Clinical Research

Comparison of the Clinical Results of Simple Arm Sling, Velpeau Bandage and Eight Bandage Used in the Conservative Treatment of Clavicle Shaft Fractures

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ABSTRACT

Objective: The aim of our study was to compare the clinical results of simple arm sling, velpeau bandage and eight bandage used in the conservative treatment of paediatric clavicle shaft fractures.

Material and Method: Patients who were treated conservatively for isolated clavicle shaft fractures between June 2021 and January 2023 were included in our study. Visual Analogue Scale (VAS) scores measured during outpatient clinic visits, bandage-related complications during the treatment process, Pediatric/Adolescent Shoulder Survey scores of patients in all three groups after treatment, displacement of the fracture before treatment, and shortening of the clavicle at 1st year after treatment were determined.

Results: The study was conducted with a total of 82 patients, 51 boys and 31 girls, aged between 6 and 18 years. The 1st day and 1st week VAS pain score values of the Velpeau bandage method were found to be statistically significantly lower than the simple arm sling and eight bandage methods, and the 1st day and 1st week VAS pain score values of the simple arm sling method were found to be statistically significantly lower than the eight bandage method ($p < 0.05$).

Conclusion: Simple arm sling, velpeau bandage and eight bandage have similar reliability results in the conservative treatment of paediatric clavicle shaft fractures. We think that the use of velpeau bandage in the treatment of these fractures provides better early pain control compared to simple arm sling and eight bandage and reduces bandage-related problems especially in the use of eight bandage.

Keywords: *Adolescents, Bandage, Children, Clavicle, Fracture.*

ÖZ

Çocuk ve Ergenlerde Klavikula Cisim Kırıkları Konservatif Tedavisinde Kullanılan Basit Kol Askısı, Velpeau Bandajı ve Sekiz Bandajının Klinik Sonuçlarının Karşılaştırılması

Amaç: Klavikula kırıklarının çoğu 10-19 yaş aralığında görülür ve bu kırıklar tüm pediatrik kırıkların %10-15'ini oluşturur. Klavikula kırıklarının %70-%95'ini klavikulanın cisim kırıkları oluşturur

Çalışmamızda amacımız; pediatrik klavikula cisim kırıkları konservatif tedavisinde kullanılan basit kol askısı, velpeau bandajı ve sekiz bandajının klinik sonuçlarını karşılaştırmaktır.

Gereç ve Yöntem: Çalışmamıza 2021 Haziran ile 2023 Ocak tarihleri arasında izole klavikula cisim kırığı nedeniyle konservatif tedavi edilen hastalar dahil edildi. Üç farklı konservatif yöntemle takip edilen hastaların kırık sonrası 1. gün ve 1. haftada poliklinik kontrolleri sırasında ölçülen Visual Analog Scale (VAS) ağrı skorları, tedavi sürecinde bandaja bağlı oluşan komplikasyonlar, tedavi sonrası 6. haftada ve 1. yılda her üç gruptaki hastaların Pediatric/Adolescent Shoulder Survey (PASS) skorları, hastaların tedavi öncesi kırıktaki deplasman miktarları, tedavi sonrası 1. yıl klavikulada kısalma miktarları belirlendi.

Bulgular: Çalışma; yaşları 6 ile 18 arasında değişmekte olan, 51'i (%62.2) erkek ve 31'i (%37.8) kız olmak üzere toplam 82 hasta ile yapılmıştır. Velpeau bandaj yönteminin 1.gün ve 1. Hafta VAS ağrı skoru değerleri, basit kol askısı ve sekiz bandaj yönteminden, basit kol askısı yönteminin 1.gün ve 1. Hafta VAS ağrı skoru değerleri ise sekiz bandaj yönteminden istatistiksel olarak anlamlı düzeyde düşük bulunmuştur ($p < 0.05$).

Sonuç: Pediatrik klavikula cisim kırıklarının konservatif tedavisinde basit kol askısı, velpeau bandajı ve sekiz bandajı benzer güvenilirlik ve tatmin edici sonuçlara sahiptir. Bu kırıkların tedavisinde velpeau bandajının kullanımının, basit kol askısı ve sekiz bandajına göre daha iyi erken ağrı kontrolü sağladığını özellikle sekiz bandajı kullanımında görülen bandaja bağlı sorunları azalttığını düşünmekteyiz.

Anahtar Sözcükler: *Bandaj, Çocuk, Ergen, Kırık, Klavikula.*

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Most clavicle fractures occur in the 10-19 age range and these fractures constitute 10-15% of all paediatric fractures (1). Although clavicle fractures are 91.2% common in the male population, the incidence in the general population is 91.7 per 100,000 (1).

Clavicle shaft fractures constitute 70%-95% of all paediatric clavicle fractures, and most of these fractures are displaced (2). These fractures are common caused by direct blunt trauma to the shoulder or upper arm (60%), direct trauma to the clavicle (24%) or falling on

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the extended arm (11%) (3).
It is observed abnormal appearance, tenderness, pain and limited shoulder movements in physical examination of patients. The plain radiographs are usually sufficient to make the diagnosis (4).
Conservative treatment are used for the treatment of most fractures except for situations including open fractures, vascular and nerve injuries, patients with multiple fractures, severe fracture displacement, significant shortening and fractures causing skin irritation (5). Simple arm sling, velpeau and eight bandages are conservative treatment methods used for fracture immobilisation for several weeks (6). The duration of immobilisation may vary depending on the duration of union, the severity of the fracture, the age of the child and the amount of pain (6). The results of conservative treatment are generally satisfactory, but studies comparing the effectiveness of different bandaging methods used in the conservative treatment are limited (7). In our study, our aim was to compare the clinical results of simple arm sling, velpeau bandage and eight bandage used in the conservative treatment of paediatric clavicle shaft fractures.

MATERIAL AND METHOD

Between June 2021 and January 2023, a total of 82 paediatric patients who were treated conservatively for isolated clavicle shaft fracture were retrospectively evaluated. In the power analysis performed on a similar study (8) using the G power programme, the minimum sample size was found to be 64 and 82 patients in our study were found to be a sufficient number. The study was approved by the local University Hospital Non-Interventional Human Research Ethics Committee (2022-13097), and data collection and analysis were performed in compliance with the Declaration of Helsinki. All patients were informed about the surgery procedure and an informed consent was signed.
The effects of the use of simple arm sling, velpeau bandage and eight bandage in the conservative treatment of these patients on the clinical outcomes of the patients were retrospectively investigated. All imaging and medical records were extracted from electronic patient records (Picture Archiving and Communication System-PACS software) in our hospital.
Fractures between the ages of 6 and 18, closed fractures, fractures of the shaft of the middle third of the clavicle according to the Allman classification (9), acute fractures, patients with at least 1 year of follow-up were included in the study. Pathological fractures, distal or proximal clavicle fractures, open fractures, neurovascular injuries, patients with polytrauma, fractures displaced more than 15 millimeters (mm), and comminuted fractures causing skin irritation were excluded from the study.
Visual Analogue Scale (VAS) pain scores measured during outpatient clinic visits on the 1st day and 1st week after fracture were investigated in patients who were followed up with three different conservative methods. The following complications were recorded as bandage-related complications: upper extremity numbness, swelling and wound problems in the shoulder region due to tight bandage, crepitation sensation due to loosening of the bandage or insufficient stabilisation, and early presentation to the outpatient clinic due to loosening or removal of the bandage. Conservative treatment was continued with the bandaging method started in the emergency department. Immobilisation was applied with the elbow in 90 degrees of flexion, shoulder in internal rotation and forearm in neutral rotation by using simple arm sling in group 1 (Figure 1a) and by using velpeau bandage in group 2 (Figure 1b).

Figure 1a. *Simple arm sling.*

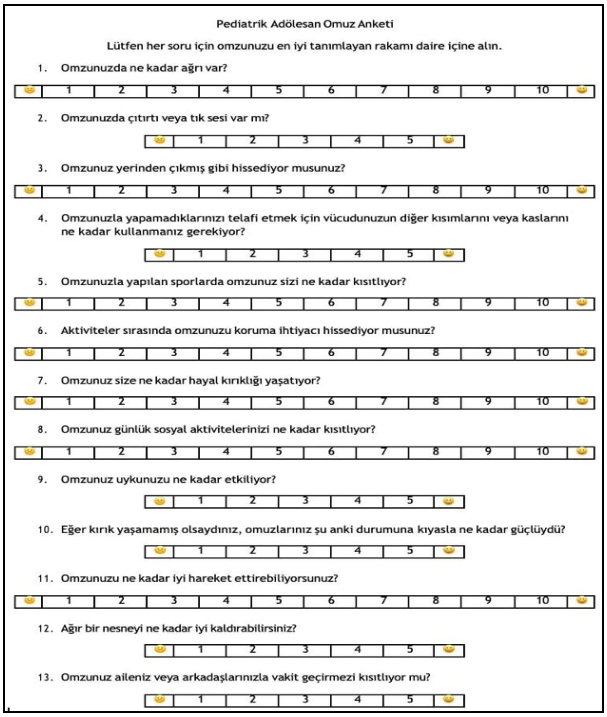
Figure 1b. *Velpeau bandage.*

The shoulder was fixed to the trunk with a separate strap and shoulder abduction was limited in group 2.
In group 1 and 2 patients, elbow exercises were demonstrated and recommended during the outpatient clinic control in the 1st week, with the shoulder remaining immobilised. In Group 3 patients (Figure 1c) in whom eight bandages were used, forceful manoeuvres for reduction were avoided. Patients and caregivers in

this group were informed about how to make corrections in case of loosening or tightening of the bandage.

Figure 1c. *Eight bandage.*

In group 3 patients were allowed elbow exercises but were advised to avoid movements that strain the fractured upper extremity. Patients in all three groups were advised to wear a full-time bandage including sleeping and bathing. In the patients in the three groups, absence of palpation pain at the fracture site, reduction of VAS score to 0 or 1, and the appearance of a bone bridge on plain radiographs were considered as union criteria, then the use of bandages was discontinued and the number of days of union was recorded. The same rehabilitation programmes were applied to all patients followed up with conservative treatment and explained and demonstrated to the patients and their caregivers. The Pediatric/Adolescent Shoulder Survey (PASS) scores of the patients in all three groups were compared at 6 weeks and 1 year after treatment (Figure 2).


Pediatrik Adölesan Omuz Anketi

Lütfen her soru için omzunuzu en iyi tanımlayan rakamı daire içine alın.

1. Omzunuzda ne kadar ağrı var?
2. Omzunuzda çıtırtı veya tık sesi var mı?
3. Omzunuz yerinden çıkmış gibi hissediyor musunuz?
4. Omzunuzla yapamadıklarınızı telafi etmek için vücudunuzun diğer kısımlarını veya kaslarını ne kadar kullanmanız gerekiyor?
5. Omzunuzla yapılan sporlarda omzunuz sizi ne kadar kısıtlıyor?
6. Aktiviteler sırasında omzunuzu koruma ihtiyacı hissediyor musunuz?
7. Omzunuz size ne kadar hayal kırıklığı yaşatıyor?
8. Omzunuz günlük sosyal aktivitelerinizi ne kadar kısıtlıyor?
9. Omzunuz uykunuzu ne kadar etkiliyor?
10. Eğer kırık yaşamamış olsaydınız, omuzlarınız şu anki durumuna kıyasla ne kadar güçlüydü?
11. Omzunuzu ne kadar iyi hareket ettirebiliyorsunuz?
12. Ağır bir nesneyi ne kadar iyi kaldırabilirsiniz?
13. Omzunuz aileniz veya arkadaşlarınızla vakit geçirmezi kısıtlıyor mu?

Figure 2. *Turkish version of PASS.*

The amount of displacement in the fracture was measured in mm before treatment in the three groups (Figure 3a).

Figure 3a. *Measurement of initial fracture displacement.*

In first year after treatment, the amount of shortening of the clavicle was determined according to the contralateral clavicle length in plain radiographs (anteriioposterior) and the results were compared (Figure 3b).

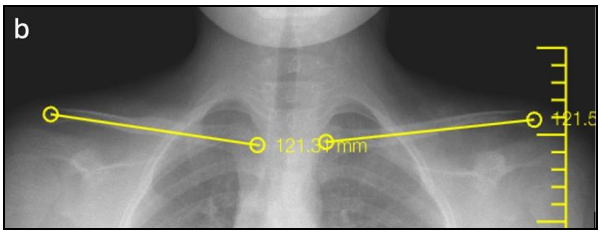


Figure 3b. *Measurement of shortening on the clavicle anteroposterior radiograph at 1 year.*

Since the clavicle lengths changed with age and the patients were in growth periods, the shortening amounts were calculated as percentages to make comparisons more reliable.

Statistical Analysis

IBM SPSS Statistics 22 (IBM SPSS, Turkey) programme was used for statistical analyses while evaluating the findings obtained in the study. The conformity of the parameters to normal distribution was evaluated by Shapiro Wilks test. In addition to descriptive statistical methods (mean, standard deviation, frequency), Kruskal Wallis test was used for intergroup comparisons of parameters that did not show normal distribution and Dunn's test was used to determine the group causing the difference. Wilcoxon Signed Ranks test was used for intra-group comparisons of parameters that did not show normal distribution. Significance was evaluated at $p < 0.05$ level.

RESULTS

A total of 82 clavicle shaft fractures were treated with three different bandages options. 51 (62.2%) of the patients were boys and 31 (37.8%) were girls. The mean age of the patients was 10.06±3.67 years and the median was 9 years. In the study, 25 (30.5%) patients were treated with simple arm sling, 28 (34.1%) with velpeau bandage and 29 (35.4%) with eight bandages. During the conservative treatment, 85.4% of the patients had no bandage-related problems, while 14.6% had bandage-related problems (Table 1).

Table 1. *Distribution of bandage method and bandage-related problems.*

	n	%
Bandage method		
Simple arm sling	25	30,5
Velpeau bandage	28	34,1
Eight bandage	29	35,4
Presence of bandage related problems		
None	70	85,4
Present	12	14,6
Bandage related problems (n =12)		
Unplanned hospital admission due to bandage dislocation	4	33,3
Crepitation feeling	4	33,3
Tightening	4	33,3
Numbness	2	16,7
Wound problem	2	16,7

The bandaging problems related to the 3 different methods used in the conservative treatment of the patients are shown in table 2.

Table 2. *Evaluation of bandage related problems among bandage methods.*

		Bandage method		
		Simple arm sling n (%)	**Velpeau bandage n (%)**	**Eight bandage n (%)**
Presence of bandage related problems	None	22 (%88)	27 (%96,4)	21 (%72,4)
	Present	3 (%12)	1 (%3,6)	8 (%27,6)
Bandage related problems	Unplanned hospital admission due to bandage dislocation	0 (%0)	0 (%0)	4 (%50)
	Crepitation feeling	3 (%100)	0 (%0)	1 (%12,5)
	Tightness, swelling of the upper extremities	0 (%0)	1 (%100)	3 (%37,5)
	Numbness	0 (%0)	1 (%100)	1 (%12,5)
	Wound problem	0 (%0)	0 (%0)	2 (%25)

The 1st day and 1st week VAS pain score values, 6th week and 1st year PASS score values, and the amount of fracture displacement in the clavicle are shown in table 3.

Table 3. *Clinical results of patients treated with all 3 bandage methods.*

	Min-Max	Median
1st day VAS Score	3-9	6
1st week VAS Score	2-7	4
Bone consolidation (day)	21-35	24,5
6th week PASS Score	24-55	28
1st year PASS Score	13-15	13
Initial displacement (mm)	0-15	7,5
1st year shortening amount (%)	(-2)-4	2

There is a statistically significant difference between bandage methods in terms of 1st day and 1st week VAS pain score values ($p < 0.05$). As a result of the pairwise comparisons made to determine the difference, the 1st day and 1st week VAS pain score values of the velpeau bandage method were found to be statistically significantly lower than the simple arm sling and eight bandage methods, and the 1st day and 1st week VAS pain score values of the simple arm sling method were found to be statistically significantly lower than the eight bandage method ($p < 0.05$) (Table 4). There was no statistically significant difference between the bandage methods in terms of union time (the day immobilisation was terminated), 6th week PASS score and 1st year PASS score values ($p > 0.05$) (Table 4).

Table 4. *Evaluation of operating parameters between bandage methods.*

			Bandage method			P value	
			Simple arm sling	Velpeau bandage	Eight bandage		
VAS Score	1st day	Min-Max (median)	5-8 (6)	3-6 (5)	5-9 (7)	**<0,001*,¥**	
	1st week	Min-Max (median)	3-7 (4)	2-4 (3)	3-7 (6)	**<0,001*¥**	
Bone consolidation (days)		Min-Max (median)	21-35 (24)	21-28 (23)	22-35 (25)	0,100¥	
PASS Score	6th week	Min-Max (median)	24-55 (27)	24-44 (28)	24-40 (30)	0,685¥	**<0,001*β**
	1st year	Min-Max (median)	13-15 (13)	13-14 (13)	13-14 (13)	0,562¥	
Initial displacement amount (mm)		Min-Max (median)	0-13 (6)	0-14 (6,5)	0-15 (8)	**0,024*¥**	
1st year shortening amount (%)		Min-Max (median)	0-4 (2)	0-4 (2)	-2-4 (1)	**0,041*¥**	

*¥Kruskal Wallis Test; βWilcoxon Signed Ranks test; *p<0.05: statistically significant*

There is a statistically significant difference between bandage methods in terms of initial shortening and displacement amount values (respectively, p =0.024; p <0.05). As a result of pairwise comparisons to determine the difference, the initial displacement values of the simple arm sling and velpeau method were found to be statistically significantly lower than the eight bandage methods (respectively, p =0.008; p <0.05). There was no significant difference between the other bandage methods in terms of initial shortening amount (p>0.05). There is a statistically significant difference between the bandage methods in terms of 1st year shortening amount values (respectively, p =0.041; p <0.05). The 1st year shortening amount values of the eight bandage method were found to be statistically significantly lower than the simple arm sling and velpeau bandage methods (respectively, p =0.012; p <0.05). There was no statistically significant difference between the other bandage methods in terms of 1st year shortening amount values (p >0.05).

DISCUSSION

A review of the current literature has shown that the best conservative management of paediatric clavicle shaft fractures is controversial. Although there are publications showing that most surgeons working in the United States prefer to use a simple arm sling to conservatively treat their patients (10), it has been concluded that orthopaedic surgeons in Germany prefer eight bandages in 88% of cases in the conservative treatment of clavicle fractures (11). In the literature, simple arm sling and eight bandage have been widely used in the treatment of these fractures, but studies on the use of velpeau bandage, which provides better early pain control, is easier to use and is associated with fewer complications, are limited (12).

In our study, we observed that the results of all 3 methods were satisfactory and reliable. It was observed that simple arm sling and velpeau bandage were more preferred in patients with less fracture displacement at the beginning, earlier pain control was achieved in patients treated with velpeau bandage, bandage-related complication rates were lower in velpeau bandage method, and shortening of the clavicle in the 1st year after treatment did not affect the functional results in patients selected within certain criteria. Although the advantage of the eight bandage, which is more preferred in depressed fractures, was more beneficial in preventing clavicle shortening at 1 year, we observed that all 3 methods had similar results in PASS scores at 6 weeks and 1 year, VAS pain scores were higher in the first weeks in patients treated with the eight bandage compared to other methods, and bandage-related problems were more common. Our study is important in terms of guiding the confusion experienced by emergency physicians and even orthopaedists when choosing bandage methods used in the conservative treatment of clavicle fractures. In addition, it is one of the limited number of studies evaluating the clinical results of patients treated with 3 different bandage types and examining the effectiveness of the length differences in the clavicle on the shoulder functions of the patients.

In the literature, meta-analyses have reported that both surgical and conservative treatment of displaced middle third clavicle fractures have good functional results (13). Although eight bandages and shoulder-arm slings are frequently used among conservative treatments for clavicle fractures, there are few studies comparing the superiority of both methods (8). There are publications suggesting that the application of eight bandages is more difficult than arm sling, patients feel more pain in the first days, and the use of arm sling is recommended because of these disadvantages (8). In our study, when the 1st day and 1st week VAS pain scores of the patients were analysed, it was observed that the best pain control method was the velpeau bandage, followed by the simple arm sling method, and the worst pain control method was the eight bandage. In addition, when the complications related to the bandaging method were analysed, similar results were found with the pain score.

In the conservative treatment of clavicle fractures in the paediatric age group, post-treatment functional scoring and clinical results were similar between shoulder-arm

sling and eight bandages (14). Although VAS pain score, DASH (15) and Constant score (16) were used to measure clinical outcomes in most of the similar studies in the literature, the Turkishised PASS score (Figure 3) and VAS pain score scales, which were developed more specifically for paediatric patients and consisted of relatively easier questions, were used in our study. The PASS score was preferred because it gives more reliable results (17, 18) for investigating the clinical outcomes of shoulder lesions in paediatric patients compared to other upper extremity scoring scales such as Constant and DASH scores.

In the literature, primarily conservative treatment is recommended for children younger than 10 years of age and the success of treatment in these children is reported to be high regardless of the type of immobilisation. In clavicle fractures, it has been reported that fractures displaced less than 20 mm are suitable for conservative treatment and more displaced fractures should be treated surgically (19).

In our study, union was observed in patients who were treated conservatively within the framework of the specified criteria and no complication developed in 85.4% of these patients. Problems related to the bandaging method were observed in 14.6% of the patients who were followed up conservatively, but these problems did not affect the union result. When the VAS pain scores of all patients decreased to 0 or 1, bone bridge was formed on plain radiographs, and pain complaints disappeared, the fracture was considered to have fused and the bandaging method was discontinued. There was no statistically significant difference between the 3 methods used in terms of discontinuation of bandage use ($p>0.05$) and complete union was observed in all patients.

There are publications reporting that surgical indications for shortening resulting from paediatric clavicle fractures should be reviewed and good results were observed despite shortening and initial fracture displacement (20). In our study, it was observed that the shortening seen in the simple arm sling and velpeau bandage was not reflected in the PASS scores at the 6th week and 1st year compared to the patients treated with the eight bandage with relatively less shortening.

In addition to the common opinion in the existing literature, when the long-term results of conservative treatment of clavicle fractures in adolescents were analysed, it was reported that the patient-reported results were excellent and nonunion was very rare, but shortening of the fracture may have a small negative effect on the result (21). In another study, it was reported that the shortening of the clavicle length after treatment did not change the functional results of the patient and did not affect social activities such as participation in sports (22).

In our study, only patients with fracture displacement less than 15 mm at the beginning were included in the study in order to evaluate the effectiveness of bandage methods more accurately. The change in the clavicle lengths of these patients after treatment was not reflected on the functional results when the PASS scoring of the patients in the 1st year was analysed and our results are compatible with the literature.

This study has some limitations. The first one is the retrospective design of the study and the small sample size and no evaluate muscle strength.

Conclusion

Simple arm sling, velpeau bandage and eight bandages have similar reliability and satisfactory results in the conservative treatment of paediatric clavicle shaft fractures. The 1-year treatment results of patients selected according to certain criteria are excellent regardless of the method of bandaging and the amount of shortening of the clavicle. The use of a Velpeau bandage in the treatment of these fractures provides better early pain control than simple arm sling and eight bandages. The use of a Velpeau bandage is associated with fewer bandage-related problems, especially those seen with the use of an eight bandage.

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