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The effect of long- or short-arm casting on the stability of reduction and bone mineral density in conservative treatment of Colles' fractures

Colles kırıklarının konservatif tedavisinde kısa veya uzun kol alçılamanın kemik mineral yoğunluğu ve redüksiyon üzerine etkisi

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Amaç: Colles kırıklarının (CK) konservatif tedavisinde uygulanan kısa veya uzun kol alçılamanın, önkol kemik mineral yoğunluğu (KMY) ve redüksiyon kayıplarına olan etkisi araştırıldı.

Çalışma planı: Tek taraflı izole CK saptanan 83 hasta (48 kadın, 35 erkek; ort. yaş 53; dağılım 30-76) kapalı redüksiyon ile tedavi edildikten sonra, 44'üne uzun kol, 39'una kısa kol alçılama yapıldı. Kırıklar Frykman sınıflamasına göre değerlendirildi. Redüksiyon sonrasında her iki el bilek grafileri çekilerek radial yükseklik ve inklinasyon ve volar tilt ölçüldü. Radyografik değerlendirme Sarmiento ve ark. tarafından önerilen yöntemle yapıldı. Birinci haftada sağlam taraf referans olarak değerlendirilmek üzere, dört ayrı bölge (ultradistal, 1/3 proksimal, orta diyafiz ve tümü) esas alınarak önkol KMY ölçümleri yapıldı. Alçılar ortalama 45.3 gün (dağılım 40-55 gün) sonra açıldı; KMY ölçümü ve radyografik incelemeler tekrarlandı. Sonuçlar Dünya Sağlık Örgütü'nün osteoporoz ölçütleri göz önüne alınarak değerlendirildi.

Sonuçlar: Alçı grupları yaş, cinsiyet, Frykman sınıflaması, etkilenen ve dominant taraf açısından benzer bulundu. Kemik mineral yoğunluğu T skorlarına göre, olguların %20'sinde osteoporoz saptandı. Alçı uygulanan önkolun tamamında KMY'de azalma görüldü; ancak KMY farkı sadece orta diyafiz bölgesinde anlamlı idi ($p<0.05$). Kemik mineral yoğunluğu kaybının alçı tipi ile ilişkisi saptanmadı. Tedavi sonunda açısal ölçümlerde anlamlı kayıp olmasına rağmen, bu kayıplar uygulanan alçı tipi ile ilişkili bulunmadı ($p>0.05$).

Çıkarımlar: Colles kırıklarının tedavisinde uzun veya kısa kol alçılamanın önkol KMY ve redüksiyon kaybına etkisi olmadığı sonucuna varıldı.

Anahtar sözcükler: Kemik yoğunluğu; alçı, cerrahi; Colles kırığı/metabolizma/fizyopatoloji/tedavi; önkol yaralanması/etyoloji; kırık fiksasyonu/yöntem; radius kırığı/komplikasyon.

Objectives: We evaluated the effect of long- or short-arm casting on the stability of reduction and bone mineral density (BMD) in the forearm in patients treated conservatively for Colles' fractures (CF).

Methods: Eighty-three patients (48 females, 35 males; mean age 53 years; range 30 to 76 years) with an isolated unilateral CF underwent closed reduction followed by a randomly assigned long-arm (n=44) or short-arm (n=39) casting. Fractures were classified according to the Frykman's system. After reduction, radiographs of both forearms were taken, on which radial height and inclination, and volar tilt were measured and assessed according to the criteria by Sarmiento et al. In the first week, BMD measurements were made on the unaffected side to obtain reference values from four sites of the forearm, namely ultradistal, 1/3 proximal, middle diaphysis, and total. Following removal of the casts (mean 45.3 days; range 40 to 55 days), radiographic and BMD assessments were repeated. Osteoporosis was defined according to the criteria of the World Health Organization.

Results: The two casting groups were similar with respect to age, sex, Frykman's classification, involved side, and the dominant extremity. Osteoporosis was detected in 20% according to the T scores. All the sites in the fractured forearm showed density losses, but the difference was significant only in the middle diaphysis ($p<0.05$). No significant relationship was found between BMD losses and the cast type. Angular measurements showed significant deterioration after union; however, none was found to be related to the cast type ($p>0.05$).

Conclusion: Our results show that BMD losses and deterioration in reduction following treatment of CF occur irrespective of which type of casting is used.

Key words: Bone density; casts, surgical; Colles' fracture/metabolism/physiopathology/therapy; forearm injuries/etiology; fracture fixation/methods; radius fractures/complications.

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The Colles' fracture (CF) extends 3-4 cm to the proximal due to the distal joint of the radius, including the metaphyseal region. It composes 8-15% of all fractures, 17% of upper extremity fractures, and 1/6 of the fractures treated at emergency services.[1,2] Closed reduction and casting is the most preferred method in the treatment for CF.[1,3] However, it is controversial how and in what way the casting should be performed in the treatment of such fractures.[1,2,4] Long-arm casting restricts the patients' functions of the upper extremities; consequently various problems may appear at the joint of the elbow with no present pathology.[5]

In this prospective and randomized study, we evaluated the effect of the long- or short-casting on the bone mineral density (BMD) of the forearm and loss of reduction in CF.

Patients and method

Of 1164 patients who presented with radius distal tip fractures to our emergency service between January 2001 and January 2002, 442 had CF. Among them, 83 patients (48 female, 35 male; mean age 53; range 30 to 76 years) with a closed epiphyseal line and unilateral fracture caused by low-energy trauma, and who were successfully followed up were included in the study. Exclusion criteria were as follows; multifractures, neurovascular injury and history of medication that may influence the BMD.

Table 1. Evaluation criteria for anatomic results by Sarmiento et al.[4]

Result	Criteria
Excellent	No deformity or undetermined
	Dorsal angulation<0°
	Shortening <3 mm
	Radial inclination loss <4°
Good	Hafif deformite
	Dorsal açılanma 1°-10°
	Kısalma 3-6 mm
	Radial inklinasyon kaybı 5-10°
Moderate	Moderate deformity
	Dorsal angulation 11-140°
	Shortening 7-12 mm
	Radial inclination loss 10-14°
Poor	Dorsal angulation>15°
	Shortening >12 mm
	Radial inclination loss >15°

The patients underwent closed reduction and casting at the emergency service. The patients, whose last digit of registration number was even, were immobilized by long-arm, and the ones ending with an odd digit by short-arm casting. The cast was done at 15-20 degrees of ulnar deviation and 15-20 degrees of flexion of the wrist.

Fractures were evaluated in accordance with the Frykman's classification because of its wider use and easier comprehensibility.[1] Radiographs of both wrists were taken following the reduction and casting. Radiographic parameters measured included radial height, radial inclination and volar tilt. Evaluations were done at days 1, 3, 7, 21 and 45. All casts were removed at the end of the week six. Radiographs of the wrists were obtained for control purposes, and assessed according to the method suggested by Sarmiento et al.[4] (Table 1).

After the reduction, BMD was measured in the affected and unaffected forearms within three days following the removal of the cast. Values of the unaffected side were used as reference. The measurements were done by the same instrument (Hologic QDR-2000) based on four regions of the forearm (ultradistal, 1/3 proximal, middle diaphysis and total).[6] The differences were obtained by subtracting the mean value measured from the involved forearms following the union from the mean value measured from each site in order to determine the relation of the bone mineral density and angular changes with the type of casting.

The results were evaluated in accordance with the osteoporosis criteria of the World Health Organization (Table 2).[7] T-test was used for comparing the mean values between the groups. Statistical analyses were done with the SPSS 11.0 software program.

Table 2. Criteria of the World Health Organization for osteoporosis evaluation [9]

	Standart sapma	Kemik kaybı
Normal	> (-1)	–
Osteopenia	(-1) - (-2.5)	%10-25
Osteoporosis	< (-2.5)	%25
Permanent osteoporosis	< (-2.5)	%25 and one or multi fractures associated with osteoporosis

Table 3. Mean values for bone mineral density measured from unaffected and fractured forearms (mean ± standard deviation)

Bone mineral density	Unaffected arm	Fractured arm
Total value	0.51±0.09	0.49±0.10
Total T-score	-1.83±1.35	-2.26±1.94
Total Z-score	-0.89±1.16	-1.39±1.94

Results

Fractures involved the right arm in 48 cases, and the left arm in 35 cases; the dominant arm was the right in 74 cases, and the left in nine cases. Fractures occurred in the dominant arm of 42 cases with dominant right arm, and in the non-dominant arm of 32 cases. In cases with dominant left arm, three fractures involved the dominant arm and six were in the non-dominant arm. A risk analysis showed that the risk for dominant arm was not higher than the other arm (odds ratio=0.655; p=0.727). Based on the Frykman's classification, the most common fracture was type I (28.9%), followed by type III (18.1%) and type IV (15.7%) fractures, respectively. Long-arm casting was used in 44, and short-arm casting in 39 of the fractures. The mean immobilization period was 45.3 days (range 40 to 55 days). Although the BMD values measured from the fractured forearm were lower than the values measured from the unaffected forearm after the union, only the values measured from the middle diaphyseal region of the forearm had significant difference ($p<0.05$) (Table 3). No significant relation was found between BMD values and type of casting (Table 4). Success of the reduction was assessed by comparison with the radiographic values of the unaffected wrist. The only value not approximating the normal values following the reduction was the value for volar tilt. Although there was significant loss in all values measured after the reduction compared to the unaffected arm, losses were not related with the type of casting used ($p>0.05$) (Tables 5, 6).

Discussion

Colles' fracture is the most common type of fractures associated with osteoporosis.[8] And, closed

Table 4. Mean differences between the measurements of the bone mineral density by the type of casting in the unaffected and fractured forearms

Bone mineral density	Type of casting	Mean difference	*p*
At the ultradistal area	Long arm	0.00670	0.22
	Short arm	0.03770	
At the middle diaphysis area	Long arm	0.01520	0.38
	Short arm	0.03526	
At the 1/3 proximal area	Long arm	0.00097	0.67
	Short arm	0.01261	
Total	Long arm	0.00930	0.21
	Short arm	0.03677	

reduction and casting is the most preferred treatment method.[1,2] Radial height, radial inclination and volar tilt angular degrees are the parameters used in the evaluation of the treatment results.[9-11] It was shown that angular measurements didn't change in the unaffected right and left wrists.[12] In our study, we used the values obtained from unaffected arms of the cases as reference.

There was loss in all angular values throughout the treatment in patients who underwent conservative treatment by casting, and the maximum loss was observed at the end of the first week.[11,13] During the casting, there is edema associated with trauma in the forearm and wrist; this edema regresses in time, causing the cast to get a little loose and fail to fulfill its function for stabilization.[14] This opinion was supported by the occurrence of position losses during the first week in a study by Earnshaw et al.[11] In a study by Cohen and Frillman[14] comparing the conventional casting treatment with a shapable material coated with polymer, it has been demonstrated that loosening in immobilization with this material can be eliminated reshaping it by heat so that reduction losses can be minimized.

Some authors reported that radial height cannot be normalized in treatment by casting, and the angulation of the volar tilt toward the dorsal and loss in the radial height are associated with the disintegration in the metaphysis.[14] In our study, it was

Table 5. Mean value of the angular measurements obtained from the patients (degree)

	Unaffected forearm	After reduction	After union
Inclination angle of the radius	19.27±4.68	20.34±3.32	17.57±4.60
Radial height of the radius	11.09±3.33	11.69±2.01	9.82±3.21
Volar tilt of the radius	8.58±4.70	4.17±6.08	2.83±7.86

Table 6. Variations between the type of casting and angular values

	Type of casting	Mean difference	*p*
Difference at radial height	Long arm	-3.2	0.55
	Short arm	-2.7	
Difference at radial inclination	Long arm	-5.2	0.95
	Short arm	-5.1	
Difference at volar tilt	Long arm	-4.1	0.96
	Short arm	-4.0	

observed that the volar tilt value couldn't be restored by casting while radial height reached to its normal value. Lesser amount of disintegration in the metaphysis in our patients (type VII and VIII fractures composed only 15% of the cases) explains obtaining a more successful outcome in the restoration.

We had loss of reduction during the treatment by casting, which was parallel to the results obtained by Altissimi et al.[13] However, when the radiographic evaluation criteria by Sarmiento et al[4] have been taken into consideration, we achieved "excellent" results in the radial height, radial inclination and volar tilt in our patients. Superiority of long- or short-arm casting over each other for the maintenance of the reduction in cases with Colles' fracture couldn't be demonstrated.[15] Similarly, we couldn't show the effect of the type of casting on reduction loss and radiographic results statistically.

The World Health Organization redefined the osteoporosis in the World Congress on Osteoporosis (1996) using DEXA (dual enery X-ray absorptiometry). Necessity to perform BMD measurement in cases with radius distal tip fracture had been accepted in that meeting.[7,16,17] Nilsson and Westlin,[17] found no difference in the BMD measurements obtained from both forearms in healthy subjects. 20% of our cases had osteoporosis in the measurements obtained from the unaffected forearms after the occurrence of the fracture. Eren et al.[18] found osteoporosis in 25 of 26 female patients presented with radius distal tip fracture. Wigderowitz et al.[19] compared the BMD measurements obtained from female patients with CF with the BMD measurements obtained from healthy women; a significant difference was found in the BMD measurements of the forearm in all cases compared to the young adults, and 31% of cases had osteoporosis.

Studies investigating the variations in the bone mass and bone balance following the radius distal tip fractures revealed BMD loss associated with immobilization of the forearm and hand.[6,20,21] Although we have observed decrease in the BMD of the whole forearm, comparable to the literature, the decrease was not significant in the regions other than the middle diaphysis of the forearm. Ingle et al.[6] indicated that following the CK, BMD loss occurred in the metacarpus and phalanx at the distal of the fracture; and no loss occurred in the middle diaphyseal and 1/3 proximal regions of the forearm. In another study, they reported that the BMD loss was at the distal of the fracture.[21] Harma et al.[22] showed that BMD loss was in the trabecular region, but no significant change was observed in the cortical region in 23 postmenopausal cases with CF. However, Schneider et al.[23] proposed that the loss was in the trabecular region rather than the cortical region. Although related studies showed that the loss was at the distal of the fracture and trabecular bone, and no BMD variation was seen in the cortical bone, we have found significant loss in the middle diaphyseal region. Even tough the best assessment method in distinguishing the cortical-trabecular regions is the peripherical quantitative computed tomography, all other studies except Harma et al.[22] and we used the DEXA method for assessments.[18,19,23] Therefore, it is not possible to reliably define the BMD variation in the cortical region or proximal of the fracture. As it is believed that there is a 20% increase in the substance resulting from the fracture in the region including 15-25 cm proximal of the joint surface defined as ultradistal region in the measurement of the bone mineral density, Ingle and Eastell[21] didn't include and evaluate that region in their study. We included the ultradistal region in our evaluations, and found BMD loss in that region, which was not statistically significant. Similarly, Harma et al.[22] observed loss in the ultradistal region, and suggested that loss increases in this region as it is rich in trabecular bone.

Knirk and Jupiter[24] indicated that the fracture was at the dominant arm in 58 of the cases with CF while Cooney et al.[25] reported this rate as 83%. We have found a 54.2% rate of fracture at the dominant arm, similar to the study by Kelly et al.[10] A risk analysis showed that risk for fracture is not higher in any of the arms. It suggests that the people do not use the dominant arm as support while falling, and the arm used as support has a relation with the side the body weighs down.

There are several studies reporting presence of loss in the BMD of the forearm following the treatment by casting in Colles' fractures.[6,8,20,21] However, effect of the type of casting on the BMD of the forearm has not been studied yet. Abbaszadegan et al.[26] compared external fixator and short-arm casting in the treatment for CF, and didn't find any difference between the two methods about their effect on the BMD of the forearm. We have studied the effect of the type of casting on the BMD of the forearm. Although there was a decrease in the BMD of the forearm by short- or long-arm casting, no significant difference was found in terms of the effect on the BMD values of the forearm between the two types of casting.

In conclusion, closed reduction and short-arm casting is sufficient in the treatment for CF. Long-arm casting has no superiority in the maintenance of the reduction and variations of the BMD values of the forearm compared to the short-arm casting. Short-arm casting can avoid problems at the joint of the elbow that may occur in the patient, and it allows the patient to go easy with his/her daily life throughout the treatment.

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