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ORIGINAL STUDY

Extension casting for both-bone forearm fractures in children

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Paediatric forearm fractures are commonly treated with closed reduction and cast immobilization. Determining the best way to cast these fractures during the initial presentation may prevent the need for re-manipulation .

An analysis of casting technique for all patients under eighteen years of age treated with closed reduction and cast immobilization for both-bone fractures of the forearm at a regional tertiary referral hospital over 7 years was undertaken.

One-hundred and eighty-nine consecutive patients with 207 fractures were reviewed. No significant association was found between casting technique and failure rates (p=0.124). However, if manipulation and plaster was performed by a trainee, failure rates were significantly reduced when extension casting was utilized (p=0.029).

Closed reduction and cast immobilization with the elbow in an extended position is an effective treatment option for both-bone forearm fractures in a paediatric population and is a safer option when performed by more junior staff-members.

Keywords : forearm fractures in children ; extension casting.

INTRODUCTION

Forearm fractures are common in the paediatric population accounting for 40% of all paediatric fractures (*6*). The majority of cases can be successfully managed with closed reduction and cast immobilization (*2,5,9*). Both-bone fractures of the forearm are particularly difficult to manage due to inherent instability. Loss of reduction remains a common complication with re-manipulation rates of up to 17% reported (*1*). A significant psychological, physiological and financial burden is associated with loss of reduction to the patient, their family and the health system.

Traditionally paediatric forearm fractures have been immobilized in an above elbow plaster cast with the elbow flexed to 90 degrees. In 2005 Bochang et al (*1*) reported that immobilization of forearm fractures with the elbow in extension is a viable alternative to traditional flexion casting.

There are no conflicts of interest to declare. No funding was received for this study. The protocol for the research project has been approved by an Ethics Committee.

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The extension casting technique has been adopted by a number of surgeons at our institution since Bochang's paper. Direct comparisons of casting techniques are limited within the literature. An attempt to establish the efficacy of different casting techniques, especially in regards to loss of reduction, would help reduce the burden associated with the need for re-manipulation.

MATERIALS AND METHODS

A retrospective review of prospectively collected data of all paediatric patients presenting with a fracture at a regional tertiary referral hospital between 1st of January 2005 and 31st of December 2011 was undertaken.

Only those patients suffering a both-bone forearm fracture requiring admission were included. Patients were excluded if found to have an open-injury or were not managed in an above elbow cast.

There were three casting techniques used in this period; traditional flexion casting (elbow flex to 90 degrees), extension casting (elbow flexed to 10 degrees) and a ¾ dorsoradial plaster slab with the elbow in a mid-flexed position. The type of cast used (flexion/extension/slab) was determined by supervising surgeon preference and was not patient or fracture specific.

Follow-up was specific to the patient and injury. In most cases this involved formal anteroposterior and lateral radiographs following reduction, then weekly review and radiographic examination for 2 to 3 weeks before a final review with radiographs at the 5 to 6 week mark when the cast was removed.

Data was collected prospectively over this time period in a digital database (Filemaker Pro – Microsoft corp. Seattle WA). Data collected included; sex, age, side of fracture, site of fracture and experience of primary operator (consultant/registrar). Data regarding type of cast was obtained via the use of operative reports and confirmed with outpatient notes and radiographs.

Primary outcome measure was loss of reduction requiring re-manipulation or conversion to internal fixation. Decision to remanipulate and subsequent treatment was complex and multi-factorial. This was at the discretion of the supervising surgeon and was determined by patient age, parent preference, degree of reduction loss and direction of loss of reduction. Secondary outcome measures included associations between loss of reduction, age, sex, type of fracture and seniority of person manipulating the fracture.

Statistical analysis was carried out using Sigma Stat (SPSS Inc, Chicago, Il) for statistical testing. Categorical data was analysed using the Chi-Square test. Mixed data sets were analysed using the One-way ANOVA or t-test for parametric data and the Mann-Whitney non-parametric rank sum test for non-parametric variables. A p-value of 0.05 was deemed to signify significance for all statistical tests.

RESULTS

One-hundred and eighty-nine consecutive patients with 207 fractures were reviewed. Ninety-four fractures were treated in flexion casting, 79 were treated in extension casting and 34 in a mid-flexion dorsoradial slab (Table I).

Table I. — Details of treatment groups

	Flexion Casting (n=94)	Extension Casting (n=79)	Mid-Flexion Casting (n=34)	P-value
Age (mean)	8.74 (3.4)	7.45 (3.4)	9.41 (3.0)	0.006
Gender (M:F)	69:25	41:38	26:8	0.004
Site	Proximal: 3 Middle: 32 Distal: 59	Proximal: 3 Middle: 30 Distal: 46	Proximal: 1 Middle: 12 Distal: 21	0.978
Side (R:L)	41:53	41:38	15:19	0.483

A total of 17 (9%) patients returned to the operating theatre for management of loss of reduction. Twelve (71%) required remanipulation and plaster immobilisation and five (29%) required internal fixation. Failure rates were 9 of 94 (9.57%) in the flexion casting group, 3 of 79 (4%) in the extension casting group and 5 of 34 (15%) in the mid-flexion group (P= 0.063).

No significant association was found between loss of reduction and sex (p=0.348), age (p=0.09) or seniority of manipulator (p=0.402).

Of the 207 fractures, 126 were distal third (61%), 76 (37%) were middle third and 5 (2%) were proximal third fractures. Distal fractures where slightly more likely to fail, with 12 failure (70% of failures), compared to midshaft with 5 (29%) and proximal fractures (0%). However this was not significant (p=0.605).

Although not significant (p=0.065), the relative risk of a distal radius fracture losing position when treated in a flexion cast was 6.33 when compared to an extension cast, with 13% (11 of 80) of these fractures losing position when treated in a flexion cast, compared to only 2% (1 of 46) of those treated in an extension cast. This was not apparent for middle-third fractures (p=0.963).

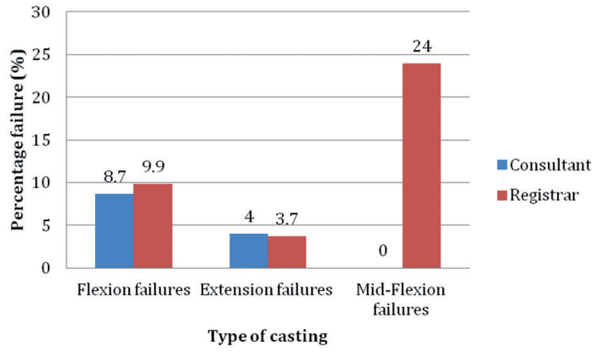

Fig. 1. — Type of casting and failure rates; comparing trainees to consultants

In the hands of a trainee (registrar), extension casting was significantly less likely to result in loss of reduction when compared to flexion casting (p=0.029). No distal third fracture treated by a trainee lost position when treated using extension casting (0 of 30). Mid-flexion casting had a very high chance of failure (24%) when performed by a trainee. This was not the case when the fracture was manipulated by a senior staff-member (consultant) (p=0.492) (Table II) (Figure 1).

DISCUSSION

Although not significant, in this series of 207 fractures, a lower failure rate was noted with extension casting. Patients were 2.5 and 3.8 times more likely to lose position of fracture reduction and require further intervention when flexion or mid-flexion casting techniques were used respectively. This is the largest case series to compare extension casting to other methods.

Extension casting for forearm fractures have been described previously (*1,3,7,8*). Most recently Bochang et al. (*1*) reported a remanipulation rate of 0 of 60 fractures treated with an extension cast, compared to 9 of 51 (17.6%) fractures managed with traditional flexion casting. Although following similar trends, our results were not so striking.

A possible reason for the reduced failure rate could be the effect of extension casting on deforming supinating forces acting on the proximal fracture fragments (*4,7*). A fulcrum effect also exists with flexion casting, whereby a fracture initially stable in a flexed elbow position, subsequently becomes unstable and looses position as soft tissue swelling subsides. This is caused by the flexion cast acting with gravity to produce a fulcrum at the fracture site (*7,8*). However our data suggests that compared to flexion casting, extension casting is more effective for distal fractures. A similar

Table II. — Operator versus loss of reduction

Operator	Flexion failures (Total)	Extension failures (Total)	Mid-Flexion failures (Total)	P-value
Consultant	2 (23)	1 (25)	0 (13)	0.492
Registrar	7 (71)	2 (54)	5 (21)	0.029

biomechanical argument can be made regarding the brachioradialis muscle and its deforming force on the distal radius. Extension casting may be able to negate these effects.

Loss of reduction was significantly reduced when extension casting was used by trainees and junior staff members. This finding may be explained by the ease of application of this casting technique. The cast is completed with the arm in one position and the potential for loss of reduction when completing the flexed above elbow cast is avoided. This may provide some benefit where reduction and casting is performed by a sole-operator, often a trainee, in an after-hours procedure. Strikingly, no distal third fracture lost position using extension casting when applied by a trainee. Mid-flexion casting had very poor results when applied by a trainee with a very high failure rate of 24%. This may be the lack of exposure to this type of casting by trainees, as it is not commonly performed or taught.

One of the recognized complications of traditional flexion casting is pressure ulcers occurring in the cubital fossa. In our series we recorded two such events in the flexion group and none in the extension group, a further benefit to the extension casting technique.

There have been several criticisms of extension casting published in the literature. Including; elbow stiffness, cast slipping and awkwardness (*1,3,7,8*). No patient required physiotherapy or further intervention during the study period. Walker et al. (*8*) attempted to address this concern in their case series. Objectively they found return to full range of motion at two weeks in all patients. These results have been replicated in other studies (*1,3,7,8*). Cast slipping can be prevented with attention to a firm supracondylar mould and placing the elbow in slight flexion. Bochang et al. (*1*) found that simple tasks including eating, dressing and writing were similarly restricted regardless of the position of the elbow.

This study had several limitations. The retrospective nature of the review and the lack of randomization results in inherent bias. Cast failure and need for remanipulation was multi-factorial and was not standardized amongst the cohort. Severity of fracture was also not matched amongst the groups, and this may also represent a bias. Also this study spans five years of data, it is still not powered enough to assess the role of extension casting on proximal third fractures.

In conclusion, closed reduction and cast immobilization with the elbow in an extended position is an effective treatment option for both-bone forearm fractures in a paediatric population, and may result in less complications when reduction is being carried out by trainee surgeons.

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