What level of immobilisation is necessary for treatment of torus (buckle) fractures of the distal radius in children?

Daniel C Perry

Associate Professor in Orthopaedic Surgery, Oxford Trauma, University of Oxford.

Consultant Orthopaedic Surgeon, Alder Hey Children's Hospital, Liverpool.

Phoebe Gibson

Parent Representative. Alder Hey Clinical Research Facility Parent Carer Forum.

Damian Roland

Consultant in Paediatric Emergency Medicine, University Hospitals of Leicester, Leicester.

Shrouk Messahel

Consultant in Paediatric Emergency Medicine, Alder Hey Children's Hospital, Liverpool.

Torus fractures, also known as buckle fractures, are the most common fractures of the wrist in children, involving the distal radius and/or ulna bone [1]. They typically occur up to 14 years old, usually after a low energy fall[2]. The immaturity of a child's bone enables it to act like a 'crumple zone' of a car, absorbing force and crushing – or buckling – as it is injured. These differ to greenstick fractures, in which the bone bends (rather than crushes) resulting in a complete break in one cortex and a bend on the opposite side (akin to snapping a fresh twig from a tree). Torus fractures result in a mild deformity without a break in the bone surface. As such, these fracture types are considered minor injuries with pain being the main clinical feature. This can result in the need for assistance with school work, time off physical activities, and help with self care.

Parents typically expect that any fracture needs plaster cast immobilisation to ensure adequate healing. However, torus fractures heal very quickly, with pain almost completely resolved by 3 weeks [3]. It is has been demonstrated that simple splints that can be removed at home may be safe and effective alternatives [4].

In 2016, the National Institute for Health and Care Excellence (NICE) reviewed the treatment of torus fractures of the distal radius. NICE concluded that quality of evidence was poor, and recommended that these injuries should not be immobilised in a rigid cast, instead recommending either a splint or a bandage (the latter essentially postulating that no treatment may be equally as effective as bandage offers minimal or no structural support). NICE also recommended discharge from the emergency department without subsequent follow-up [5]. Other international guidelines, such as those from Melbourne, Australia [6] and Colorado, US [7], also suggest the possibility of using a splint, however the recommendation is less directed with both also initially advocating cast immobilisation, and the Colorado guidelines recommending follow-up.

Box 1 – Guidelines on the treatment of torus fractures

Country	**Guidance**	**Examples**
England & Wales	National NICE recommendation: a bandage or easily removable splint and	40% of surveyed departments continue to use casts in the treatment of this fracture [3]

	immediate discharge from the emergency department (5).	
United States	No national guidance but local guidance commonly recommends cast or an easily removable splint, and follow-up 'as needed' (depending in part upon immobilisation device used).	Colorado Pathway [7].
Canada	No national guidance but local guidance commonly recommends the use of an easily removable splint, and follow-up with a primary care provider.	60% of Emergency Clinicians treat with a removable splint [8].
Australia	No national guidance but local guidance commonly recommends the either use of a cast or an easily removable splint, with discharge from the emergency department where cast is not used.	Melbourne Pathway [6].

Despite the guidance (Box 1) generally advocating against cast immobilisation and outpatient follow-up, a recent survey of practice within 100 UK Emergency Departments demonstrated that 40% used casts in the treatment of this fracture, and 60% routinely planned outpatient follow-up [3]. Likewise, a survey in Ireland identified 70% of responders using traditional casts and clinic follow-up [9] and studies from the USA and Australia, have demonstrated very high rates of cast immobilisation and outpatient follow-up and repeated radiographic assessment

[10–12]. The NICE recommendation of using a bandage, or of using no treatment, has not being adopted.

It is thus unclear if children with a torus fracture of the distal radius require splint immobilization or would do as well with a bandage or even no immobilization at all. Furthermore, the safety and acceptability of immediate discharge after diagnosis is not clear, and this approach has not been universally adopted.

What is the evidence of uncertainty?

Box: Search strategy and key words.

We searched Pubmed using the terms "buckle" OR "torus" AND "fracture*" to identify papers between January 2017 and 28th May 2020. A 2018 Cochrane review of the RCT-based evidence on interventions for treating wrist fractures in children was also included [13]. For completeness, our search overlapped the period of the Cochrane review (Cochrane search date May 2018). 59 new papers were identified, of which only two were prospective cohort studies, with no new randomised controlled trials (RCTs).

A Cochrane review of nine randomised controlled trials, including 695 patients in studies comparing removable splints versus rigid casts (summarised in Table 1) and 237 for those comparing bandages versus rigid casts (summarised in Table 2). The quality of evidence was low or very low reflected the absence of blinding in all trials, and a high rate of participant attrition and imprecise estimates of the effect size owing to low sample sizes.

For both studies that evaluated a rigid cast versus either a removable splint, or a bandage, there were no reported differences in serious events and no discernible differences in pain at follow up (1-4 weeks later). In both studies there were 'treatment failures', defined as the need to switch to a rigid cast (bandage group (n=4), splint group (n=5)) but these were at parental request rather than specific clinical need. There is no evidence that supports the need for follow up of these patients, although recent survey practice of Emergency Departments reveals this continues to be offered.

Is ongoing research likely to provide relevant evidence?

Box - Recommendations for future research.

There is now an international desire to address uncertainties such as this in children's orthopaedic injuries. This desire has driven the development of a research agenda [24]. Future studies regarding torus fractures of the distal radius in children must investigate whether ;
Amongst children with torus fractures of the distal radius is treatment without immobilisation as good as treatment with immobilisation, and can affected children be safely discharged at the point of diagnosis without the need for outpatient follow up? The comparison would need to include 'current practice', which includes various forms of immobilisation device. Key outcomes include pain, functional recovery, school attendance and serious adverse events, such as re-fracture, in both of the treatment arms. The outcomes would need to be generalizable to all healthcare settings which see these patients, e.g. Urgent Care Centres and Emergency Departments.

We searched the ISRCTN and ClinicalTrials.gov to identify ongoing research related to 'wrist fractures' and 'forearm fractures' in children. Only one related to the treatment of torus fractures. The FORCE (forearm fracture recovery in children evaluation) Study, which is a trial investigating the clinical effectiveness, using the primary outcome of pain at day 3, of 'the offer of a soft-bandage' and immediate discharge versus rigid immobilisation (i.e. cast, backslab or removable splint) and standard follow-up amongst children with torus fractures of the distal radius [25]. This will therefore directly address the key uncertainties related to the type of immobilisation required, and the necessity for follow-up following diagnosis. The FORCE Study is limited to children in the UK and has so far recruited over 900 children from Emergency Departments throughout England; it is expected to report late in 2021. The is as an 'eTrial' using text message and e-mails to collect patient-reported outcomes, principally pain and functional recovery, from families up to 6 weeks from the injury.

Early patient involvement in the FORCE study found poor acceptability among parents of 'no treatment' in children with torus fractures. The intervention arm is thus 'the offer of a soft-bandage' to be applied and used at the discretion of the family, and is proving acceptable to participants. The sample size is adequate to quantify rarer adverse events (i.e. re-fracture). The size and scope of the FORCE study means it is likely to provide high quality evidence regarding the uncertainties related to the necessity for immobilisation and follow-up described in this article, but more studies may be needed globally to understand acceptability of interventions in different settings. The inability to blind participants to the intervention will mean the study is prone to observer bias, and the 'offer of a bandage' means that 'no treatment' is not assessed. A cost-effectiveness analysis will also be performed.

What should we do in the light of uncertainty?

Given the uncertainty, we suggest hospitals and clinical teams develop a protocol for management of children with this injury in line with the NICE guidelines for using a removable splint and immediate discharge. Any form of removable splint is acceptable, including backslab and futura splints, as the recovery and pain appear similar. Clinicians should explain to the parent that the wrist should be immobilized for 3 weeks and then families can remove the splint at home. Parents should be encouraged to give children simple analgesia, and return to the clinic if they face any difficulties with pain or re-injury. The implementation of this pathway will require clinicians to consider the accuracy of the diagnosis made in the acute setting.

How patients were involved in this article

Phoebe Gibson is a parent representative and co-author on the management group of the FORCE study, and has co-produced this article with the clinical team.

What patients need to know

- Torus fractures are minor breaks of the wrist bones, and the most common fractures seen in childhood.

- There is reassuring evidence of a full recovery with no serious problems, including no evidence of repeat injury, when simple splints are used to ‘rest’ the wrist.
- Doctors are unsure if these fractures really need to be treated with a splint to ‘rest’ the wrist, or if they are just as well treated more like a sprain with early movement - research is ongoing to find the answer to this.

What you need to know

- There is reassuring evidence of a full recovery with no serious problems, including no evidence of repeat injury, when simple splints, with a full recovery by 6 weeks.
- Splint immobilisation and immediate discharge is the treatment usually recommended in guidelines, however the quality of evidence underpinning the guidelines is rated low or very low quality.
- There is wide variation in practice internationally in terms of the type of immobilisation device used and the necessity for outpatient follow-up.

Education into Practice

What methods of immobilisation would you use in a child with a torus fracture?

What is the local arrangement for follow-up amongst children with torus fractures?

Illustrations

Figure. This is an AP and lateral radiograph of the wrist. This illustrates a torus fracture of the distal radius and ulna with compression of the bones dorsally, though no break in the bone surface.

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DCP drafted the initial version of the manuscript. PG, DR and SM edited the manuscript. All authors approved the final version of the manuscript. DCP is the guarantor and corresponding author.

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Competing Interests

We have read and understood the BMJ Group policy on declaration of interests and declare the following interests: All authors are co-applicants on the National Institute for Health Research FORCE Study.

Table 2 - Randomised controlled trials comparing removable splints versus cast for torus (buckle) fractures

Study ID	No. participants Age	Intervention, duration of use & follow-up	Key Outcomes	Other notable findings
Davidson 2001[4]	201 (85 cast, 116 splint) Mean: 8.9 years; range 2 to 15 years	Splint: Pre-fabricated wrist splint. Cast: Short arm cast. Follow up: Outpatient clinic 3 weeks after injury for all children to remove cast and splint. Outcome: success of treatment at 3 weeks in terms of healing and adverse events.	All fractures united clinically and radiologically with no fracture displacement.	Compliance with both types of treatment was good except in two very young patients who tried to remove their splints shortly after they had been applied.
Karimi 2013[17]	142 (77 cast, 65 splint) Mean: 9.5 years; range 1.2 to 17 years	Splint: Pre-fabricated wrist splint. Cast: Short arm cast. Follow-up: Removable splints followed by phone with home removal of splint at 3 weeks. Casts followed up in clinic at 3 weeks. Outcome: Non-validated score of pain and satisfaction at 3 weeks. Adverse events.	There were no adverse events or skin problems in either group. 28 in the splint group & 24 in the cast group experienced mild to moderate pain with activity (P = 0.61). 58 in the splint group and 66 in the cast group found the treatment convenient.	
Oakley 2008[18]	95 (47 cast, 48 splint) Mean: 8.5 years; range 9 months to 15 years	Splint: Fibreglass backslab. Cast: Short-arm cast. Follow-up: Radiographs at 12 to 16 days after injury. Immobilisation extended by 2 weeks if significant tenderness or discomfort remained.	There was no difference in the median pain scores throughout follow-up. 40 in the cast group, and 28 in the splint group had returned to “full activity” by 2 weeks. There were no adverse events.	This study used a splint which is not a direct comparison with a typical splint used in other studies

		Outcome: Patients given a daily diary, including a VAS assessment of pain.		
Plint 2006	113 (56 cast, 57 splint) Mean: 9.72 years; range 6 to 15 years	Splint: Pre-fabricated wrist splint. Casts: Short arm cast. Follow-up: Casts were removed in clinic at 3 weeks. Splints were removed at home when child comfortable. There was phone contact at 7,14,20 and 28 days post injury to record pain & recovery and postal follow-up to 6 months. Outcome: Primary outcome measure was the ASKp (Activities Scales for Kids performance) questionnaire performed by phone at 14 days.	Patients in the splint group had a significantly higher ASKp score at day 14 postinjury than the cast group ($P < .041$). Specifically, the children in the splint group had close to “normal” ASKp scores at day 14, whereas those in the cast group had scores that correlate with mild disability. ASKp score was not significantly different between the groups for days 7, 20, and 28 post injury. Five children in the cast group returned to the ED for problems with their casts (4 returned for wet casts and 1 had placed a pencil under the cast). No children in the splint group returned to the ED for problems with their splint. There were no refractures.	
Pountos 2010[15]	50 (24 cast, 26 splint) Mean: 9 years; range 2 to 16 years	Splint: Pre-fabricated wrist splint. Cast: Plaster cast (unspecified) Follow up: Outpatient clinic 4-6 weeks after injury for all children. Unclear when the splint was removed. Cast removed at clinic visit.	There was no difference in pain scores, with a score of 3.1 in splint vs. 2.9 in the cast group. There was no difference in the use of analgesia, and no apparent difference in function.	Note a three way trial of plaster cast, splint and tubigrip bandage.

		Outcome: All had radiographic assessment at follow-up. "Average" pain in the preceding weeks was determined at the follow-up visit using a VAS. An unvalidated assessment of function also made.	The amount of deformity worsened (all by less than 5 degrees) in 3 patients (2 splint group and 1 cast group).	
Williams 2013[14]	94 (cast 51, splint 43) Median: 9.5 years (splint) and 9 years (cast); range 2 to 16 years	Splint: Pre-fabricated wrist splint. Cast: Short arm cast. Follow-up: All followed up at 3 weeks. Splints removal permitted as the child became more comfortable. Casts removed in clinic at 3 weeks. There was phone contact at 1, 3, 7 and 21 days post injury to record pain & recovery. Outcome: Assessment of pain, convenience and preference – though unclear if validated tools used.	Pain scores were higher in the splint group, though the difference was not statistically significant. The satisfaction was higher in the splint group, with families showing a preference for this treatment.	

Table 3 - Randomised controlled trials comparing bandages versus cast for torus (buckle) fractures

Study ID	No. participants Age	Intervention, duration of use & follow-up	Outcomes	Other notable findings
Jones 2001[21]	50 (25 cast, 25 bandage) Mean: 6.2 years; range 3 to 10 years	Bandage: A layer of soft wool covered with cotton crepe initially Cast: Short-arm cast. Follow-up: Removed of cast at clinic visit. Wool removal unclear.	High parental satisfaction with both treatments.	This is unpublished, available only as a conference abstract.

		Outcome: Follow-up to determine satisfaction at 3 weeks.		
Kropman 2010[20]	92 (45 cast, 45 bandage) Mean: 10 years; range 4 to 12 years)	Bandage: A layer of soft wool covered with cotton crepe initially. This was converted to a tubigrip at 1 week, to be worn for 3 weeks. Cast: Initially treated in a backslab, which was converted to a full short arm cast at 1 week and removed at 4 weeks. Follow-up: 1 and 4 weeks with radiographs, and at 6 weeks. Outcome: Pain diary was completed at home throughout the first 3-weeks post-injury including pain VAS.	The mean VAS for pain at 1, 2 and 3 weeks, demonstrated significantly increased pain at week one in the bandage group (26±19 mm, vs. 20±16mm (p = 0.03)), though no difference at other time points. None of the fractures showed secondary angulation in either group. No re-fractures were seen during follow-up in either group. No difference between the intake of painkillers was seen between groups (*p* = 0.56). There were no adverse events.	
Pountos 2010[15]	53 (24 cast, 29 bandage) Mean: 9 years; range 2 to 16 years)	Bandage: A double tubigrip bandage. Cast: A short arm plaster of paris cast. Follow up: Outpatient clinic 4-6 weeks after injury for all children. The cast was removed at the clinic visit. Unclear when tubigrip removed. All had radiographic assessment at follow-up. Outcome: “Average” pain in the preceding weeks was determined at the follow-up visit using a VAS. An unvalidated assessment of function also made.	There was no difference in pain scores, with a score of 2.3 in bandage vs. 2.9 in the cast group. There was no difference in the use of analgesia, and no apparent difference in function. The amount of deformity worsened (all by less than 5 degrees) in 2 patients (1 bandage group and 1 cast group).	Note a three way trial of plaster cast, splint and tubigrip bandage..

West 2005[19]	42 (21 cast, 18 bandage) (Age unclear – though specify children)	Bandage: A layer of soft wool covered with cotton crepe. Cast: Initially treated in a backslab, which was converted to a full cast at 1 week. Follow-up: Bandages were reviewed in clinic weekly for 4 weeks, and the bandage changed at each visit. Casts were seen at 1 week and removed at 4 weeks. Outcome: No validated outcome assessment, though reported on process and adverse events.	All patients in the bandage group had discontinued its use in week 2. There were no adverse events or skin problems in either group.	Two other children included initially in the bandage group failed to return for their first visit in the fracture clinic and did not make it into the analysis.

References

1 Naranje SM, Erali RA, Warner WC, *et al.* Epidemiology of Pediatric Fractures Presenting to Emergency Departments in the United States: *Journal of Pediatric Orthopaedics* 2016;**36**:e45–8. doi:10.1097/BPO.0000000000000595

2 Chung KC, Spilson SV. The frequency and epidemiology of hand and forearm fractures in the United States. *The Journal of Hand Surgery* 2001;**26**:908–15. doi:10.1053/jhsu.2001.26322

3 Widnall J, Capstick T, Wijesekera M, *et al.* Pain scores in torus fractures: Using text messages as an outcome collection tool. *Bone & Joint Open* 2020;**1**:3–7. doi:10.1302/2046-3758.12.BJO-2019-0002

4 Davidson JS, Brown DJ, Barnes SN, *et al.* Simple treatment for torus fractures of the distal radius. *J Bone Joint Surg Br* 2001;**83**:1173–5.

5 National Clinical Guideline Centre (UK). Fractures (Non-Complex): Assessment and Management (NG38). 2016.

6 Victorian Paediatric Orthopaedic Network. Clinical Practice Guidelines: Distal radius and or ulna metaphyseal fractures - Emergency Department. https://www.rch.org.au/clinicalguide/guideline_index/fractures/Distal_radius_and_or_ulna_metaphyseal_fractures_Emergency_Department_setting/

7 Children's Hopsital Colorado. Clinical Pathway: Buckle Fracture. https://www.childrenscolorado.org/4adc96/globalassets/healthcare-professionals/clinical-pathways/fracture-buckle.pdf

8 Koelink E, Schuh S, Howard A, *et al.* Primary Care Physician Follow-up of Distal Radius Buckle Fractures. *Pediatrics* 2016;**137**:e20152262. doi:10.1542/peds.2015-2262

9 Abdelhady A, Ahmed A, Umana E, *et al.* Management of Paediatric Buckle (Torus) Wrist Fractures in Irish Emergency Departments: A National Survey. *Ir Med J* 2018;**111**:793.

10 Ling S-NJ, Cleary AJ. Are Unnecessary Serial Radiographs Being Ordered in Children with Distal Radius Buckle Fractures? *Radiology Research and Practice* 2018;**2018**:1–4. doi:10.1155/2018/5143639

11 Luther G, Miller PE, Mahan ST, *et al.* Decreasing Resource Utilization Using Standardized Clinical Assessment and Management Plans (SCAMPs): *Journal of Pediatric Orthopaedics* 2019;**39**:169–74. doi:10.1097/BPO.0000000000000873

12 Williams BA, Alvarado CA, Montoya-Williams DC, *et al.* Buckling down on torus fractures: has evolving evidence affected practice? *J Child Orthop* 2018;**12**:123–8. doi:10.1302/1863-2548.12.170122

13 Handoll HH, Elliott J, Iheozor-Ejiofor Z, *et al.* Interventions for treating wrist fractures in children. *Cochrane Database Syst Rev* 2018;**12**:CD012470. doi:10.1002/14651858.CD012470.pub2

14 Williams KG, Smith G, Luhmann SJ, *et al.* A randomized controlled trial of cast versus splint for distal radial buckle fracture: an evaluation of satisfaction, convenience, and preference. *Pediatr Emerg Care* 2013;**29**:555–9. doi:10.1097/PEC.0b013e31828e56fb

15 Pountos I, Clegg J, Siddiqui A. Diagnosis and treatment of greenstick and torus fractures of the distal radius in children: a prospective randomised single blind study. *J Child Orthop* 2010;**4**:321–6. doi:10.1007/s11832-010-0269-3

16 Plint AC, Perry JJ, Correll R, *et al.* A randomized, controlled trial of removable splinting versus casting for wrist buckle fractures in children. *Pediatrics* 2006;**117**:691–7. doi:10.1542/peds.2005-0801

17 Karimi Mobarakeh M, Nemati A, Noktesanj R, *et al.* Application of Removable Wrist Splint in the Management of Distal Forearm Torus Fractures. *Trauma Mon* 2013;**17**:370–2. doi:10.5812/traumamon.5094

18 Oakley EA, Ooi KS, Barnett PLJ. A randomized controlled trial of 2 methods of immobilizing torus fractures of the distal forearm. *Pediatr Emerg Care* 2008;**24**:65–70. doi:10.1097/PEC.0b013e318163db13

19 West S, Andrews J, Bebbington A, *et al.* Buckle Fractures of the Distal Radius Are Safely Treated in a Soft Bandage: A Randomized Prospective Trial of Bandage Versus Plaster Cast. *Journal of Pediatric Orthopaedics* 2005;**25**:322–5. doi:10.1097/01.bpo.0000152909.16045.38

20 Kropman RHJ, Bemelman M, Segers MJM, *et al.* Treatment of Impacted Greenstick Forearm Fractures in Children Using Bandage or Cast Therapy: A Prospective Randomized Trial. *The Journal of Trauma: Injury, Infection, and Critical Care* 2010;**68**:425–8. doi:10.1097/TA.0b013e3181a0e70e

21 Jones S, Smith I, Jones M. Treatment of distal radius buckle fractures. In: *Poster Abstract 41*. 2001.

22 Symons S, Rowsell M, Bhowal B, *et al.* Hospital versus home management of children with buckle fractures of the distal radius. A prospective, randomised trial. *J Bone Joint Surg Br* 2001;**83**:556–60.

23 Hamilton TW, Hutchings L, Alsousou J, *et al.* The treatment of stable paediatric forearm fractures using a cast that may be removed at home: comparison with traditional management in a randomised controlled trial. *Bone Joint J* 2013;**95-B**:1714–20. doi:10.1302/0301-620X.95B12.31299

24 Perry DC, Wright JG, Cooke S, *et al.* A consensus exercise identifying priorities for research into clinical effectiveness among children's orthopaedic surgeons in the United Kingdom. *Bone Joint J* 2018;**100-B**:680–4. doi:10.1302/0301-620X.100B5.BJJ-2018-0051

25 Achten J, Knight R, Dutton SJ, *et al.* A multicentre prospective randomized equivalence trial of a soft bandage and immediate discharge versus current treatment with rigid immobilization for torus fractures of the distal radius in children: protocol for the Forearm Fracture Recovery in Children Evaluation (FORCE) trial. *Bone & Joint Open* 2020;**1**:214–21. doi:10.1302/2046-3758.16.BJO-2020-0014.R1