Treatment of Impacted Greenstick Forearm Fractures in Children Using Bandage or Cast Therapy: A Prospective Randomized Trial

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Background: To evaluate the relative risks and advantages of using soft bandage therapy (BT) for impacted greenstick fractures of the distal forearm compared with cast therapy (CT).

Methods: At a single center from September 2005 to October 2006 all patients with an impacted greenstick fracture were randomized to BT or CT.

Results: A total of 92 patients were randomized and assigned. No fracture displacement was seen. Three patients from the BT group were converted to standard treatment. A significant difference in pain was seen between both groups after 1 week in favor of the CT group. Discomfort was significantly less in the BT group compared with the CT group. After 4 weeks, the wrist function was significantly better in the BT group. After 6 weeks, the wrist functions of both the groups were comparable.

Conclusions: BT for impacted greenstick fractures of the distal forearm is a safe technique, patients treated with bandage suffer greater pain at the start of the treatment, are able to return to normal activities sooner, and have less discomfort when compared with the standard CT.

Key Words: Impacted greenstick fracture, Buckle fracture, Bandage, Forearm.

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Up to 20% of fractures in children are distal forearm fractures. Bones in children are more elastic compared with adults; therefore, a forearm fracture in a child is often of an impacted greenstick type. Such a fracture is characterized by an impacted cortex (no disruption) on both sides of the bone. The standard treatment of impacted greenstick fractures of the distal forearm in children till the age of 13 years is cast therapy (CT) for 2 to 4 weeks. No studies have been published examining the impact of CT on a patient’s quality of life. Because an impacted greenstick fracture has certain intrinsic stability, one could hypothesize that CT is a form of over treatment introducing limited mobility and unnecessary morbidity. The main disadvantages of CT are discomfort, (too heavy, must remain dry, pain developed by pressure of the cast) function loss and the possibility of development of dystrophy.

The aim of this prospective randomized study was to evaluate the relative risks and advantages of using soft bandage therapy (BT) for impacted greenstick fractures compared with CT. The primary end point was secondary displacement of the fracture. The secondary end points were complications, discomfort, pain, and range of motion of the wrist and elbow. Our hypothesis was that BT of impacted greenstick fractures of the distal forearm would obtain the same results compared with CT.

PATIENTS AND METHODS

Study Design

The study, which was approved by the ethics committee of our institution, was a prospective, single-center, randomized clinical trial. From September 2005 to October 2006, all parents of patients with a diagnosis of an impacted greenstick fracture of the distal radius or ulna were asked to participate in the study.

Inclusion criteria were:

1. Impacted greenstick fracture, which comprises 1/3 of the distal radius or ulna.
2. Patients with an age of between 4 and 13 years.
3. Signed informed consent.

Exclusion criteria were:

1. Complicated fractures.
2. The necessity to reposition the fracture.

The enrolled patients were thereafter prospectively randomized between soft bandage and CT using a randomization plan from www.randomization.com and were treated according to the intention to treatment principle. The randomization scheme was obtained by using sealed envelopes containing the indication to BT or CT that were put into a container in 15 blocks (3 BT, 3 CT). The envelopes were extracted by the physician in the Emergency Department. The emergency physician who referred the patients to the study made the initial diagnosis of the impacted greenstick fracture. Patients with a typical greenstick were not included. All radiographs were reviewed by a trauma surgeon and radiologist within 24 hours. Patients in the bandage group were given verbal and written instructions of handling the bandage and removing the bandage for comfort only, or removing for desired activities, and discontinue completely when desired. Patients in the cast group were given the usual verbal and written cast-care instructions (e.g., avoid getting the cast wet). All of the patients were instructed to avoid contact sports till 4 weeks after treatment. Children and their parents were given...
a log book to complete at home for 3 weeks postinjury including the visual analog scale (VAS), and they were asked to fill in all possible discomforts during treatment. The children could indicate the treatment was too tight, too loose, too heavy, or that they experienced itching or neck pain. The intake of painkillers was reported. Patients not meeting the inclusion and exclusion criteria were treated by the standard protocol, consisting of CT for 3 weeks. The reason for not participating in the study was noted.

**Cast Therapy**

Patients randomized to be treated in a plaster cast (CT) were initially placed into a below-elbow back-slab cast. After 1 week, the cast was made circular and continued for another 3 weeks.

**Soft Bandage Therapy**

In the first week, the treatment (BT) consisted of a layer of wool, which was covered with a layer of commercial cotton crepe bandage supported by a sling. After 1 week, a tubi-grip was placed for the period of 3 weeks.

**Follow-Up**

After randomization at the Emergency Department, the patients were seen after 1, 4, and 6 weeks. At 1 and 4 weeks a lateral and anteroposterior radiograph was made to control if no secondary angulation developed.

**Definitions**

A *typical greenstick fracture* is defined as a fracture in which the cortex is completely disrupted on the convex aspect and incompletely fractured on the concave aspect.  

An *impacted greenstick fracture*, *torus fracture*, or *buckle fracture* is defined as a specific type of greenstick fractures in which the cortex has become impacted.  

Secondary angulation was defined as a deviation of the fracture of more than 5 degrees when compared with prior initiating treatment. The VASs were used for the evaluation of pain severity and relief. One could indicate at a scale from 0 till 100 the grade of pain experienced. 0 = no pain at all, 100 = maximum predictable pain.

**Statistical Analysis**

All statistical analyses were performed using SPSS version-11.0 software (Chicago, IL). Parametric data are presented as mean ± SD and nonparametric as median and range. A two-tailed *p* < 0.05 was considered statistically significant.

The sample size for each of the two randomized cohorts was calculated at a total population of 90 patients. The power of the study was 80% with a significance level of *p* = 0.05 by log-rank test. To enroll 90 patients, we estimated, on the basis of previous years, a period of around 10 months would have been necessary to project this study.

**RESULTS**

**Patients**

A total of 130 patients with the diagnosis of an impacted greenstick fracture between September 2005 and October 2006 were considered for inclusion. Thirty-eight patients (29%) were not included because the patient or the parents declined to participate in the study. Ninety-two patients were initially randomized and assigned to the two groups: 46 patients to group BT and 46 patients to group CT. Two patients were afterward excluded because they did not have an impacted greenstick fracture, one patient had a contusion of the distal forearm, and another patient had a Salter Harris 2 epiphysiolysis of the distal radius. Figure 1 shows a flowchart that describes the randomization process.

Demographic and clinical data are reported in Table 1. Between the two randomization groups no statistical significant difference was found in the demographic data.

**Follow-Up**

Two patients were lost to follow-up. One patient treated with BT did not return to the outpatient clinic. Another patient treated with CT did not want to continue to participate in the study after 1 week and was thereafter treated according to the standard treatment. The remaining 88 patients were included in the follow-up. At the request of the parents, three patients assigned to the bandage group were converted to the standard treatment within 1 week. During the daytime, these children used their arm without regard for the fracture and
they had pain during the evening as a result. Five patients lost their VAS and discomfort form. In all 88 patients, the range of motion in the wrist and elbow was tested after 4 and 6 weeks.

Complications
None of the fractures showed secondary angulation in either group. No refractures were seen during follow-up in either group.

Pain
To quantify pain the VAS was used. No significant difference between the intake of painkillers was seen between both groups ($p = 0.56$). For those treated in a bandage after 1, 2, and 3 weeks, the mean VAS was $26 \pm 19$ mm, $4 \pm 5$ mm, and $1 \pm 2$ mm, and for those treated in a plaster cast $20 \pm 16$ mm ($p = 0.03$), $3 \pm 4$ mm ($p = 0.96$), and $1 \pm 2$ mm ($p = 0.70$), respectively (Fig. 2).

Comfort
Patients were asked to fill in any discomfort during their BT or CT. Figure 3 shows how often discomfort was reported in both therapy groups each week during the first 3 weeks of the treatment. After 3 weeks, itching was mentioned a total of 219 times as discomfort in the cast group versus 140 times in the bandage group ($p < 0.001$). Other complaints were not significantly different between both groups during 3 weeks.

Wrist Function
After 4 and 6 weeks, the range of movement of the wrist and the elbow was measured in both groups. The median range of movement (flexion - extension) after 4 weeks in the bandage group was 154 degrees (range, 130–180 degrees) versus 121 degrees (range, 60–180 degrees) in the cast group ($p < 0.001$), after 6 weeks the median range of movement was 165 degrees (range, 140–190 degrees) and 163 degrees (range, 90–190), respectively ($p = 0.49$). The function of the wrist is listed in Figure 4.

DISCUSSION
Impacted greenstick fractures, torus fractures, or buckle fractures are terms, which describe the same stable wrist fracture in children. These fractures of the wrist are common injuries among children, yet little has been published regarding their treatment or outcomes. North American preference seemed to be casts for immobilization, but several studies from the United Kingdom have suggested that treatment with splints is common. More recently, some North American studies showed benefit from removable splinting as well. Additionally, a recent study showed advantage of soft cast for treatment of impacted greenstick fractures. West et al. was the first to report the comparison of soft bandage with cast treatment. They concluded that soft bandage treatment had no adverse effects and highly desirable results for patients.

Our study is the first to compare in detail the functioning of children, using a qualified pain scale and taking notice of any discomfort of the different therapies. Results indicate BT is a safe technique, as no secondary angulation was seen during follow-up.

After 1 week, the mean VAS in the bandage group was significantly higher compared with the VAS in the cast group. When the patients, who are unable to regulate their activities in

Fig. 2. The visual analog scale during treatment with bandage or cast therapy week 1 (n = 89), 2 (n = 83), and 3 (n = 83). BT, bandage therapy; CT, cast therapy.

Fig. 3. Discomfort of bandage therapy or cast therapy after 1 (n = 89), 2 (n = 83), and 3 (n = 83) weeks. BT, bandage therapy; CT, cast therapy; 1, 1 week; 2, 2 weeks; 3, 3 weeks.

Fig. 4. Range of motion flexion, extension, abduction, adduction, pronation, and supination of the wrist at 4 and 6 weeks after bandage therapy (n = 44) or cast therapy (n = 44). BT, bandage therapy; CT, cast therapy; 4, 4 weeks; and 6, 6 weeks.
the BT group, were excluded at 1 week, the mean VAS was not significantly different with the CT group ($p = 0.17$).

The wrist function after 4 weeks of BT was significantly better than the CT. After 6 weeks of therapy, the wrist functions of both groups were comparable. The wrist regained normal function sooner in the BT group compared with the CT group.

The parents of three children allocated to the bandage group requested conversion to standard treatment within 1 week. Those children used their arm without regard of the fracture during the daytime and had pain in the evening as a result. Patients who are unable to properly follow instructions might be better treated with the standard cast treatment, because the bandage treatment might cause problems for the child and disorder for their parents. Therefore, if there is a request of changeover to cast treatment by parents of children who do not follow instructions properly, changeover should probably be rewarded without discussion.

There is a risk that parental anxiety regarding a child’s fracture may be exacerbated by the responsibility of looking after a child with BT. Parents could have concerns regarding removal of the soft bandage and what to expect thereafter. For those reasons, a clear explanation of removal and applying a new bandage were given during this study. In this study, no parents involved in the study had any problems with its removal and with removing the bandage, no parent involved in the study had any problems with its removal.

Thirty-eight patients (29%) who followed inclusion criteria declined to participate in the study. One reason could be that parents are concerned that their child is used for experimental treatment, this despite they were well informed. Another reason could be that parents expect CT if a fracture is diagnosed and the fact that one extra radiograph must be made could be a motive as well.

In our opinion, no further discussion should follow whether parents have a request for CT or a changeover to CT during bandage treatment. Figure 5 shows the flowchart for patients with an impacted greenstick fracture.

**CONCLUSION**

BT for impacted greenstick fractures of the distal forearm is a safe technique, patients treated with bandage suffer greater pain at the start of the treatment, are able to return to normal activities sooner, and have less discomfort when compared with the standard CT.

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**REFERENCES**


