ORIGINAL ARTICLE

Which is superior in the treatment of AO Type 42A tibial shaft fracture? A comparison of talon intramedullary nailing and conventional locked intramedullary nailing

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ABSTRACT

BACKGROUND: This study aimed to compare the clinical and radiological outcomes of conventional locked intramedullary nailing (IMN) and talon IMN in AO Type 42A tibial fractures.

METHODS: A total of 93 patients with AO Type 42A fracture were retrospectively analyzed. The patients were divided into two groups: Those treated with conventional IMN (Group 1), and those treated with talon distal locked nailing (Group 2). The patients were statistically compared in terms of age, sex, mechanism of injury, follow-up time, time to union, smoking status, presence of open fracture, presence of concomitant fibula fracture, development of malunion and nonunion, and the number of intraoperative fluoroscopy shots captured. All patients were evaluated with American Orthopaedic Foot and Ankle Society and Tegner Lysholm scores for clinical outcomes.

RESULTS: A total of 93 patients (68 men and 35 women) participated in the study. Group 1 consisted of 35 (71.4%) men and 14 (28.6%) women, a total of 49 patients, while Group 2 consisted of 33 (75%) men and 11 (25%) women, a total of 44 patients. There were no significant differences between the two groups in terms of age, sex, mechanism of injury, follow-up times, smoking status, concomitant fibula fracture, presence of malunion, and presence of open fracture ($p>0.05$). However, there were significant differences between both groups in terms of time to union, nonunion rate, and the number of fluoroscopy shots captured ($p<0.05$). American Orthopaedic Foot and Ankle Society and Tegner Lysholm score were analyzed and compared, no statistically differences were found ($p=0.786$ and $p=0.764$).

CONCLUSION: Although talon IMN reduces radiation exposure, locked conventional IMN has lower nonunion rates and achieves union faster.

Keywords: Distal locking; fracture; screw; talon; tibia.

INTRODUCTION

Tibial shaft fractures are the most common long bone fractures.[1,2] These fractures, many of which are caused by high-energy injuries, are frequently treated in daily orthopedic practice. Meanwhile, closed-locked intramedullary nailing (IMN) is a popular and current method of treatment for long bone fractures of the lower extremity. It has been reported in the literature as an appropriate and safe technique for tibial shaft fractures.[3–6] With the advancement of implant technology, alternative implants to existing locked IMN have been developed. It can be thought that distal locking with free-hand technique especially increases radiation exposure, because distal locking with this technique is completely dependent on fluoroscopy.

Therefore, the effects of implant designs such as expandable nails, which can be an alternative, on the healing of tibial shaft

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fractures, have been investigated in addition to locked IMN.[7–9] Furthermore, alternatives to distal locking and the effects of screw numbers or screw angles on rotational stability and union have been investigated.[10,11]

In our study, IMN with two different distal locking mechanisms were compared. While distal locking nails are classic nails with proximal and distal locking mechanisms, taloned IMN are implants that provide stability with distally removable hooks and proximal locking screws. The effects of distal locking and different designs are the subjects of interest now, even up to date. At the same time, it has been previously investigated whether a taloned IMN or a distal locking nail is superior.[12] Our study differs as it only involved one type of fracture. This study aimed to investigate the clinical and radiological results of IMN with two different distal locking mechanisms (distal locking with two screws and talon distal locked nailing) in AO Type 42A tibial shaft fractures.

MATERIALS AND METHODS

The study sample consisted of 93 patients who underwent IMN for AO Type 42A tibia fracture between 2014 and 2020. Informed consent was obtained from all the patients and all their data were retrospectively analyzed. The patients were divided into two groups: Conventional locked tibial IMN (Group 1-Fig. 1), and talon distal locked nailing (Group 2-Fig. 2). There were 49 patients who underwent conventional IMN and 44 patients who underwent talon distal locking nailing. The study included adult patients with AO Type 42A tibial shaft fracture from high-energy trauma-related injuries, while patients with pathological fractures, additional injuries, segmental fractures, and pregnant women were excluded from the study. All patients' age, sex, follow-up time, mechanism of injury, smoking status, presence of concomitant fibula fracture, presence of open fracture, time to achieve union, development of malunion and nonunion, and the number of intraoperative fluoroscopy shots taken were retrospectively analyzed. All patients were evaluated with American Orthopaedic Foot and Ankle Society and Tegner Lysholm scores for clinical outcomes. All patients were followed up with X-rays at first, third, sixth, ninth, and twelfth months after surgery. Radiologically, the presence of callus tissue in three out of four cortices on anterior-posterior and lateral radiographs was considered union. The study was approved by the local ethics committee (decision no: 2021/19).

Surgical Procedure

After pre-operative preparations were done the patients were operated. For all patients, the same surgical procedure was performed for both groups. After the necessary sterilization procedures, patients were placed in the supine position. Then, an incision was made over the patellar tendon, and the patellar tendon was divided into two. However, the fat pad was not resected. After the fracture was reduced with a closed technique and the guidewire was placed, rimerization was performed. The size of the tibial IMN was determined during the rimerization. A subdimension of the rimerized sizes was used as the nail size (if rimerization was done with 11 mm and a 10 mm nail was chosen). For conventional nails, distal locking was performed using the free-hand technique with fluoroscopy. Distal-locking screws were used, and no dynamization was performed during follow-up. For talon IMN, distal locking was performed without using fluoroscopy by a mechanism involving opening through the nail in line with the design of the IMN. Proximal locking was then performed on the system, and then each operation was concluded. Prophy-

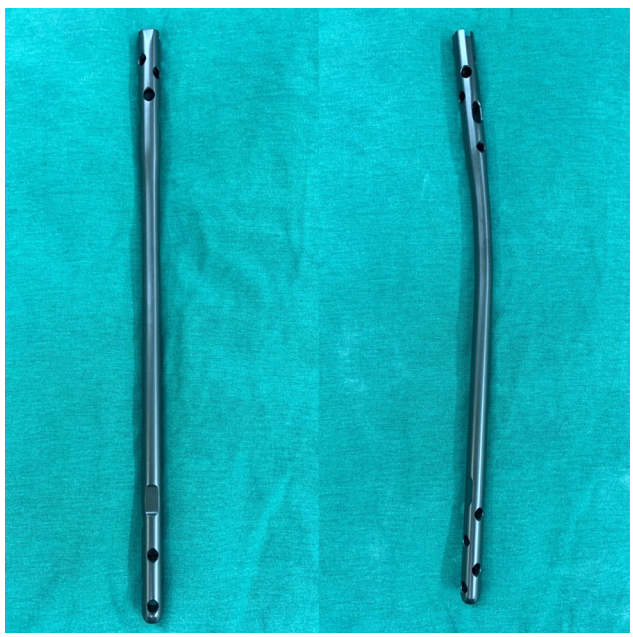

Figure 1. Locked Intramedullary nail.

Figure 2. Talon Intramedullary nail.

lactic low-molecular-weight heparin was administered to all patients. None of the patients used splints. They were mobilized with half weight-bearing on the first post-operative day, full weight-bearing was initiated 4 weeks later.

Statistical Analysis

The descriptive statistics of the variables analyzed in the study were expressed as mean±standard deviation, median (minimum-maximum), and nominal variables as n (%), represented with appropriate charts. Statistical significance of nominal variables between the two techniques was tested using the Chi-square test and continuous variables using the Mann-Whitney U test. In all statistical analyses, the level of significance was set at $p<0.05$. IBM SPSS version 22.0 (IBM Corp, Armonk, NY, USA) software was used for data analysis.

RESULTS

A total of 93 patients (68 men and 35 women) participated in the study. Group 1 consisted of 35 (71.4%) men and 14 (28.6%) women, a total of 49 patients, while Group 2 consisted of 33 (75%) men and 11 (25%) women, a total of 44 patients. The mean follow-up time was 11.2±2.6 months for group 1 and 11.6±5.7 months for Group 2. The mean age was 39 (18–78) years for Group 1 and 34.5 (19–78) years for Group 2. Radiologically, the time taken to achieve union was 4.7±1.6 months for Group 1 and 5.6±2.2 months for Group 2. The distribution of the injuries resulting in the fracture for Group 1 patients is as follows: A fall, 26 (53.1%); road traffic accident, 21 (42.9%); and crush injury, 2 (4.1%). Meanwhile, the distribution of the injuries resulting in the fracture for group two patients is as follows: A fall, 18 (40.9%); road traffic accident, 22 (50%); firearm injuries, 2 (4.5%); and crush injuries, 2 (4.5%). Three (6.1%) of the patients in Group 1 had Type 1 open injury, while of the patients in Group 2, 2 (4.5%) had Type 1 open fractures, and another 2 (4.5%) had Type 3A open fractures. Twenty-seven (55.1%) patients in Group 1 and 25 (56.8%) of the patients in Group 2 were smokers. While 46 (93.9%) of the patients in Group 1 had concomitant fibula fractures, all patients in Group 2 had concomitant fibula fractures. Fibula fractures were not fixed in either group. Two (4.1%) of the patients in Group 1 developed malunion, however, none of the patients in Group 2 developed malunion. One (2%) of the patients in Group 1 had nonunion, while 13 (29.5%) of the patients in Group 2 had nonunion. When the number of intraoperative fluoroscopy shots was analyzed, it was found that the mean number of fluoroscopy shots was 53 (33–170) in Group 1 and 32 (21–66) in Group 2. One patient in Group 2 underwent revision surgery with conventional locked nailing (Figs. 3–6).

There were no significant differences between the two groups in terms of age, sex, mechanism of injury, follow-up times, smoking status, concomitant fibula fracture, presence of malunion, and presence of open fracture (Table 1).

However, there were significant differences between the two groups in terms of time taken to achieve union, non-union rate, and the number of fluoroscopy shots taken.

Figure 3. Pre-operative X-rays of tibial shaft fracture.

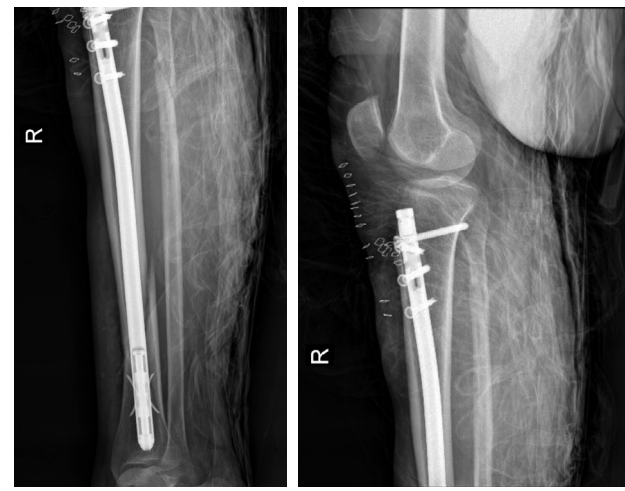

Figure 4. Post-operative X-rays of tibial shaft fracture with talon intramedullary nail.

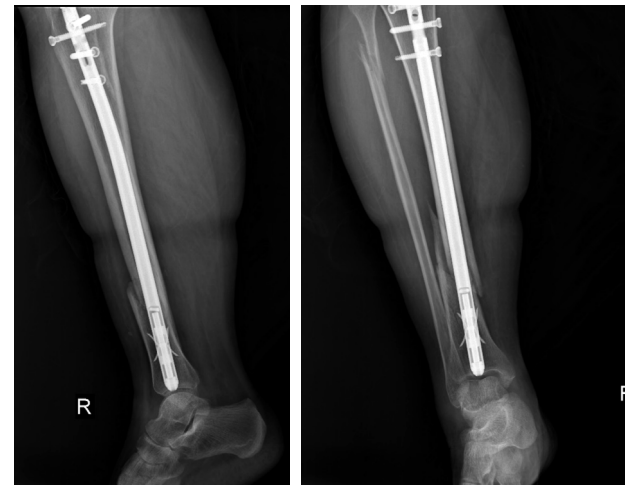

Figure 5. After fixation of tibia shaft fracture with Talon intramedullary nail and displacement of tibial shaft.

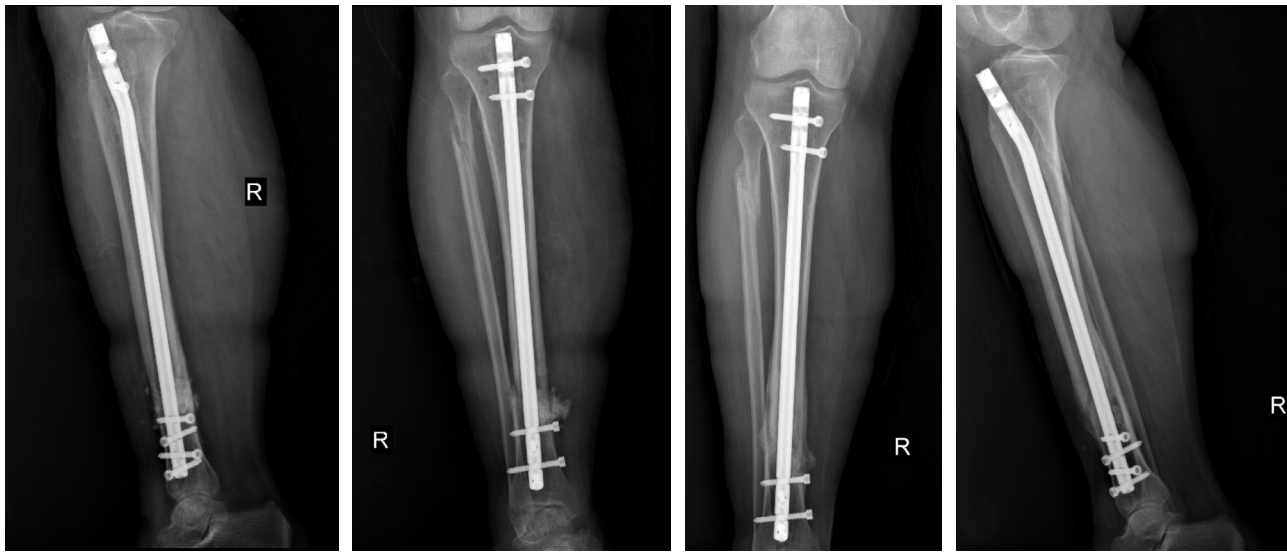

Figure 6. Revision with locked intramedullary nail and post-operative 16 months follow-up.

Union time in the talon IMN group was 5.6±2.2 months and 4.7±1.6 months in the locked IMN group (p=0.0001). In the talon IMN group, there were 13 patients with non-union, while there was only one patient with non-union in

Table 1. Statistical analysis of parameters of patients

	Talon intramedullary nail	Locked intramedullary nail	p-value
Age	37.6±14.2	39.4±14.4	0.551
	34.5 (19–78)	39 (18–78)	
Follow-up (month)	11.6±5.7	11.2±2.6	0.68
	11 (6–30)	11 (7–17)	
Gender			
Male	33 (75)	35 (71.4)	0.816
Female	11 (25)	14 (28.6)	
Injury mechanism			
Falling	18 (40.9)	26 (53.1)	*
Traffic accident	22 (50)	21 (42.9)	
Gunshot	2 (4.5)	0 (0)	
Crush injury	2 (4.5)	2 (4.1)	
Presence of open fracture			
Closed	40 (90.9)	46 (93.9)	*
Type I	2 (4.5)	3 (6.1)	
Type 3A	2 (4.5)	0 (0)	
Cigarette			
Yes	25 (56.8)	27 (55.1)	1.000
No	19 (43.2)	22 (44.9)	
Presence of fibula fracture			
Yes	44 (100)	46 (93.9)	*
No	0 (0)	3 (6.1)	
Malunion			
Yes	0 (0)	2 (4.1)	*
No	44 (100)	47 (95.9)	

*P-value can not be calculated due to small number of patients in some categories.

Table 2. Statistical analysis of union, nounion and flouroscopy views

	Talon Imn	Locked Imn	p-value
Union time (month)	5.6±2.2	4.7±1.6	=0.0001
	5 (3–8)	4 (3–8)	
Nounion, n (%)			
Yes	13 (29.5)	1 (2)	=0.0001
No	31 (70.5)	48 (98)	
Flouroscopy view	32 (21–76)	53 (33–170)	=0.0001

the locked IMN group (p=0.0001). The talon IMN group had mean intraoperative fluoroscopy shots of 32, while the locked IMN group had 53 (p=0.0001) (Table 2).

The mean AOFAS score was 80.4±12.2 in Group 1 and 81.6±11.2 in Group 2, the mean.

Tegner Lysholm score was 78.6±8.7 in Group 1 and 78.3±8.9 in Group 2. American Orthopaedic Foot and Ankle Society and Tegner Lysholm score were analyzed and compared, no statistically differences were found (p=0.786 and p=0.764).

DISCUSSION

In this study, we analyzed the results of two different intramedullary tibial nails in AO Type 42A fractures. Our study investigated the effect of the difference in the distal locking mechanisms of the IMN technique, which is a common treatment method used in trauma clinics.

Many authors prefer rimerization when using IMN. However, there are some risks to rimerization, including an increased risk of infection for open fractures and thermal damage to the bone.[13,14] In this study, there were patients with open fractures in both groups, rimerized IMN was performed on them, and no additional problems were encountered. There was no significant difference between the two groups in terms of the number of open fractures cases.

From this study, it was found that patients in Group 2 had a higher number of nonunion. After surgical treatment of tibial shaft fractures with locked IMN, union was generally achieved within 16 weeks in series.[3,4,15,16] In our series, the results of the treatments performed with conventional nailing were similar to those in the literature, while the rates of nonunion were found to be higher in those treated with talon distal nailing. We attribute this to the more rigid stabilization in patients with the distal locking. Distal stabilization with talon nails can be considered unsuccessful because of the large metaphyseal region and the inadequate stability of the talon locking system.

Surgical treatment of tibial fractures with nailing with different distal locking mechanisms has been investigated in many studies.[17–20] In these studies, the results of distal non-locked or expandable IMN were analyzed. Again, the time to union was 16 weeks in these studies, which is similar to our results. On the other hand, Kneifel and Buckley, in their study, compared the number of distal locking screws and found that, a single screw had higher failure rates and had no effect on time to union.[21] In our study, two distal locking screws were used for all patients in the conventional locked nailing group, and dynamization was not performed.

With the increase of minimally invasive surgical techniques in recent years, it is seen that the use of fluoroscopy has increased. Fluoroscopy exposure increases especially in distal locked IMN using the free-hand technique. In the face of this situation, there has been a search for new techniques to reduce radiation exposure.[22] For this reason, it was observed in our study that there was much less radiation exposure in the surgeries performed with talon nails. This technique increases the preference for orthopedic surgeons. There is a considerable advantage of talon nailing considering fluoroscopy exposure.

Meanwhile, post-operative early weight bearing is one of the advantages of IMN. In our study, patients in both the groups were mobilized with a half load on the first postoperative day. Moreover, it has been shown in the literature that early weight bearing is safe after IMN.[23] However, it is not known how advantageous distal locking mechanisms provide early load bearing in talon nails. There is also no study showing that early load bearing is advantageous in talon nails. This situation may bring to mind the question of whether giving an early load on talon nails is a disadvantage. However, we started to give full load to both groups at the end of the 4th week after considering all these risks.

One of the most important conditions to return to daily activities, to start activities such as sports and walking, jogging, is to ensure the healing of the fracture. Many factors need to be considered in an ideal way to ensure fracture healing. There are many factors that affect healing. Being an open fracture, use of pre-applied external fixators, and presence of deep infection are known to be the basis for non-union.[24] In this study, both groups were homogenized to minimize the effects of factors that affect the healing of fractures. In this way, we tried to reveal the difference between both implant designs by reducing the effect of other variables.

In the present study, all patients were operated using the same technique in both groups. During the first insertion from the proximal tibia, the patellar tendon is divided into two. In the literature, it has been shown that the lateral parapatellar approach is associated with a decrease in the duration of surgery and the number of fluoroscopy shots.[25] In our study, no comparison was made between the two groups in terms of the duration of surgery. On the literature, Çamurcu et al.[12] found that the operation time was three times

shorter than the distal locking screw group. However, it has been shown that the number of fluoroscopy shots is lower in talon nails. Although a comparative analysis of the duration of surgery was not performed for both groups, it can be thought that the decrease in the use of fluoroscopy will shorten the duration of the surgery.

In our study, we aimed to exclude the factors that may affect union related to the fracture type by addressing a single type of fracture. When we look at the literature, an isolated fracture type was not evaluated in studies examining the results of IMN designs. However, it has been shown that IMN designs are the gold standard method in tibia shaft fractures and show various advantages over each other.[26] On the other hand, when we look at the studies on tibia shaft fractures in the literature, it is seen that a, b, and c subtypes are examined together according to the AO classification.[27]

Our study has some limitations. First, the retrospective nature of the study is a limitation. The number of patients may be considered another limitation, but we attempted to group patients with the same characteristics to keep the fracture type the same in both groups and to minimize the effect of other variables on the results. Although this reduced the number of patients, it enabled us to homogenize both groups. Furthermore, size of the nail was not investigated. We know that the size of the nail could effect the union time but in our study the size was not investigated that they had any effects on our results.

Conclusion

The rates of nonunion are higher in distal talon IMN. This problem is less common in intramedullary locked nailing with a more rigid distal locking design. However, talon nailing reduces the amount of radiation exposed intraoperatively, which is one of its advantages over the locked IMN. Radiological union criteria were observed earlier with locked IMN.

Ethics Committee Approval: This study was approved by the Gaziantep University Clinical Research Ethics Committee (Date: 06.01.2021, Decision No: 2021/19).

Peer-review: Internally peer-reviewed.

Authorship Contributions: Concept: S.B.T.; Design: S.B.T.; Supervision: S.B.T.; Data: B.B., A.M.; Analysis: S.B.T., A.M.; Literature search: S.B.T.; Writing: S.B.T.; Critical revision: S.B.T., B.B., A.M.

Conflict of Interest: None declared.

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ORİJİNAL ÇALIŞMA - *ÖZ*

AO Type 42A tibia şaft kırıklarında hangisi daha üstün? Talonlu intrameduller çivi ile kilitli konvansiyonel intramedüller çivinin karşılaştırılması

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AMAÇ: Çalışmadaki amacımız Tibia AO Type 42A kırıklarda konvansiyonel kilitli intramedüller çiviler ile talon kilitlemeli intramedüllerin klinik ve radyolojik sonuçlarını kıyaslamaktır.
GEREÇ VE YÖNTEM: AO Type 42 A kırığı olan 93 hasta geriye dönük olarak incelendi. Hastalar konvasiyonel intramedüller çivi yapılanlar (Grup 1) ve talonlu distal kilitleme yapılanlar (Grup 2) olarak ikiye ayrılmışlardır. Hastalar yaş, cinsiyet, yaralanma mekanizması, takip süresi, kaynama zamanı, sigara içiciliği, açık kırık varlığı, eşlik eden fibula kırığı varlığı, malunion, nounion gelişmesi ve operasyon sırasında çekilen skopi sayıları açısından istatistiki olarak karşılaştırıldı. Hastalar American Orthopaedic Foot and Ankle Society and Tegner Lysholm skorları hesaplanarak klinik skorlar açısından da kıyaslandı.
BULGULAR: Çalışmaya 68 erkek ve 35 kadın olmak üzere 93 hasta alındı. Grup 1 35 (%71.4) erkek, 14 (%28.6) kadın olmak üzere 49 hasta ve grup 2 33 (%75) erkek, 11 (%25) kadın olmak üzere 44 hastadan oluşmaktaydı. Her iki grup arasında yaş, cinsiyet, yaralanma mekanizması takip süreleri, sigara içiciliği, eşlik eden fibula kırığı, malunion varlığı, açık kırık varlığı açısından anlamlı fark saptanmamıştır ($p>.05$). Her iki grup arasında kaynama zamanı, nonunion ve skopi sayıları açısından anlamlı fark olduğu görüldü ($p<.05$). American Orthopaedic Foot and Ankle Society and Tegner Lysholm skoru açısından her iki grup arasında istatistiki olarak anlamlı fark bulunamadı ($p=0.786$ and $p=0.764$).
TARTIŞMA: Talonlu intramedüller çiviler radyasyon maruziyetini azaltmaktadır fakat kilitli konvansiyonel intramedüller çivilerde nonunion oranları daha düşüktür ve kaynama daha erken sağlanmaktadır.
Anahtar sözcükler: Distal kilitleme; kırık; vida; pençe; kaval kemiği.

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