Original Article

Journal of Kathmandu Medical College, Vol. 11, No. 4, Issue 42, Oct.-Dec., 2022

Functional outcome of long-arm cast versus double sugar-tong splint in acute paediatric distal forearm fractures: A randomised controlled trial

Banjade D,[1] Adhikari S,[2] Adhikari R,[3] Tamang RS,[4] Dahal SC,[5] Lamichhane MR[6]

[1]Deepak Banjade, [2]Sushan Adhikari, [3]Rabindra Adhikari, [4]Ramesh Syangtan Tamang, Consultant, Department of Orthopaedics, Bharatpur Hospital, Chitwan, Nepal; [5]Saroj Chandra Dahal, [6]Megh Raj Lamichhane, Consultant, Pokhara Academy of Health Sciences, Pokhara, Nepal.

Abstract

Background: The treatment of choice for paediatric distal forearm fractures has been a long-arm cast (LAC) following closed reduction. An alternative treatment is to use a double sugar-tong splint (DSTS), found equally effective to provide three-point fixation and comparable outcomes to cast.

Objectives: To compare the functional outcome between LAC and DSTS for the treatment of paediatric distal forearm fractures.

Methods: A randomised controlled trial was done among 36 patients of 5-15 years with acute distal forearm fractures without neurovascular deficit treated with LAC and DSTS recruited by convenience sampling at a tertiary care centre after ethical approval. Acceptability of reduction, loss of reduction, union rates, cast comfort, range of motion and complications were studied at follow-up upto 12 weeks and analysed using SPSS v.11.5.

Results: Among a total of 36 patients, 18 cases were treated by the LAC method and others by the DSTS method. Both LAC and DSTS were comparable in the maintenance of reduction, the remanipulation rate was 8.3% (n = 3), not significant (p-value = 0.967). All had a union at six weeks follow-up. No statistical difference in mean VAS score (p-value = 0.524), mean loss of flexion (p-value = 0.397), and mean loss of pronation/supination (p-value = 0.814). No statistically significant difference in activities of daily living was noted. No complications were encountered.

Conclusion: DSTS is safe and as effective as LAC in the treatment of distal forearm fractures in children, identical in terms of functional outcome, maintenance of reduction, complications, and time to union.

Key words: Forearm injuries; Paediatrics; Plaster Casts, Splints.

Access this article online

Website: www.jkmc.com.np

DOI: https://doi.org/10.3126/jkmc.v11i4.53547

HOW TO CITE

Banjade D, Adhikari S, Adhikari R, Tamang RS, Dahal SC, Lamichhane MR. Functional outcome of long-arm cast versus double sugar-tong splint in acute paediatric distal forearm fractures: A randomised controlled trial. J Kathmandu Med Coll. 2022;11(4):232-9.

Submitted: Sep 06, 2022
Accepted: Dec 21, 2022
Published: Dec 30, 2022

Address for correspondence

Dr. Deepak Banjade
Consultant, Department of Orthopaedics,
Bharatpur Hospital,
Bharatpur-10, Chitwan, Nepal.
E-mail: drbanjadepak@gmail.com

ISSN: 2019-1785 (Print), 2091-1793 (Online)

INTRODUCTION

Distal forearm fractures that account for more than 40% of paediatric long bone fractures occur at the peak of growth velocity and are mostly closed and without neurovascular deficits.[1] Presence of tough periosteum and continued remodelling makes them suitable for non-operative treatment.[2,3] The treatment of choice has been a long-arm cast (LAC) with three-point fixation following closed reduction.[3,4] The double sugar-tong splint (DSTS) is a long-arm plaster construct that prevents pronation-supination and limits flexion-extension of the elbow, effective to provide three-point fixation, with the advantage of reduced risk of compartment syndrome and can even be applied in presence of significant swelling where long arm cast is contraindicated.[4,5]

Although closed reduction and casting of displaced fractures remain the mainstay of treatment for the majority of patients, the optimal type of cast remains debatable.[6-8] Although well-molded casts may provide the best potential to maintain fracture alignment, theoretical risks of acute circumferential immobilisation include neurovascular compromise and compartment syndrome. Splinting is another option that avoids the potential complications associated with casting.[9] Hence, this study aimed to determine the effectiveness of DSTS compared with LAC in terms of maintenance of reduction, functional outcome, delayed union, nonunion, and malunion.

METHODOLOGY

Present study was a randomised controlled trial conducted at the department of Orthopaedics, B. P. Koirala Institute of Health Sciences (BPKIHS), Dharan, Sunsari, Nepal, a tertiary care hospital in Eastern Nepal, over a period of 11 months between 2018 October to 2019 August with institutional ethical approval (Ref. 356/075/076-IRC; Code: IRC/1339/018). All children between 5-15 years with isolated traumatic distal third extraarticular forearm fractures without distal neurovascular deficit presenting to the Emergency and the outpatient departments were included in the study by convenience sampling. Patients with re-fractures, polytrauma, fracture dislocations, pathological fractures, and compartment syndrome were excluded. The participants were then randomly allocated in the LAC or DSTS group (Figure 1). The null hypothesis was that there is no significant difference in functional outcome between the two procedures namely LAC and DSTS for the treatment of distal forearm fractures in children. The primary objective of the study was to compare the functional outcome and efficacy of double sugar-tong splint with that of a long arm cast for the treatment of distal forearm fractures. The secondary objectives were to determine the time required for fracture union and cast related complications.

The sample size was calculated considering 95% CI and 80% power of the study and with reference to the study by Levy et al.[2] Radial apposition at injury time and post reduction were reported as 46.9% and 93.2% in double sugar-tong splint group and 68.8% and 94.1% in long arm cast group respectively. The net reduction in two groups were 46.3% and 25.3% respectively. The proportion of reduction based on baseline were calculated as 98.72% in double sugar-tong splint group and 36.77% in long arm cast group. Considering P1 = 98.72% and P2 = 36.77%; $Z_{\alpha/2}$ at 5% = 1.96 and Z_{β} at 5% = 1.645. The sample size was calculated using following formula:

$$n = \frac{2(Z_{\alpha/2} + Z_{\beta})^2 PQ}{(P1-P2)^2}$$

where $P = (P1 + P2)/2 = (98.72 + 36.77)/2 = 67.75\%$

$Q = 100 - P = 100 - 67.75 = 32.25\%$

$$= \frac{2(1.96+1.645)^2 \times 67.75 \times 32.25}{(98.72-36.77)^2}$$

$= 14.797 \approx 15$ (in each group)

Adding 20% for non-response rate, the total final sample size calculated was 36 with 18 in each group. Randomisation was done by random number allocation using Microsoft Excel's random number generation technique. Ethical clearance was obtained from the Institutional Review Committee (IRC) (Ref. 356/075/076). Prior informed and written consent from the guardians and assent from the children was taken after explaining the procedures, complications, and possible outcomes, as per the National Ethical Guidelines for Health Research in Nepal, 2019.[10] The patients were administered analgesics and limb splinted. A thorough general physical and systemic examination was carried out to look out for underlying exclusion criteria and record any distal neurovascular deficit. The diagnosis was confirmed by X-ray of the forearm with wrist and elbow on anteroposterior (AP) and lateral views. Classification of the fracture was done according to Arbeitsgemeinschaft für Osteosynthesefragen (AO) classification. Fractures were manipulated and reduced by orthopaedic residents under supervision under appropriate analgesia and/or sedation. Methods of analgesia/anaesthesia included haematoma block or conscious sedation performed in either the emergency department, plaster room, or operating room. All initial immobilisation utilised plaster of Paris for both the DSTS and LAC groups. Radiographic measurements were taken at the initial presentation, post-reduction, and at each follow-up visit with assessments for cast index, sagittal and coronal angulation, displacement, and apposition. All radiographs were digital. Cast index and three-point index measurements were calculated to ensure that reduction will be maintained properly within the cast or splint like that described in the work by Alemdaroglu et al.[11] The patients were followed up at one, two, three, four, and six weeks. The AP and lateral radiographs were obtained at all scheduled follow-up appointments. In patients 15 years of age or below, loss of reduction (LOR) was defined as angulation >20 degrees in the distal thirds of the bone. Furthermore, any change in angulation of >10 degrees from the immediate post-reduction radiograph was deemed LOR. At the follow-up visit, DSTS was overwrapped with casting

material if necessary. Fractures with concern for the loss of reduction outside the acceptable parameters were considered for remanipulation new LAC was applied. The option to convert to a short-arm cast was available at the four- and six-week appointments based on clinical and radiographic evidence of healing. All patients were followed to the clinical and radiographic union, typically at the six- or eight-week mark, when the casts were to be removed. They were then asked to return at least one more time between second and fourth weeks after cast removal to ensure a return of full range of motion and repeat radiographs. At the end of the final follow-up, the functional outcome was assessed using a questionnaire to evaluate difficulties in performing seven daily activities during the period of cast adapted from the Performance version of the Activities Scale for Kids.[12] The parents and children were evaluated for the comfort of the cast using a visual analog scale (VAS) with the highest score for maximal comfort.[13] The range of motion (wrist flexion-extension, forearm supination-pronation, and elbow flexion-extension) was measured in degrees by using a goniometer. Collected data were entered in Microsoft Excel 2013 and converted into SPSS Statistics for windows, version 11.5 (SPSS Inc., Chicago, Ill., USA) for statistical analysis. For descriptive analysis proportion, percentage, mean and standard deviation were calculated. Graphical and tabular presentations were made. For inferential statistics, the Chi-square test for categorical data, t-test, or Mann Whitney U test for continuous data was applied to find out the significant differences between the two groups (LAC group and DSTS group) with study variables at 95% confidence interval where p-value = 0.05. Fisher's Exact test was used for the test of independence.

RESULTS

A total of 36 cases were treated over the study period of which 19 were male and 17 were female children. Most of them were in the 8-11 years age group (N = 36). The mode of injury was similar between the groups. All of these variables were not statistically significant suggesting that randomisation was successful (Table 1). Regional anaesthesia was sufficient in most of the patients (26, 72.22%). Most of the post-manipulation and reduction radiographs were within acceptable parameters. Only one patient in LAC group required immediate remanipulation after initial reduction and one patient in each LAC and DSTS group required remanipulation after one week follow-up, which were re-reduced to acceptable limits (Table 2). Signs of healing were present in all cases at six weeks (Table 3, Figures 2, 3, 4, and 5). Cast discomfort measured with VAS score showed similar compliance in both groups: 5.67 ± 0.77 versus 5.50 ± 0.79 in LAC and DSTS respectively (p-value = 0.524). Functional parameters with respect to forearm range of motion and activities of daily living were comparable between the groups at the final follow-up (Table 4).

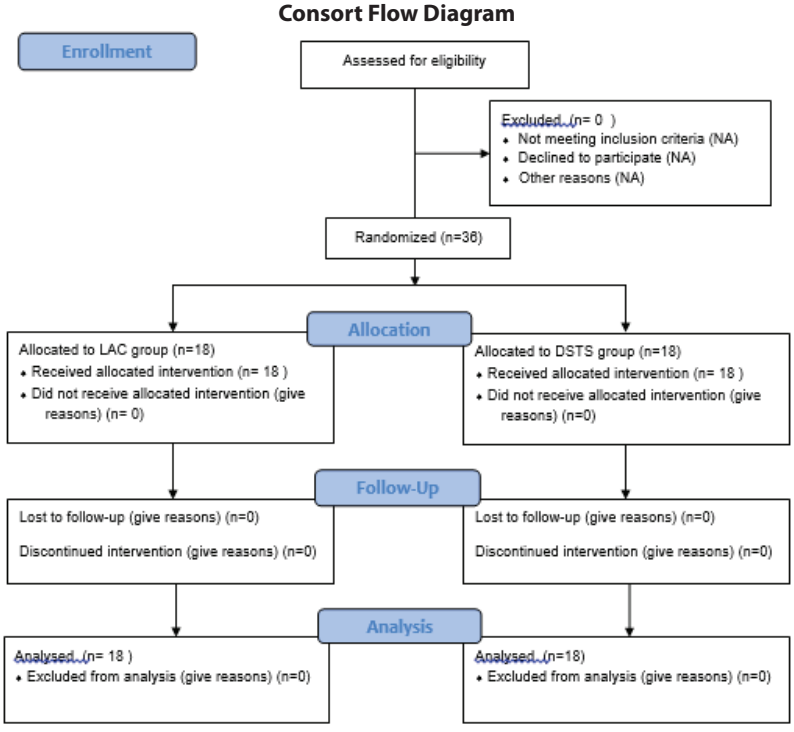

Figure 1: CONSORT flow diagram of the study.

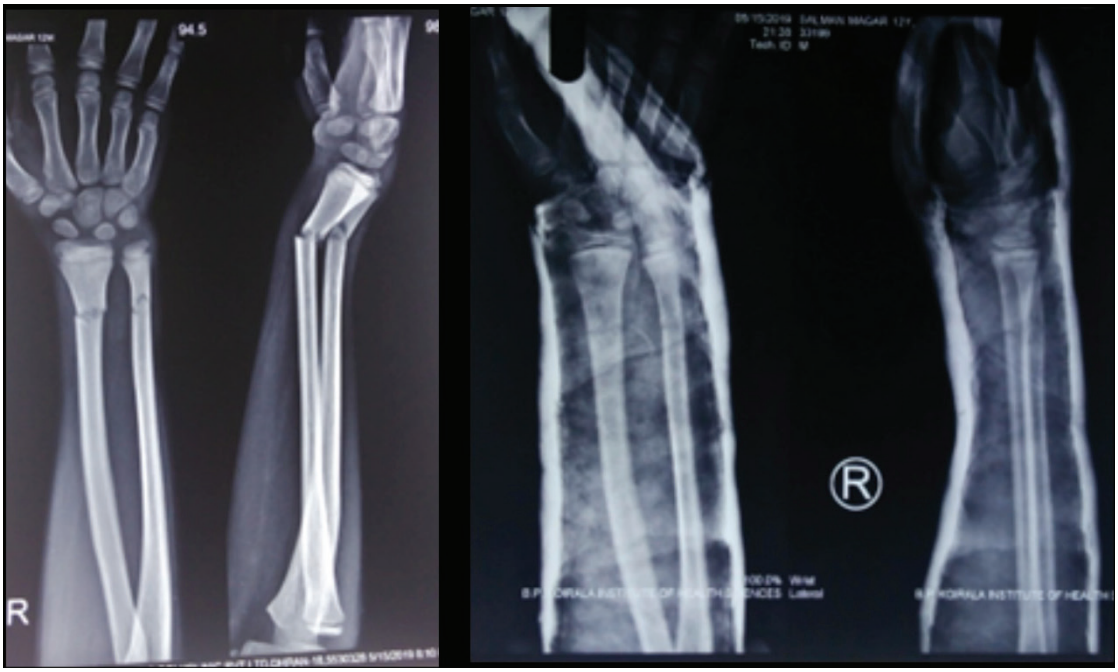

Figure 2: Prereduction and post-reduction X-rays in LAC group (AP and lateral views)

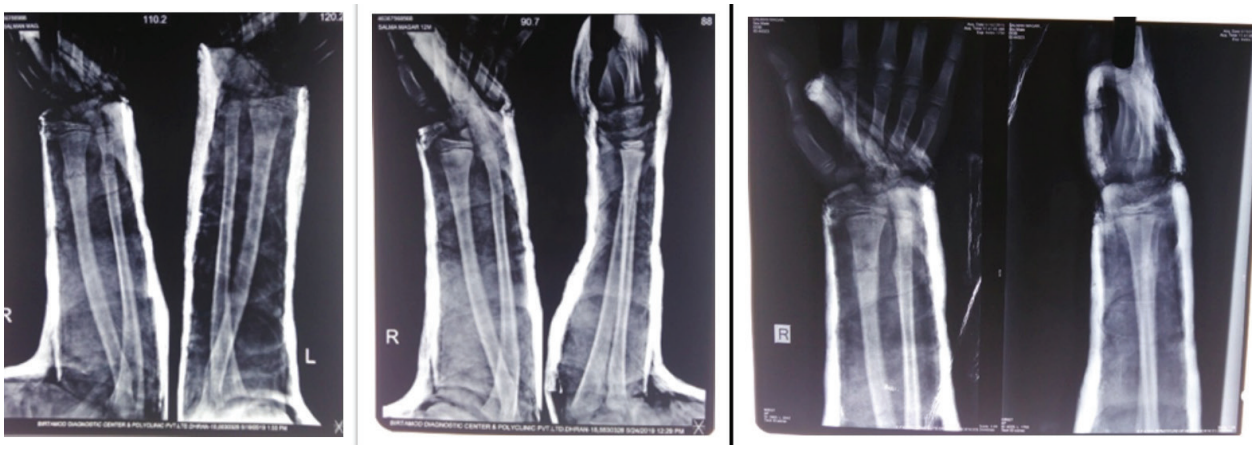

Figure 3: X-rays (AP and lateral views) in LAC group at one week, three weeks, and six weeks follow-up respectively

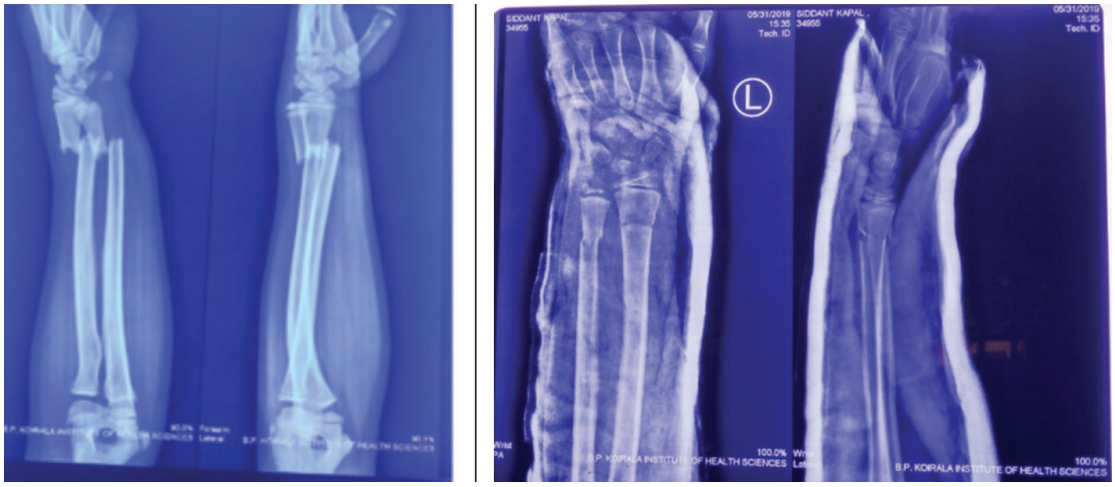

Figure 4: Prereduction and post-reduction X-rays in DSTS group (AP and lateral views)

Figure 5: X-rays (AP and lateral views) in DSTS group at one week, three weeks, and six weeks follow-up respectively

Table 1: Demographic profile of the patients

Parameters		Group		p-value
		LAC (N = 18)	DSTS (N = 18)	
Mean age (Mean ± SD)		**10.06 ± 2.90**	**9.56 ± 3.11**	**0.621**
Gender distribution, n (%)	Male	9 (50)	10 (55.6)	0.197
	Female	9 (50)	8 (44.4)	
Side involved, n (%)	Right	6 (46.2)	7 (53.8)	0.729
	Left	12 (52.2)	11 (47.8)	
Mode of injury, n (%)	Fall from height	11 (73.3)	4 (26.7)	0.067
	Fall on ground	7 (38.9)	11 (61.1)	
	Road traffic accidents	-	2 (100)	
	Others	-	1 (100)	
Injury to hospital time, n (%)	<24 hours	14 (53.8)	12 (46.2)	0.341
	24-48 hours	3 (33.3)	6 (66.7)	
	>48 hours	1 (100)	-	

SD = standard deviation.

Table 2: Distribution of different variables among two groups, n (%)

Variables		Group		p-value
		LAC (N = 18)	DSTS (N = 18)	
Anaesthesia	Regional	14 (53.8)	12 (46.2)	0.457
	General	4 (40)	6 (60)	
Remanipulation after initial reduction	Remanipulation required	1 (100)	-	0.310
	Remanipulation not required	17 (48.6)	18 (51.4)	
Remanipulation after one week follow-up	Remanipulation required	1 (50)	1 (50)	0.967
	Remanipulation not required	17 (48.5)	17 (51.5)	

Table 3: Analysis of clinico-radiological union, n (%)

Variables		Groups		p-value
		LAC	DSTS	
Union (callus) at three weeks	Callus present	3 (37.5)	5 (53.6)	0.423
	Callus not present	15 (62.5)	13 (46.4)	
Union at six weeks		18 (100)	18 (100)	

Table 4: Functional outcomes after cast removal

Parameters		Groups		p-value
		LAC	DSTS	
Loss of range of motion	Loss of elbow flexion (degrees) (Mean ± SD)	9.44 ± 9.22	11.94 ± 8.25	0.397
	Loss of forearm supination (degrees) (Mean ± SD)	8.89 ± 6.08	11.50 ± 5.36	0.181
	Loss of forearm pronation (degrees) (Mean ± SD)	8.89 ± 7.58	10.67 ± 4.51	0.399
	Total loss of rotation (degrees) (Mean ± SD)	22.86 ± 9.35	22.17 ± 7.098	0.814
Grading of limitation of pronation/supination	Excellent	33.33	11.11	
	Good	27.78	44.44	
	Fair	16.17	27.78	
	Poor	22.22	16.17	
Activities of daily living: Days of school missed	Missed school (days) (Mean ± SD)	18.50 ± 11.07	15.72 ± 10.08	0.436

DISCUSSION

Paediatric forearm fractures are commonly seen and heal reliably.[14] Nonunion in children is essentially only seen in the setting of a pathologic condition or disruption in vascular supply; whereas loss of reduction and malunion is the most important risk.[1] These fractures are known to have a substantial capacity to remodel due to proximity to the physis. Indeed, it has even been shown that a gentle, non-anatomic reduction that only improves alignment with subsequent placement in a short arm cast will remodel and result in overall good outcomes.[15] Consequently, guidelines have been set for allowable post-reduction angulation and displacement that can be corrected by remodelling. The principle of treatment, then, is providing adequate immobilisation, which can maintain the reduction within these parameters until the child's bone can heal and remodel.[6,11] Historically, these injuries were treated with a LAC for the duration of treatment or until enough healing had taken place that the cast could be changed for a LAC. An alternative treatment algorithm is to use a DSTS at the time of initial reduction and overwrap the splint with fibreglass at the time of the first follow-up.[2] In this study, mean age was found to be 9.81 years, similar finding was noted that is 8.73 years and 8.94 years by Levy et al.,[2] and Acree et al.,[16] respectively. Fall on ground with outstretched hands was found to be the most common mode of injury in both group, similar finding was noted by McQuinn et al.[15] Most of the patients presented with injury to the left forearm (23, 63.9%), the non-dominant side. The left side was injured in 23 patients with 11 in DSTS and 12 in LAC group and the right side in the remaining 13 patients, seven in DSTS and six in LAC group. Similar findings were noted by Levy et al.[2] with 70.4% injury to left forearm. Most of the fractures were reduced under regional anaesthesia, which was true for both the groups. Other studies have not observed the role of anaesthesia between the two groups and so these observations could not be compared. In current study, remanipulation rate was 8.3% (n = 3). Of the total reduction attempted, only one case was remanipulated once again. On first follow-up one week later two cases, one each in LAC group and DSTS group, presented with loss of reduction, and they were also remanipulated. In study conducted by Levy et al.,[2] 15 (21.11%) cases were remanipulated, 10 out of 37 cases in LAC group and five out of 34 cases in DSTS group. There were no week-to-week differences between the two groups in regards to sagittal alignment, coronal alignment, apposition, or displacement. Sagittal alignment at immediate post-reduction and week two showed that the DSTS was slightly better (average 2.0 vs. 5.0 degrees, respectively, p-value = 0.04). For the entire treatment period there was an increased risk of loss of reduction of ≥10 degrees in the LAC group versus the DSTS group (seven patients vs. two patients, respectively, p-value = 0.0001). Study by Acree et al.,[16] showed reduction was maintained with acceptable alignment in most cases (94%). Although a sugar-tong splint slightly maintained fracture alignment better, this was not statistically significant. Study by Lee et al.,[4] showed that loss of reduction occurred in 16 cases in short arm double splint group (34%) and 10 cases in sugar-tong splint group (29.4%), which did not differ significantly between the groups (p-value= 0.169). Murphy et al.,[17] concluded that at four weeks post-injury follow-up, there were no statistically significant differences between use of an SSTS or LAC when comparing post-immobilisation sagittal alignment (LAC 10.3±7.2, SSTS 8.4±5.1°; p-value = 0.46), coronal alignment (LAC 6.9± 4.6, SSTS 7.6 ± 9.3°; p-value = 0.46), or need for repeat manipulation or surgery (LAC 4/50, SSTS 3/50; p-value = 0.70).

Goldstein et al.,[18] conducted a study in which 33 patients were treated with closed reduction and immobilisation in a sugar-tong splint, 10 patients were acutely casted, and two patients were placed into a short arm volar splint. Twenty-five patients who were initially splinted were treated to completion without the need for operative intervention. Eight of the patients treated with sugar-tong splints (24%) required surgery. Eight patients who were initially casted were treated to completion closed. Two of the patients who were initially casted (22%) required operative intervention for loss of reduction. Both of the patients who were initially immobilised using a volar splint were treated to completion without operative intervention. There was no statistically significant difference in the need for operative intervention amongst these groups.

Sixty-four (38%) patients demonstrated radiographic LOR with 90% of LORs occurring in the first two weeks. LOR was significantly more common in distal radius fractures [48/110 (44%)] than with either proximal [2/14 (14%), p-value = 0.04] or mid-shaft radius fractures [7/41 (17%), p-value = 0.004]. There was no difference in LOR by location for ulna fractures [proximal = 2/13 (15%), middle = 4/38 (11%), distal = 20/77 (26%), p-value >0.08]. There was no difference in radial LOR in patients with isolated radius fractures compared with both bone forearm fracture (17/40 vs. 40/125, p-value = 0.22), or ulnar LOR between isolated ulna and both bone forearm fracture (0/3 vs. 26/125, p-value >0.99), Dittmer et al. 2019.[3] Initial complete displacement and the degree of obliquity of the fracture were the most important risk factors for redisplacement. Fractures that were completely displaced initially were 11.7 times more likely to redisplace than were angulated but incompletely displaced fractures. A 20° oblique fracture was 4.9 times more likely to redisplace and a 30° oblique fracture was 10.9 times more likely to redisplace than a 0° true transverse fracture. The three-point index was superior to the other radiographic indices for predicting redisplacement, with a sensitivity of 94.7%, a specificity of 95.2%, a negative predictive value of 98.4%, and a positive predictive value of 85.7%. The gap index was the next-best measure, but it had a sensitivity of 63.2%, a specificity of 76.2%, a negative predictive value of 87.3%, and a positive predictive value of 44.4%.[11] There was no significant difference in limitation of elbow flexion in 2 groups with mean limitation of flexion being 9.44 degrees ± 9.22 in LAC and 11.94 degrees ± 8.25 in DSTS group. In the previous study conducted by Colaris et al.,[19] the limitation of flexion and extension of the elbow was 1.2 ± 4.4 degrees in long arm cast group. The cause of limitation in current study could be the fact this assessment was done at three months while in the previous study final assessment was done at six months.

Using Daruwalla grading system for limitation of pronation and supination, excellent result was seen in 33.3% cases, good in 27.78%, fair in 16.17% and poor in 22.22% in the LAC group while in the DSTS group excellent result was seen in 11.11%, good in 44.44%, fair in 27.78% and poor result in 16.17% of cases.[20] In the previous study by Colaris et al.,[19] the results in the LAC-alone group were excellent in 21%, good in 38%, fair in 26%, and poor in 15%.

There was no significant difference in the cast comfort as evidenced by VAS score of 5.67 ± 0.77 and 5.50 ± 0.79 respectively in LAC and DSTS group. The findings match with the previous study by Dittmer et al.[3] Comparing the functional result in recent literature is complicated by different outcome measures and treatment techniques. Activity score for children[12] was used as a measure for functional outcome and no significant difference (p-value= 0.436) was found between two groups regarding total and sub group scores. Similar finding was found by Colaris et al. (2013),[19] which reported that there were no significant differences in activities of daily living in the two groups. There were no cast related complications encountered in the two groups. The previous study by Levy et al.,[2] shows no significance in complications as well.

The limitations of the study are: this was a single centre study with small sample size and short follow-up.

CONCLUSION

DSTS is safe and as effective as LAC for six weeks in the treatment of closed fractures in distal forearm in children. Both methods were identical in terms functional outcome, maintenance of reduction and other complications and time to union. As remodelling process is faster in children management of nonunion/ delayed union could not be assessed and the recovery of movement of forearm could not be evaluated properly. So, a longer duration of study is recommended for better evaluation and management of complications.

Conflict of interest: None
Source(s) of support: None

REFERENCES

1. Flynn JM, Skaggs DL, Waters PM, editors. Rockwood & Wilkins' fractures in children. 8th ed. Philadelphia (PA): Wolters Kluwer Health; 2015. [Full Text]
2. Levy J, Ernat J, Song D, Cook JB, Judd D, Shaha S. Outcomes of long-arm casting versus double-sugar-tong splinting of acute a distal forearm fractures. J Pediatr Orthop. 2015 Jan;35(1):11-7. [PubMed | Full Text | DOI]
3. Dittmer AJ, Molina D 4th, Jacobs CA, Walker J, Muchow RD. Paediatric forearm fractures are effectively immobilised with a sugar-tong splint following closed reduction. J Pediatr Orthop. 2019 Apr;39(4):e245-7. [PubMed | Full Text | DOI]
4. Lee JH, Hong SH, Kim YJ, Back JH, Lee JS. Effect of different splints on displacement after closed reduction of the distal radius fractures: A comparison of short arm double splint and sugar-tong splint. J Korean Soc Surg Hand. 2015 Sep;20(3):104-9. [Full Text | DOI]
5. Bae DS, Valim C, Connell P, Brustowicz KA, Waters PM. Bivalved versus circumferential cast immobilisation for displaced forearm fractures: A randomised clinical trial to assess efficacy and safety. J Pediatr Orthop. 2017 Jun;37(4):239-46. [PubMed | Full Text | DOI]
6. Boutis K, Willan A, Babyn P, Goeree R, Howard A. Cast versus splint in children with minimally angulated fractures of the distal radius: A randomised controlled trial. Can Med Assoc J. 2010 Oct;182(14):1507-12. [PubMed | Full Text | DOI]
7. Hendrickx RPM, Campo MM, van Lieshout APW, Struijs PAA, van den Bekerom MPJ. Above-or below-elbow casts for distal third forearm fractures in children? A meta-analysis of the literature. Arch Orthop Traum Surg. 2011 Dec;131(12):1663-71. [PubMed | Full Text | DOI]
8. Bohm ER, Bubbar V, Yong-Hing K, Dzus A. Above and below-the-elbow plaster casts for distal forearm fractures in children: A randomised controlled trial. J Bone Joint Surg Am. 2006 Jan;88(1):1-8. [PubMed | Full Text | DOI]
9. Bong MR, Egol KA, Leibman M, Koval KJ. A comparison of immediate postreduction splinting constructs for controlling initial displacement of fractures of the distal radius: A prospective randomised study of long-arm versus short-arm splinting. J Hand Surg Am. 2006 May;31(5):766-70. [PubMed | Full Text | DOI]
10. Nepal Health Research Council (NHRC). National ethical guidelines for health research in Nepal, 2019 [internet]. Kathmandu: NHRC; 2019. Available from: https://nhrc.gov.np/wp-content/uploads/2019/10/ERB_Guideline_2019.pdf. [Full Text]
11. Alemdaroğlu KB, Iltar S, **Çimen** O, Uysal M, Alagöz E, Atlihan D. Risk factors in redisplacement of distal radial fractures in children. J Bone Joint Surg Am. 2008 Jun;90(6):1224-30. [PubMed | Full Text | DOI]
12. Young NL, Williams JI, Yoshida KK, Wright JG. Measurement properties of the activities scale for kids. J Clin Epidemiol. 2000 Feb;53(2):125-37. [PubMed | Full Text | DOI]
13. Shields BJ, Cohen DM, Harbeck-Weber C, Powers JD, Smith GA. Paediatric pain measurement using a visual analogue scale: A comparison of two teaching methods. Clin Pediatr (Phila). 2003 Apr;42(3):227-34. [PubMed | Full Text | DOI]
14. Luther G, Miller P, Waters PM, Bae DS. Radiographic evaluation during treatment of paediatric forearm fractures: implications on clinical care and cost. J Pediatr Orthop. 2016 Jul;36(5):465-71. [PubMed | Full Text | DOI]
15. McQuinn AG, Jaarsma RL. Risk factors for redisplacement of paediatric distal forearm and distal radius fractures. J Pediatr Orthop. 2012 Oct-Nov;32(7):687-92. [PubMed | Full Text | DOI]
16. Acree JS, Schlechter J, Buzin S. Cost analysis and performance in distal paediatric forearm fractures: is a short-arm cast superior to a sugar-tong splint? J Pediatr Orthop B. 2017 Sep;26(5):424-8. [PubMed | Full Text | DOI]
17. Murphy RF, Plumblee L, Sleasman B, Barfield W, Dow MA, Mooney JF 3rd. Clinical and radiographic comparison of single-sugar-tong splint to long-arm cast immobilisation for paediatric forearm fractures. J Pediatr Orthop B. 2019 Nov;28(6):549-552. [PubMed | Full Text | DOI]
18. Goldstein RY, Otsuka NY, Egol KA. Re-displacement of extraphyseal distal radius fractures following initial reduction in skeletally immature patients: Can it be prevented? Bull Hosp Jt Dis. 2013;71(2):132-7. [PubMed | Full Text]
19. Colaris JW, Biter LU, Allema JH, Bloem RM, van de Ven CP, de Vries MR, et al. Below-elbow cast for metaphyseal both-bone fractures of the distal forearm in children: A randomised multicentre study. Injury. 2012 Jul;43(7):1107-11. [PubMed | Full Text | DOI]
20. Daruwalla JS. A study of radioulnar movements following fractures of the forearm in children. Clin Orthop Relat Res. 1979 Mar;(139):114-20. [PubMed | Full Text]