailing for treating these fractures.

Materials and Methods: This was a prospective interventional study on 30 patients with extra-articular fractures of the lower third of tibia admitted under the Department of Orthopaedics between May 2021, and May 2022. Patients were allocated randomly into two groups with 15 patients each using coin toss to decide their mode of treatment. Patients got operated on with the respective mode of treatment and were followed up at 6 weeks, 3 months, and 6 months.

Results: The most common mode of injury was found to be a Road Traffic Accident (RTA), seen in more than 50 percent of cases. The radiological union time we calculated was found to be 12.93 weeks for plating and 13.53 weeks for nailing. Four patients who underwent nailing developed malalignment compared to no patients in the plating group. The time taken after surgery to begin full weight bearing was 12.6±3 weeks for the intramedullary interlocking nailing group and 14.3±2.4 weeks for the plating group. Both groups had similar AOFAS scores with 11 in the intramedullary interlocking nailing group and 10 in the plating group obtaining excellent outcomes at the end of 6-month follow-up.

Conclusion: IMIL nailing is superior to plating in terms of lower infection rates and time taken for full weight bearing and mobilization. However, plating is superior to IMIL nailing in terms of achieving a better anatomical, fixed reduction of the fracture.

Keywords: Distal tibia fractures, locking plating, intramedullary interlocking nailing, lower extremity fractures

Introduction

Less than 7% of all tibia fractures are distal in nature. Distal tibia fractures account for less than 10% of all lower extremity fractures. It is more prevalent in males between the ages of 25 and 50. Low energy to high energy injuries are on the injury spectrum. They are primarily caused by automobile accidents, fall from great heights, and ankle twisting. Most tibia fractures are caused by high-speed crashes involving vehicles. Tibial fractures are frequently accompanied by soft tissue damage, thus if they are not correctly treated, they can significantly impair the patient. The most frequent cause is high-energy motor vehicle trauma, which is followed by falls, direct blows, and sports injuries. Because of the fragile capillaries around the ankle joint, these fractures are challenging to treat. Additionally, the tibia is subcutaneously oriented, which makes managing the fracture more challenging.

Closed comminuted fractures treated non-operatively with casts typically result in issues such as prolonged immobilisation, malunion, shortening, and joint stiffness [1-3]. Surgical treatment options include open reduction, intramedullary nailing, external fixation, external fixation with plates, and internal fixation with plates and screws [4]. To maintain the normal mechanical axis, guarantee joint stability, and restore a nearly complete range of motion are the goals of fracture treatment. Every single time, due to the deteriorated soft tissue state and varying bone quality, this task is challenging to complete. The degree of the initial injury, the quality, and the stability of the reduction all affect how well an operation goes. Long-term clinical results are influenced by the mechanism of injury, soft tissue condition, degree of comminution, and articular damage. Complications like non-union, delayed union, infection, and implant failure are usually brought about by open reduction and internal fixation with a conventional plate. The care of underlying soft tissues is crucial in the therapy of these fractures. Therefore, when utilising the internal fixation technique, it is important to focus on the vascular support of bone and soft tissue by minimising exposure, performing indirect reduction, and especially causing the least amount of harm to the periosteum. By adhering to the fundamentals of biological fracture repair, intramedullary interlocking nailing (IMIL) enables minimally invasive, symmetrical, and dynamic fracture fixation. With satisfactory results, this method is also frequently employed for distal tibial shaft fractures [5].

To preserve the vascularity of the osseous and soft tissues, the idea of managing these fractures has been shifted from absolute fixation to relative fixation using biological osteosynthesis. Biological plating maintains vascularity around the fractures and offers a modicum of stability. Our study's objective was to evaluate the effectiveness of locking plates (LP) versus intramedullary interlocking (IMIL) nailing for treating these fractures. [6, 7]. The goal of the current study was to compare the two main treatment modalities for these fractures, namely closed intra-medullary interlocking nailing (IMIL) and open reduction with distal tibial locking compression plate and ascertains the effectiveness of each method in the management of closed fractures of the distal tibia.

Material and Methods

This was a retrospective study of 30 patients who presented to the emergency room at Saveetha Medical College in Chennai between May 2021 and May 2022 with distal tibia fractures. The institution's ethical committee gave this study their clearance. All patients with extra articular distal tibia fractures (AO types 43A1, 43A2, and 43A3) who were between the ages of 18 and 60, willing to undergo surgery, be followed up on, and be eligible for anaesthesia were included in our study. Patients who were younger than 18 or older than 60, had open fractures, intra articular fractures, pathological fractures, or patients who had suffered neurovascular injury were excluded. All patients underwent a full clinical and radiological evaluation at the time of admission. Ankle AP, Lateral, and Mortise views were acquired using standard radiography, and the nature and pattern of the fracture were documented. The limb was examined for its neurovascular state and the results were recorded in the case files while the leg was temporarily immobilised with a below knee POP slab. Any related fractures were examined and recorded as well. The patients were divided into two groups at random, using coin toss: group 1 comprised patients with distal tibia fractures who were treated with ORIF with plate osteosynthesis (n = 15), and group 2 included patients who were going to undergo intramedullary interlocking nailing (n = 15) as their treatment. According to the AO classification, the fractures were divided into three types: type A1 was a simple fracture, type A2 was a wedge fracture, and type A3 was a complex fracture.

The patients underwent routine blood tests, and their surgical readiness was assessed. Any comorbid conditions were identified and mentioned in the case files. The patients were taken up for surgery after obtaining their informed, signed consent. The procedure was carried out while under spinal anaesthetic. Injection cefazolin 1 gm was administered intravenously at the time anaesthesia was induced and was continued for at least 5 days after surgery. In group 1, a 10 cm skin incision was created through an anterior-medial approach to the distal tibia. Dissection of subcutaneous soft tissues completed. Visualisation of a fracture site was done. Fracture reduction was attempted with the use of an image intensifier. Reduction was accomplished and fixed utilising plates and the necessary screws. A 5–6 cm medial longitudinal incision of the patella tendon was done in the IMIL nailing group for participants in group 2. An entry hole was created in the anterior bare region of the tibial plateau after the patellar tendon was pushed to the side. Anteroposterior and lateral images of the C-arm were used to confirm the entry point. Following a tentative reduction of the fracture with pointed bone retaining forceps, a guide wire was inserted through the entry portal to the distal end of the tibia. Reaming in sequence was done, and appropriate length IMIL nail fixation was done. Two or three proximal locking screws and two distal locking screws were used to secure the nail. Some of the patients in the IMIL nailing group required 1 or 2 poller blocking screws to reduce fracture, correct alignment, or improve fracture stability. A sterile bandage was then applied after the wound was closed in layers.

To assess the effectiveness of the fracture reduction and fixation, postoperative radiographs were taken. For a total of 5 days, patients in both groups received intravenous antibiotics. On the first post-operative day, active quadriceps exercises were begun with active ankle and toe movement as much as the patient tolerated. Depending on the method of fixation and reduction, the patients were made to walk on their fourth post-operative day with or without weight bearing on the operated limb. The patients were instructed to continue active knee and ankle mobilisation as they were taught based on the mode of fixation and reduction at the time of discharge. The American Orthopaedic Foot and Ankle Society (AOFAS) score and Clinico-Radiological examination were used to evaluate patients' clinical status at six-week, three-month, six-month, and one-year intervals.

On every follow-up, a clinical examination was conducted to evaluate the wound's condition, tenderness, ankle range of motion, stability of the fracture, and clinical union. After AP and Lateral X-rays of the ankle showed features of radiological union, partial weight bearing was permitted. The union was ascertained radiologically when at least three surfaces of the fracture site were crossed by bone trabeculae or cortical bone on a plain X-ray. The patient case records contained documentation of all the scoring and follow-up information. IBM SPSS Version 22 was used to analyse the data that was gathered. Categorical variables were expressed as number and percentages, whereas continuous variables were expressed as mean and SD. Categorical variables were compared using the chi square test. Statistical significance was defined as a P value less than 0.05.

Results

30 patients with fractures of the distal tibia shaft who presented between May 2021 to May 2022 were managed by surgical means and were followed up for a period of 1 year. They were randomly allocated into 2 groups based on coin toss.

Group 1: **Patients managed by ORIF with PO (n=15)**

The mean age of the patients was 42±11.38 years ranging from 24 to 65 years. There were 10 males and 5 females in this group (Figure 2) with the right side being more commonly involved as seen in 9 of the patients (Figure 3). According to the AO fracture classification, type AO 43A2 was the most common one seen followed by type 43A1 and 43A3. RTA was the most common mode of injury as seen in 11 patients followed by slip and fall in 2 patients. The mean duration of surgery was 137.3±9.8 minutes ranging from 125 to 147 minutes. The average blood loss was 198 ml ranging from 131 to 340 ml. The average time to fracture union was 12.93 weeks ranging from 11 to 15 weeks (Table 1). All fractures united well at the end of 32 weeks. The mean AOFAS score at 3 months was 84.2±1.69 while it was 93.7±2.3 at the end of the first year (table 3). There was no change in the score after the 1-year period. 1 patient developed superficial skin infection which was treated with antibiotics. There were no complications such as non-union, mal union or loss of fixation or reduction or implant failure encountered in this group. None of the patients were lost to follow up.

Group 2: Patients managed by IMIL nailing(n=15)

The mean age of the patients was 40.4±15.17 years ranging from 19 to 71 years. There were 5 males and 10 females in this group with the left side being more commonly involved as seen in 8 of the patients (Figure 4). According to the AO fracture classification, type AO 43A1 was the most common one seen followed by type A2 and then A3. RTA was the most commonly mode of injury as seen in 11 patients followed by fall from height and slip and fall in 2 patients each. IMIL nailing was done in all these cases. The average duration of surgery was 136.6 minutes ranging from 125 to 167 minutes. The average blood loss was 1881 ml ranging from 125 to 260 ml. The average time to fracture union was 13.53 weeks ranging from 10 to 16 weeks (table 1). All fractures united well at the end of 30 weeks. The mean AOFAS score at 3 months was 84±1.79 while it was 93±2.3 at the end of the first year (table 3). There was no change in the score after the 1-year period. There were complications of malalignment in 2 patients and 2 patients complained of anterior knee pain (Figure 5). None of the patients were lost to follow up

DISCUSSION

Distal metaphyseal fractures of the tibia are difficult to treat. They are often caused by high-energy injuries that result in axial and rotational stress on the bone. There are many different treatment options available, including conservative management, plating, nailing, AO external fixation, and Ilizarov fixation. The best treatment option for distal metaphyseal fractures is still up for debate. Conservative management can be used in cases of stable fractures with significant comorbidities, but it often results in delayed union, malunion, and joint stiffness.

Locking plate fixation provides a rigid construct and anatomical reduction, but it can lead to wound complications and infections. Hardware complications are also more common with locking plates, which might require implant removal. Intramedullary interlocking nails are less invasive than locking plates and can be used for fractures that are away from the tibial plafond. However, they can be technically more challenging to achieve and maintain reduction because of the anatomic characteristics of the distal tibia.

Intramedullary interlocking nailing and plating have been compared in several clinical studies [8-10]; the former is associated with a much shorter full weight bearing and union time as well as a lower rate of soft tissue problems and infections. On the other hand, intramedullary interlocking nail may raise reduction concerns, which has been observed to increase the rate of malunion and non-union. A study that compared the results of distal tibial fractures treated with intramedullary interlocking nailing and plate fixation found that patients who were operated with plates had lower rates of non-union and malunion and a lower rate of complications. However, they also had a longer healing time than patients who were treated with nailing. The benefit of a locked plate is that it typically results in a better reduction of the fracture. Furthermore, it promotes bone healing more quickly than intramedullary interlocking nails and provides a better stabilisation of distal tibial fractures [11-16].

In our study, most common cause for these fractures was RTA followed by slip and fall injury (Figure 1). Our results were comparable to other studies by Kumar *et al*., Ram *et al*., Pawar *et al*. [17, 18] which also showed that RTA is the most common mode of injury due to industrialization. A meta-analysis study of 354 patients managed with intramedullary nailing versus plating were analysed which showed six of eight studies in which the operative time had significant heterogeneity among studies. The meta-analysis showed less operative time in the intramedullary interlocking nailing group compared with plate group (MD=−13.37, 95%CI −19.34 to −7.40, P < 0.0001). Guo JJ and others conducted a study with 85 patients for distal metaphyseal tibia fractures treated by either plating or nailing in which they found significant difference in time taken for surgery in patients treated with plating than nailing (97.9 versus 81.2 minutes) [19]. Yong Li and others have done a study in 46 patients with distal tibia metaphyseal fractures, and they found average operating time 90±20.3 (plating) versus 76±16.6 (nailing) minutes, which is significantly high in patients treated with plating than locked nailing [20]. Whereas our study results were different in terms of surgical time. The results showed that there was minimal difference in time taken for surgery among both groups who underwent plating versus nailing (135.6 versus 139.7 minutes).

According to Ravindra P. *et al*., the average radiological union time of patients operated by plating was calculated to be 17.30 weeks and of patients operated by nailing was found to be 15.43 weeks. However, as per our study, the radiological union time we calculated was found to be 12.93 weeks for plating and 13.53 weeks for nailing (table 1). The mean radiological union time was found to be almost similar according to our study unlike other studies where plating took lesser time.

There were few observations from our study. First, in terms of the mal alignment, four patients with nailing developed this condition, whereas no patients in the plating group (rate 0%) did.Second, the duration of time after surgery to wait before full weight bearing was 12.6±3 weeks for the intramedullary interlocking nailing group, and 14.3±2.4 weeks for the plating group (table 2). Full weight bearing was allowed eventually depending on radiological union. This suggests that intramedullary nailing guarantees a significantly faster full weight bearing time than locked plating. Third, with regards to functional outcome, patients in the two groups had similar AOFAS Scores: 11 in the intramedullary interlocking nailing group and 10 in the plating group obtained excellent outcomes, 4 in the intramedullary interlocking nailing group and 5 in the plating group obtained good outcomes; none of the 30 patients obtained a fair or poor outcome (table 3).

These findings imply that the functional outcome for intramedullary nailing and locked plating are almost comparable for fractures of the distal tibia. The findings of our study show that IMIL nailing is superior to plating in terms of lower infection rates and a statistically significant shorter time to complete weight bearing. While plating is superior to IMIL nailing in terms of causing greater anatomical and fixed reductions of the fracture and having a lower rate of union. In terms of duration of surgery, union time, and functional outcomes, the two treatment modalities had similar success.

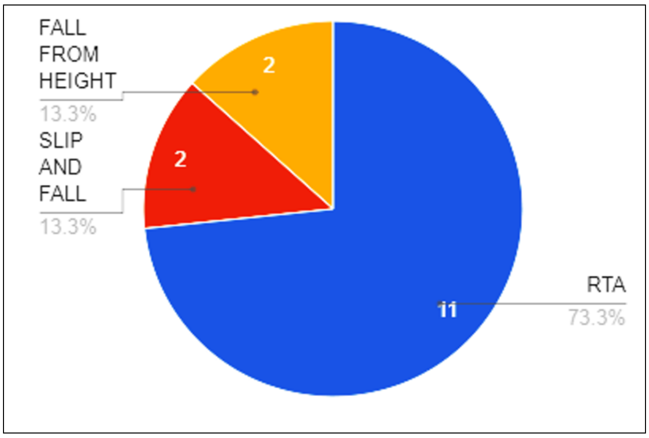

Fig 1: Mode of injury

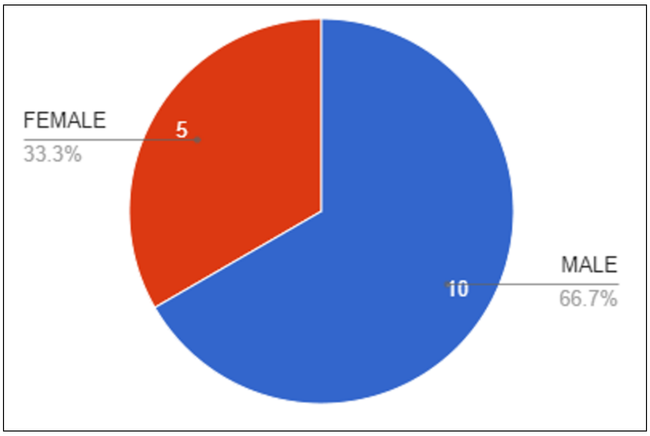

Fig 2: Gender of patients treated by Orif with PO

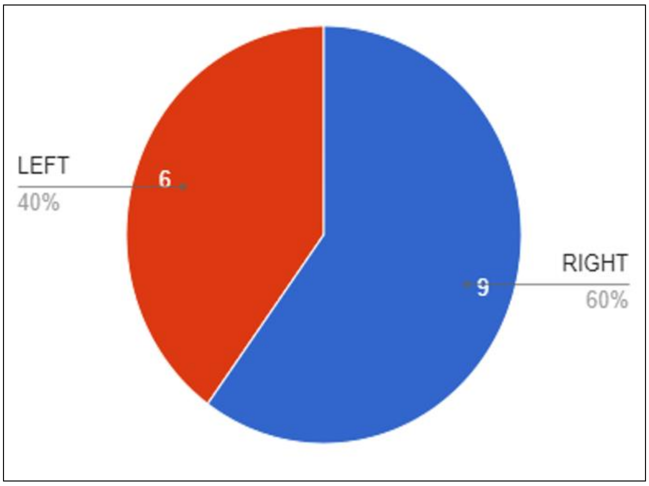

Fig 3: Side of injuyry of patients treated by Orif with PO

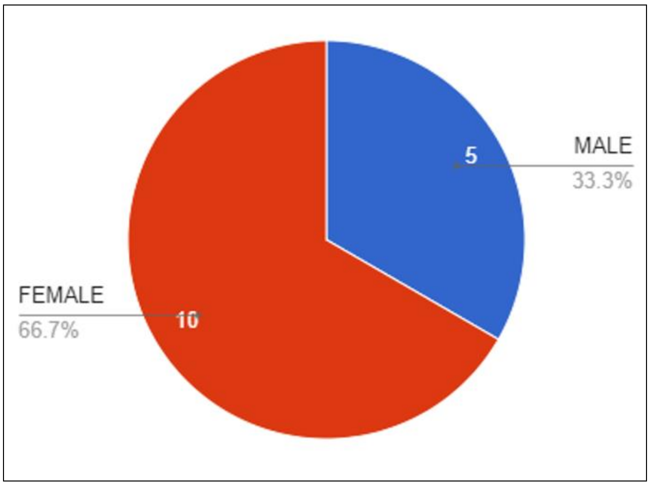

Fig 4: Gender of patients treated by IMIL Nailing

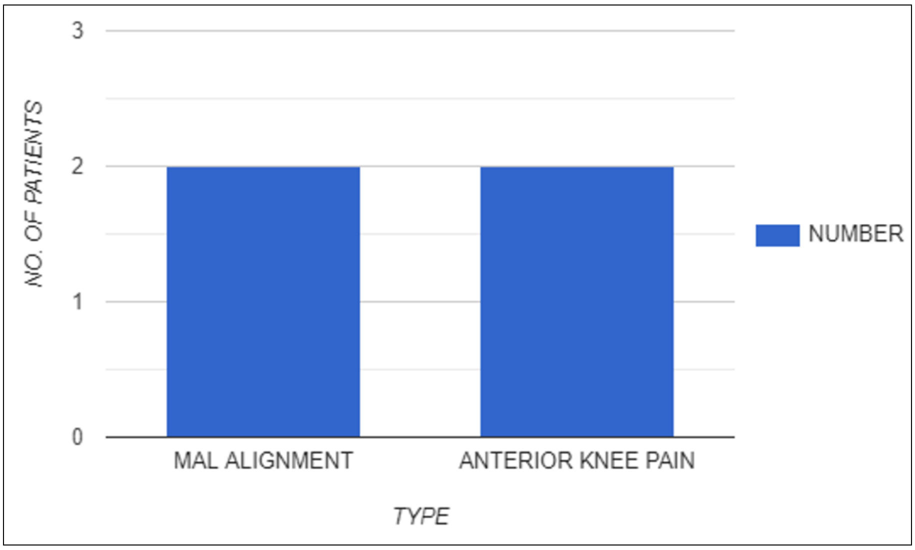

Fig 5: Complication seen in patients treated by IMIL Nailing

Table 1: Mean radiological union time

Method	Radiological Union Time (weeks)
Plating	12.93
Nailing	13.53

Table 2: Time after surgery to wait before full weight bearing

Group	Mean Time to Full Weight Bearing (weeks)	Standard Deviation (weeks)
Intramedullary Interlocking Nailing	12.6	3
Plating	14.3	2.4

Table 3: Functional outcome

Outcome	Intramedullary Interlocking Nailing	Plating
Excellent	11	10
Good	4	5
Total	15	15

Table 4: Patient demographics and data

S. No	Side	Mode of Injury	AO OTA Classification	Technique	Surgical Time (MINS)	Blood Loss (ML)	Fracture Union (Weeks)	Aofas Score Post-Op	6 Weeks	3 Months	6 Months	12 Months
1	Right	RTA	A1	IMIL	135	260	12	49	62	82	92	96
2	Right	RTA	A2	Plating	137	175	14	48	61	83	90	96
3	Left	RTA	A1	Plating	141	240	15	44	63	84	93	93
4	Right	Fall From Height	A1	Plating	147	310	12	46	63	85	90	92
5	Right	RTA	A2	Plating	142	340	11	45	68	82	90	90
6	Left	RTA	A2	Plating	131	165	12	42	64	82	86	94
7	Left	Slip and Fall	A2	Plating	132	141	13	48	67	84	90	96
8	Right	Fall From Height	A1	IMIL	156	147	14	47	67	81	91	96
9	Right	RTA	A2	Plating	141	142	14	49	65	85	92	94
10	Right	RTA	A2	Plating	125	131	12	54	75	87	91	96
11	Right	RTA	A1	Plating	126	165	14	51	68	85	91	92
12	Right	Slip and Fall	A1	IMIL	137	240	12	48	68	87	93	91
13	Left	Slip and Fall	A1	Plating	142	310	11	49	72	84	90	96
14	Left	Fall from Height	A2	Plating	127	340	14	57	68	86	96	97
15	Left	RTA	A2	IMIL	129	165	15	56	64	86	91	92
16	Left	Slip and Fall	A1	IMIL	125	141	16	52	62	83	93	91
17	Left	RTA	A1	Plating	135	147	12	42	69	87	90	90
18	Right	RTA	A2	IMIL	137	142	13	43	64	84	91	92
19	Right	RTA	A2	Plating	141	131	14	49	64	85	95	96
20	Left	RTA	A2	IMIL	147	132	13	57	71	83	90	95
21	Left	Slip and Fall	A1	IMIL	141	144	14	51	63	86	90	96
22	Left	RTA	A2	IMIL	147	240	10	59	67	83	86	93
23	Right	RTA	A1	IMIL	142	240	15	59	65	82	90	96
24	Right	RTA	A1	Plating	131	310	13	46	75	84	91	96
25	Left	Slip and Fall	A2	IMIL	132	190	12	54	68	85	92	97
26	Right	RTA	A2	IMIL	167	220	14	57	68	83	91	92
27	Left	RTA	A1	IMIL	131	250	16	41	72	83	93	91
28	Left	Fall From Height	A2	IMIL	124	124	13	47	68	87	90	90
29	Right	RTA	A2	Plating	134	135	13	48	64	84	92	92
30	Left	RTA	A1	IMIL	146	190	12	44	63	85	92	94

Conclusion

In conclusion, the functional outcome for intramedullary nailing and locked plating are almost comparable for extra-articular fractures of the distal tibia. The findings of our study show that IMIL nailing is superior to plating in terms of lower infection rates and a statistically significant shorter time to start full weight bearing. While plating is superior to IMIL nailing in terms of producing a greater anatomical and fixed reductions of the fracture. In terms of duration of surgery, union time, and functional outcomes, the two treatment modalities had similar success.

Declaration

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Conflict of interest: None declared.

Ethical Approval: Not required.

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