Journal of Pediatric Surgery Open 14 (2026) 100278

Contents lists available at ScienceDirect

Journal of Pediatric Surgery Open

journal homepage: www.elsevier.com/locate/yjpso

Evaluation of the volar flexion ulnar deviation cast (Schede Position) in paediatric distal radius fractures: A retrospective analysis and multicenter survey

Sandra Hackl [a,*], Aybike Hofmann [b], Christian Knorr [c], Hans J. Schlitt [a], Christoph Matissek [d], Thomas Franz Krebs [d], Markus Denzinger [d]

[a] Department of Surgery, University Hospital Regensburg, Regensburg 93053, Germany
[b] Department of Paediatric Urology, Marienhaus Hospital Neuwied, Neuwied 56564, Germany
[c] Department of Paediatric Surgery, RoMed Hospital Rosenheim, Rosenheim 83022, Germany
[d] Department of Paediatric Surgery, Children's Hospital of Eastern Switzerland St. Gallen, St. Gallen 9000, Switzerland

ARTICLE INFO

Keywords:
Distal radius fracture
Schede position
Paediatric fracture management
Conservative treatment

ABSTRACT

Background: Distal radius fractures are the most common fractures in children. Immobilisation in volar flexion and ulnar deviation is particularly used in the German-speaking region, where it is referred to as the Schede position, though its effectiveness is not well supported by scientific evidence. This study assessed short-term radiographic changes in angular alignment associated with Schede immobilisation compared with neutral casting and gathered data on the experience of other German paediatric surgical departments with this method of immobilisation.

Methods: This retrospective study included 362 children (< 18 years) with conservatively treated distal radius fractures between 2014 and 2023. Radiological outcomes were assessed by measuring angular deviation in anteroposterior and lateral views before and after several days of immobilisation. The primary outcome was the change in angular deviation from the initial to the follow-up radiograph. Additionally, a nationwide survey was conducted among German paediatric surgical clinics to assess clinical practice.

Results: Children treated in the Schede position had greater initial lateral angular deviation, reflecting non-random treatment allocation. Schede immobilisation was associated with significantly greater median change in lateral angular deviation compared with neutral position casting (median Δ4.8° vs. Δ2.8°). In 86 % of cases in the Schede group, the angular deviation improved between the initial and follow-up radiographs, compared with 59 % in the control group. In the survey, 88 % of departments reported using the Schede position, most centres rated their experience as "good" or "very good" (88.3 %) and 40 % reported using objective criteria to define the indication for Schede immobilisation.

Introduction

Distal forearm fractures are the most common fractures in childhood [1–3], typically resulting from a fall onto an outstretched, dorsally extended hand [4,5]. The peak incidence of this injury occurs between the ages of 10 and 12 years in girls and between 12 and 14 years in boys [2].

Treatment decisions for distal radius fractures in children are more complex than in adults due to the higher remodelling capacity of the growing bone [6]. Management primarily depends on patient age, but also on other factors such as fracture location, fracture type and degree of displacement [1,4,5,7]. While surgical intervention is usually indicated for unstable fractures or those with unacceptable displacement, the most commonly used technique is Kirschner wire fixation [7,8]. However, conservative and outpatient treatment is often preferred by both children and their parents [9].

Non-displaced fractures or those with a high likelihood of spontaneous correction are typically managed conservatively. Depending on the child's age, immobilisation is generally required for three to four weeks. The method of immobilisation varies depending on individual

* Corresponding author.
E-mail address: sandra.hackl@stud.uni-regensburg.de (S. Hackl).

https://doi.org/10.1016/j.yjpso.2026.100278
Received 6 October 2025; Received in revised form 25 January 2026; Accepted 17 March 2026
Available online 18 March 2026

factors [7]. Various conservative treatment options are available. Immobilisation in a plaster splint, with or without subsequent conversion to a circular cast during treatment, is often sufficient. In some cases additional interventions such as plaster wedging or closed reduction may be needed for fractures with significant malalignment [8].

Immobilisation in palmar flexion and ulnar deviation has historically been described as a conservative treatment strategy for distal radius fractures. Early techniques involving pronounced flexion were later modified due to concerns such as median nerve compression [10,11]. In German-speaking countries, a moderated form of this positioning is commonly referred to as the Schede position [5]. The technique is named after the German surgeon Franz Schede, who developed this method in the first half of the 20th century [12]. Although not generally recommended for adults due to potential complications such as carpal tunnel syndrome or complex regional pain syndrome (CRPS) [13,14], it remains widely used in paediatric trauma care in German-speaking countries [15,16].

To date, however, there is a lack of scientific studies evaluating the effectiveness of the Schede position in children. While several previous studies in adult populations have reported superior results with dorsiflexion immobilisation, their findings cannot be directly applied to paediatric patients due to differences in bone physiology, remodelling potential and complication profiles [17]. This highlights a relevant knowledge gap.

The aim of the present study was to evaluate whether immobilisation in Volar Flexion Ulnar Deviation Cast (Schede Position) is associated with measurable changes in angular alignment and whether these changes more frequently represent an improvement compared to neutral position casting in children with distal radius fractures. Additionally, we conducted a nationwide survey among paediatric trauma centres in Germany to evaluate the current use and experience with this type of immobilisation.

Materials and methods

Our retrospective electronic data analysis included all patients from a paediatric surgical department who were treated conservatively for distal forearm fractures. The study employed a retrospective consecutive sampling approach, including all eligible patients who presented during the defined study period in our outpatient clinic. The study was approved by the Ethics Committee of the University of Regensburg (Reference number: 22-2821-104; approval date: 16.02.2022).

The study included all patients under the age of 18 who presented for follow-up between 1 January 2014 and 31 December 2023 and who had both an initial post-injury radiograph and a follow-up radiograph to check alignment. Most children initially received treatment in the emergency department of our paediatric surgical unit. Patients who were initially treated in external facilities and later presented to our institution for follow-up evaluation were seen via the outpatient department.

For data analysis, only patients who were immobilised in either neutral position (control group) or Volar Flexion Ulnar Deviation (intervention or Schede position group) were retrospectively included. The decision to use Schede positioning was made at the discretion of the treating physician and was generally based on a greater initial angular deviation of the fracture fragments. Treatment allocation was therefore non-randomised and reflected routine clinical practice rather than group comparability. No multivariable adjustment for baseline angular deviation was performed in the present analysis. Accordingly, between-group comparisons should be interpreted as descriptive associations and not as comparative effectiveness estimates.

Patients with epiphyseal, metaphyseal and diametaphyseal fractures were included. The definition of the diametaphyseal region was based on previously published criteria [18]. These fractures were categorised into torus, greenstick and complete fractures, with fractures involving the growth plate (physis) in children being classified according to the Aitken and Salter-Harris classification [19]. Distal forearm fractures with ulnar involvement were also considered, provided that the radial fracture met the previously mentioned criteria. Additionally, patients initially treated at another hospital and referred to us later were included only if the external radiograph and relevant data for the study were available. Exclusion from the study occurred in cases of incomplete data, if the children underwent surgical treatment either primarily or before the second radiographic follow-up or if a change in the type of immobilisation occurred between the initial treatment and the follow-up assessment. Patients treated using methods other than neutral or Schede positions, such as with specialised splints or other devices, were also excluded. All patients meeting the inclusion criteria described above were assigned to one of the two treatment groups, with all relevant data recorded in an anonymised spreadsheet using Microsoft Excel 2024. The measurements were performed using the hospital's imaging software PACS (JiveX).

All radiographic measurements were performed by a single investigator experienced in paediatric trauma imaging. Angulation was measured in anteroposterior and lateral projections by drawing lines along the longitudinal axes of the proximal and distal fracture fragments. To enhance measurement consistency, all images were reviewed under identical viewing conditions. Blinding to treatment allocation was not feasible, as the cast position (neutral versus volar flexion and ulnar deviation) was readily identifiable on the radiographs. Interobserver reliability was not formally assessed due to the retrospective design. However, measurements were performed in a consistent manner throughout the study period.

Angular deviation was measured in standard anteroposterior and lateral projections on initial and follow-up radiographs. Δ-values were calculated as post- minus pre-intervention angles. For statistical purposes, negative Δ-values were converted to absolute values. However, direction of change was analysed separately by reporting the proportion of fractures demonstrating true radiographic improvement.

All statistical analyses were performed using IBM® SPSS Statistics 29. Baseline characteristics are presented as the mean $\pm$ standard deviation or median (minimum to maximum) for continuous variables and as number (percentage) for categorical variables. Normality was assessed using frequency distribution (histogram) and the Shapiro-Wilk test. Normally distributed continuous data were analysed with an unpaired or paired Student's t-test. The Mann-Whitney U test and Wilcoxon signed-rank test were used for non-normally distributed ordinal data. Categorical data were compared using the χ^2 test or Fisher's exact test, as appropriate. Multivariate analysis of variance (MANOVA) was conducted to assess potential confounding effects. Post-hoc analyses were conducted using the Mann-Whitney U test with the Dunn-Bonferroni method for adjusting multiple comparisons. The level of statistical significance was set at $p < 0.05$.

To complement the retrospective data analysis, a nationwide survey was conducted among paediatric surgical departments in Germany, with the aim of collecting information on the clinical application of the Schede position in the treatment of distal forearm fractures in children and to better contextualise the clinical relevance of the findings. The selection of contacted institutions was based on the clinic list of the German Society of Paediatric Surgery (https://www.dgkjch.de/component/fabrik/list/2, last access 01.01.2024).

For the survey, the questionnaire was initially sent by email to the administrative offices of paediatric surgical departments, using the contact information provided on each department's official website. In cases where it was indicated that the treatment of paediatric forearm fractures was not carried out within the paediatric surgery department, the questionnaire was forwarded to the appropriate department — usually trauma or orthopaedic surgery. If no response was received, follow-up telephone calls were made to the respective offices, requesting participation and the return of the completed questionnaire. The responses were reviewed and the collected data were transferred to Microsoft Excel for further analysis. The questionnaire comprised four yes/no questions and one item using a five-point Likert scale, ranging from "very good" to "very poor". In addition, questions 2 to 5 also contained a free-text field for additional comments. The five items addressed (1) use of the Schede position, (2) subjective clinical experience with this technique, (3) existence of objective indication criteria, (4) recommended positioning or degree of flexion and (5) standardised protocols regarding duration of immobilisation and transition to neutral positioning. The results were presented using pie charts to show the frequency of each answer using GraphPad Prism 6.

Results

Between 2014 and 2023, a total of 541 children with 543 conservatively treated distal forearm fractures were presented for follow-up. Two children sustained bilateral fractures and were analysed as single patients to avoid double counting. A total of 181 fractures (33.3 %) were excluded from the analysis: 62 due to incomplete radiological documentation, 92 due to immobilisation techniques other than neutral or Schede positioning (e.g. orthoses, casts in marked dorsal extension) and 27 due to an intervention between the two radiographs (22 following reduction, 5 with treatment modification before the second radiograph). Consequently, 362 patients (66.7 %) were included in the study. An overview of patient selection is shown in Fig. 1.

Most of the patients were male (n = 235, 64.9 %; male-to-female ratio of 1.8:1), the median age was 10 years (IQR 7–12). Patients in the Schede group were younger (median 9 years, IQR 6–12) than in the control group (median 10 years, IQR 7–12), but this difference was not statistically significant ($p = 0.120$). The age range extended from 1 year 3 months to 17 years. For statistical analysis, the children were divided into three age groups: 0–6 years (preschool), 7–12 years (school age) and 13–17 years (teenagers). This classification was chosen to reflect both developmental considerations and thresholds for acceptable residual angular deviation reported in the literature [8,20,21].

Of the 362 patients, 205 (56.63 %) were treated in neutral position (control group) and 157 (43.37 %) in Schede position. If a change in treatment occurred after the alignment check and radiological follow-up (e.g. switching to another cast type), patients were analysed according to their initial allocation, as the primary endpoint had already been assessed.

In the control group, 35 children (17.07 %) were initially seen in another clinic, while in the Schede group, this applied to 10 children (6.37 %). In both treatment groups, the first radiograph was taken on the day of the injury in most cases. Only one patient had the initial radiograph taken more than three days later. The alignment check was usually performed after 4–10 days in both groups, with a small number of patients (n = 26) undergoing radiological follow-up outside this time frame. The mean duration of immobilisation was similar between the two groups: in the control group it was 26.20 days (SD 5.10) and in the Schede group 25.63 days (SD 4.09), with an age-adjusted and clinic-specific standard applied for treatment duration. The mean cast angle in the Schede group was 41.3°.

The distribution of fracture types is shown in Table 1. While greenstick fractures were the most common fracture type in the control group (35.1 %), complete fractures were most frequent in the Schede group (45.2 %).

Comparative analysis indicated a significant association between group and fracture type distribution ($p < .001$).

A MANOVA showed no relevant differences in imaging protocols between groups.

In the control group, a total of 48 fractures involving the growth plate in children (according to the Aitken/Salter-Harris classification) were observed, including Aitken type 1/Salter-Harris type 2 (n=45; 93.75 %), Aitken type 2/Salter-Harris type 3 (n=2; 4.17 %), and Aitken type 3/Salter-Harris type 4 (n=1; 2.08 %). In the Schede group, there was a total of 42 fractures involving the growth plate, with Aitken type 1/Salter-Harris type 2 again being the most common (n=37; 88.10 %), followed by Aitken type 0/Salter-Harris type 1 (n=3; 7.14 %) and Aitken type 2/Salter-Harris type 3 (n=2; 4.76 %). Metaphyseal fractures were

Table 1
Comparison of fracture type distribution between the control group and the Schede group.

Group		Frequency	Percent
Control	Complete Fracture	66	32.2
	Greenstick Fracture	72	35.1
	Fractures involving growth plate (physis) according to Aitken or Salter-Harris classification	48	23.4
	Buckle Fracture	19	9.3
	Total	205	100.0
Schede	Complete Fracture	71	45.2
	Greenstick Fracture	44	28.0
	Fractures involving growth plate (physis) according to Aitken or Salter-Harris classification	42	26.8
	Buckle Fracture	0	0
	Total	157	100.0

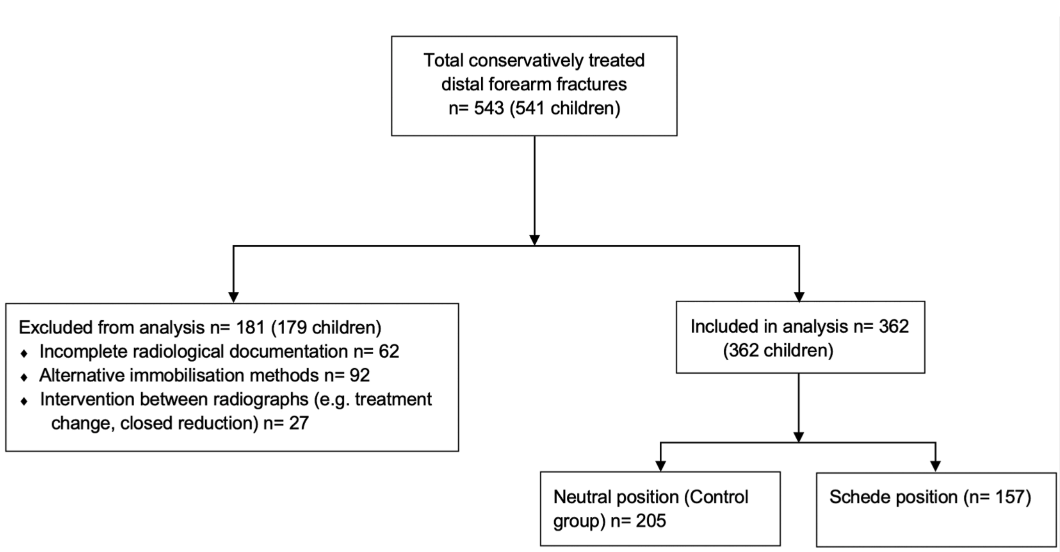

Fig. 1. Patient selection flow chart for the retrospective cohort analysis.

the most common location in both groups. Further details are presented in Table 2.

The frequency distribution of associated diagnoses is shown in Table 3. In both groups, the majority of these involved the ulna, most commonly as a fracture of the ulnar styloid process (USP).

Complications occurred in 6 cases (2.93 %) in the control group: 4 requiring surgery due to secondary displacement and 2 refractures. A refracture is defined as a new fracture at the same location within one year of the initial fracture [22,23]. In the Schede group complications occurred in 9 cases (5.73 %): 2 requiring surgery due to secondary displacement, 5 refractures, 1 surgical repositioning due to persistent angular deviation and 1 surgery after failed planned plaster wedging. Relevant refractures were more frequent in the Schede group, whereas secondary displacement requiring surgery was slightly less common. The overall complication rate did not differ significantly ($p = 0.196$).

After the second radiographic assessment, a change in treatment was made in 16 children (7.80 %) in the control group and 13 (8.28 %) in the Schede group, occurring slightly more frequently in the latter. This difference was not statistically significant ($p = 1.000$). The most common change in both groups was conversion to a forearm orthosis. Median time to treatment change following radiographic evaluation was 7 days (range 4–21 days) in both groups.

Pre-interventional lateral angular deviation differed significantly between the two groups (control group: median 11.9°, range 0.8–29.7° vs. Schede: 15.7°, range 1.9–40.3°; $p < 0.001$). This reflects clinical indication and limits direct comparability between groups. In contrast, AP deviation did not differ significantly (control group: 1.9°, range 0.1–15.5°; Schede group: 2.2°, range 0.1–22.2°; $p = 0.317$).

No significant group differences were found in post-interventional deviation in either AP ($p = 0.896$) or lateral view ($p = 0.145$). Δ-values (post- minus pre-intervention) differed significantly between groups in both planes (AP $p = 0.014$; lateral $p < 0.001$). In the lateral view, median deviation decreased from 15.7° to 9.9° in the Schede group and from 11.9° to 11.3° in the control group (Table 4).

In lateral view, improvement (defined as a reduction in angular deviation from baseline to follow-up) was observed in 135 patients (86 %) in the Schede group and 121 patients (59 %) in the control group ($p < 0.001$). In AP view, improvement was observed in 67 patients (42.7 %) in the Schede group and 121 patients (59 %) in the control group ($p = 0.174$). In the Schede group, fracture location significantly influenced improvement in AP view ($p = 0.002$), with post-hoc analyses showing greater improvement for diametaphyseal fractures compared to epiphyseal ($p = 0.001$) and metaphyseal fractures ($p = 0.003$). No significant effects of fracture type or associated injuries were found. In the control group, improvement was not significantly influenced by fracture type, location, or associated injuries. However, age group showed a significant effect on AP view improvement ($p = 0.034$), with post-hoc testing indicating differences between age groups 1 and 2 ($p = 0.038$) and between groups 2 and 3 ($p = 0.042$).

As part of the survey, 90 institutions were contacted and 43 completed questionnaires were included in the analysis, corresponding to a response rate of 47.8 %. The results are depicted in Fig. 2.

Regarding Question 1 ("Is immobilisation in the Schede position used in your clinic?"), 38 of 43 responding clinics (88.4 %) reported using the Schede position.

Table 2
Comparison of fracture location distribution between the control group and the Schede group.

Group		Frequency	Percent
Control	diametaphyseal	61	29.8
	epiphyseal	48	23.4
	metaphyseal	96	46.8
	Total	205	100.0
Schede	diametaphyseal	37	23.6
	epiphyseal	42	26.8
	metaphyseal	78	49.7
	Total	157	100.0

Table 3
Comparison of frequency distribution of associated diagnoses between the control group and the Schede group.

Group		Frequency	Percent
Control	None	136	66.3
	USP	27	13.2
	Ulnar Buckle Fracture	18	8.8
	Complete Ulnar Fracture	14	6.8
	Ulnar Greenstick Fracture	10	4.9
	Total	205	100.0
Schede	None	87	55.4
	USP	37	23.6
	Ulnar Buckle Fracture	13	8.3
	Complete Ulnar Fracture	10	6.4
	Ulnar Greenstick Fracture	9	5.7
	Ulnar fractures involving growth plate (physis) according to Aitken or Salter-Harris classification	1	.6
	Total	157	100.0

Table 4
Comparison of angular deviation in anterior-posterior view (AP view) and lateral view before and after intervention between the Schede group and the control group.

Angular deviation in degree median [range]	Schede Group (n=157)	Control Group (n=205)
AP view pre-intervention	2.2 [0.1–22.2]	1.9 [0.1–15.5]
AP view post-intervention	2.3 [0–27.5]	2.3 [0.1–37.3]
Δ AP view (pre-post)	2.4 [0–25.3]	1.7 [0–31.9]
Lateral view pre-intervention	15.7 [1.9–40.3]	11.9 [0.8–29.7]
Lateral view post-intervention	9.9 [0.5–30.5]	11.3 [0.2–30.7]
Δ Lateral view (pre-post)	4.8 [0.1–23.5]	2.8 [0–36.8]

For Question 2 ("What has been your own experience with immobilisation in the Schede position?"), most centres rated their experience as "good" or "very good" (88.3 %). Free-text comments frequently referred to perceived prevention of secondary displacement or avoidance of surgery, as well as generally good tolerance of the wrist position in children.

With respect to Question 3 ("Are there objective criteria for determining the indication for this treatment in your clinic?"), 17 clinics (39.5 %) reported using defined criteria, most based on age and degree of displacement, with dorsal angulation thresholds typically between 10° and 20°. Other centres described individualised decision-making based on fracture characteristics, patient age and perceived risk of secondary displacement.

For Question 4 ("Is there a recommendation in your clinic regarding the position or degree of flexion used for immobilisation?"), 13 clinics (30.2 %) reported defined recommendations, most commonly within a range of 30–45°. In the remaining centres, flexion was determined individually according to fracture characteristics or patient tolerance.

Regarding Question 5 ("Is there a standard procedure in your clinic regarding the duration of immobilisation and/or transition to neutral positioning?"), 33 clinics (76.7 %) reported having a standardised protocol. Fourteen clinics indicated that they do not routinely transition to a neutral position, while others reported transition after one ($n = 3$), two ($n = 8$), or three weeks ($n = 3$).

Discussion

Distal radius fractures are the most common fractures in children [1–3], mostly presenting as extension fractures [4,5], highlighting the clinical importance of this topic. The treatment of paediatric fractures generally depends on various factors, including the type and location of the fracture, the potential desire of the child and parents to resume

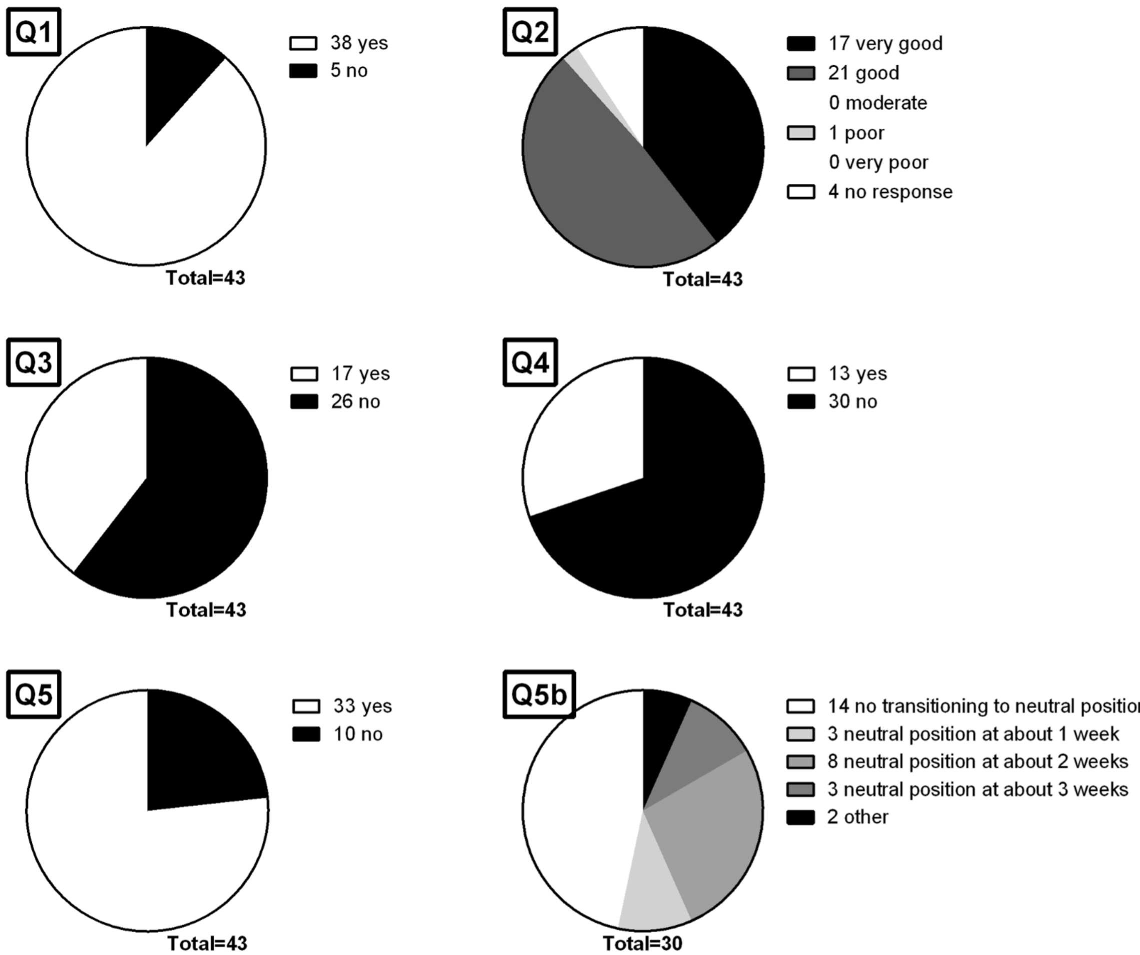

Fig. 2. Results of the survey questions regarding the clinical use of the Schede position.

sporting activities early and, in particular, the child's age with its associated remodelling potential [4]. This remodelling potential must be carefully considered to avoid unnecessary surgical interventions and anaesthesia [24]. A particularly high remodelling potential can be expected when the fracture is located close to a highly active growth plate [24]. This applies especially to the distal physis of the radius, which accounts for 75 % of the longitudinal growth of the radius and for 40 % of the entire upper limb [4,6]. A high remodelling potential is also anticipated for angular deviations in the sagittal plane, given that the range of motion in flexion and extension is greatest in this plane [6].

Angular thresholds for spontaneous correction vary by age. In children under 12 up to 35° in the sagittal and 15° in the frontal plane may be acceptable. In older children these limits are lower. Fractures exceeding these thresholds often require surgery [4,5,20]. In borderline cases, however, conservative techniques such as Volar Flexion Ulnar Deviation Casts (Schede Position) may be considered with the intention of avoiding surgery, particularly if angular deviation appears close to age-dependent thresholds. This conservative approach aligns with the preference of both parents and children to avoid surgery whenever possible [9].

This study evaluated the effectiveness of immobilisation in Schede position for children with distal radius fractures by comparing radiographic outcomes at initial presentation and at alignment control performed a few days later. Alignment control is clinically decisive, as it marks the last point at which a decision must be made whether the displacement is acceptable for the patient's age or operative treatment is required.

The patient demographics (median age 10 years, 64.9 % male) and distribution of fracture types were comparable to other cohorts [21,25,26]. However, a discrepancy was observed in the frequency of buckle fractures. Although this fracture type is very common in children, it was rarely observed among the patients included in the present study [26]. This is because, in our clinic, they are usually managed with an orthosis and follow-up often does not include additional radiographs, which was an exclusion criterion.

Compared to other prospective studies with cohort sizes ranging from 64 to 204 patients, our retrospective cohort of 362 children represents a valid sample with a significantly larger patient population and, consequently, greater statistical power [27–30]. While prospective studies are often favoured due to their forward-looking design and the ability to conduct structured follow-up, our retrospective study offers the advantage of drawing on existing data, allowing for the inclusion of a larger number of patients. This enables a more comprehensive analysis of rare events, such as refractures following distal radius fractures [31]. However, the retrospective and non-randomised study design introduces relevant confounding by indication. Immobilisation in the Schede position was preferentially applied in fractures with greater initial angular deviation, particularly in the sagittal plane. Consequently, baseline severity differed between groups, and observed differences in angular change cannot be interpreted as causal treatment effects. Regression toward the mean may have contributed to the observed changes in angular deviation. Without multivariable adjustment or stratified analysis according to baseline severity, it cannot be determined whether the observed differences in angular change are attributable to immobilisation technique or represent regression toward the mean. In addition, subgroup analyses according to fracture type (complete, greenstick and epiphyseal fractures) were not performed in the present evaluation due to limited subgroup sizes. This further limits the interpretability of between-group comparisons and restricts conclusions to the overall cohort.

In our study additional MANOVA analysis confirmed that the number of radiographs obtained was sufficiently consistent across groups, indicating that differences in imaging protocol were unlikely to bias the radiographic outcome assessment.

Regarding the primary endpoint – the change and improvement of angular deviation at radiological follow-up – Schede immobilisation was associated with greater changes in lateral angular deviation compared with neutral casting. In lateral radiographs, the Schede group exhibited greater changes in angular deviation from baseline to follow-up (median $\Delta 4.8^\circ$ vs. 2.8°; mean $\Delta 6.4^\circ$ vs. 3.8°), with the majority of these changes reflecting true correction of the fracture alignment. The absolute difference in median lateral correction between groups was approximately 2°, which represents a modest radiographic change and, by itself, does not establish clinical superiority. In contrast, changes in the control group were markedly smaller and showed no consistent clear trend toward improvement or deterioration. Importantly, 86 % of fractures in the Schede group demonstrated actual improvement, whereas only 59 % of the control group did, and 41 % of control cases even tended toward further deterioration. These findings highlight a key difference between the groups:

They suggest that the Schede position was associated with larger changes in angular deviation, whereas the control group showed smaller and more variable changes. Even minor improvements in alignment may be relevant in selected borderline situations. However, this interpretation remains speculative and cannot be confirmed by the present data. These observations may be considered in clinical decision-making, as radiological alignment assessment often represents the final point at which treatment strategy is re-evaluated.

The observed median differences in angular change were modest and should be interpreted cautiously. As absolute Δ-values reflect magnitude rather than direction of change, interpretation primarily relies on the proportion of fractures demonstrating true radiographic improvement. These differences do not imply clinical superiority of either immobilisation technique. Although a higher proportion of fractures in the Schede group showed radiographic improvement in the lateral plane, this finding must be interpreted in the context of baseline differences and potential regression toward the mean. It was not possible to retrospectively determine how often alignment changes crossed age-specific surgical thresholds, as no universally accepted correction limits exist and treatment decisions are inherently individualised and may vary between physicians at initial presentation and during follow-up. Routine documentation does not specify whether the application of the Schede position aimed to avoid surgery or whether the achieved correction was considered sufficient to prevent operative treatment. As an indirect clinical measure, the rate of secondary surgical interventions was analysed and was comparable between groups despite greater baseline deformity in the Schede cohort. Overall, these findings are descriptive and hypothesis-generating rather than evidence of comparative effectiveness.

Fractures treated with the Schede position generally showed greater initial angular deviation or displacement, as the method is typically applied to more severely misaligned fractures. This complicates direct comparison with fractures that are well aligned and suitable for standard cast treatment. Nevertheless, the Schede group showed no neurological issues like median nerve compression or increase in surgery due to secondary displacement despite these more pronounced initial deformities until follow-up examination. Within the limits of short-term observation, no increased rate of early neurological complications or secondary displacement was observed in the Schede group. However, these data do not allow conclusions regarding comparative long-term safety.

Another important limitation is that the present study assessed only short-term radiographic alignment at early follow-up. No functional outcomes, patient-reported measures, or standardized long-term radiographic assessments were evaluated. Therefore, conclusions are limited to early alignment changes and do not allow statements regarding long-term functional outcome, treatment success, or superiority of one immobilisation technique over another.

While many clinics report positive experiences with the Schede position and it is widely used by paediatric trauma surgeons, findings from adult studies suggest differing outcomes. Gupta et al. evaluated displaced extension fractures immobilised after closed reduction in palmar flexion, neutral position, or dorsiflexion in adults, with a mean age of 46 years. They found dorsiflexion to result in the lowest rate of secondary displacement and best functional outcomes [27]. These findings cannot be directly extrapolated to paediatric cases due to age-related anatomical, physiological and biomechanical differences [17].

In our study, the rate of secondary displacement requiring surgery was numerically lower in the Schede group despite generally greater baseline displacement. As previously discussed, avoiding surgery is a key consideration in treatment decisions for paediatric patients [9]. However, given the non-randomised design and baseline differences, this observation should be interpreted cautiously and not as evidence of a protective effect.

Notably, no cases of carpal tunnel syndrome due to median nerve compression, previously described in adult populations with palmar flexion immobilisation [11], were observed in our cohort.

When compared with other paediatric studies, the rate of surgical intervention due to secondary displacement in the Schede group (1.27 %) was lower than rates reported in some published paediatric cohorts (up to 11.9 %) [32–34]. Direct comparison is limited due to differences in study design, patient selection and baseline fracture characteristics. Previous publications have suggested a possible association between Schede immobilisation and secondary displacement rates in extension fractures [35]. However, definitive conclusions cannot be drawn from observational data alone.

The rate of refracture in the Schede group was 3.18 %, which was slightly higher than in the control group (0.98 %). The overall complication rate in the Schede group (5.73 %) was numerically lower than rates reported in some paediatric studies, in which complication rates of up to 21.3 % have been described [32,34].

Comparable results were reported in a large retrospective multicenter study by Wintges et al., which described a low rate of secondary displacement (2.9 %) and no persistent neurological complications in over 700 paediatric cases treated with Schede cast immobilisation [12]. Our median (4.8°) and mean (6.4°) lateral angular correction aligns closely with their reported average (5.1°), showing comparable magnitudes of radiographic change. These similarities should be interpreted descriptively rather than as confirmation of efficacy or safety. Our study offers a higher level of methodological detail by including a control group and conducting subgroup analyses based on fracture type and anatomical localisation, enabling a more differentiated assessment of the efficacy and potential indications of Schede immobilisation.

Even minor changes of angular deviation can be clinically relevant in paediatric fracture management if they influence whether thresholds for conservative treatment versus surgery are exceeded. Thus, observed changes must be interpreted in consideration of age-dependent correction potential and established surgical indication criteria.

An alternative conservative treatment option is cast wedging, though there is also very limited scientific data available on this method. In one study of 183 paediatric forearm fractures treated with cast wedging, 11 fractures (6 %) healed unsatisfactorily and six further children (3 %) required re-manipulation with cast replacement [36]. Overall complication rates reached 9 %. In comparison with published data on cast wedging, the observed surgery and complication rates in the present cohort fall within a comparable range. Reported immobilisation duration in the cast wedging study was longer (7.4 weeks) than in the present cohort (3.7 weeks) [36]. Direct comparison, however, is limited due to differences in study design and patient selection.

Furthermore, cast wedging requires a follow-up visit 8–10 days post-injury, whereas Schede casting can be performed immediately, reducing medical visits and minimising the time burden [1,37]. Schede immobilisation, compared with cast wedging, aligns with the paediatric principle of minimal intervention [8], showing shorter immobilisation compared to cast wedging, which is an important factor for both children and their parents [9]. In paediatric trauma, overtreatment remains a concern, as fractures with high potential for spontaneous correction are often unnecessarily reduced or surgically treated due to limited knowledge and experience with conservative management [8,38].

Our survey of German paediatric trauma centres revealed that 88.4 % reported good or very good experience with Schede immobilisation, reflecting its widespread clinical use. However, only 39.5 % of centres apply objective criteria for its use, such as defined angular deviations. Only 30.2 % have specific recommendations regarding degree of flexion. Reported flexion angles varied between 30° and 90°, most commonly 30–45°. This heterogeneity illustrates the lack of standardisation regarding optimal immobilisation positioning.

The survey results must be interpreted with caution. The response rate of 47.8 % introduces the possibility of response and selection bias, potentially favouring institutions already using or positively disposed towards the Schede technique. In addition, reported indications, positioning angles and outcome assessments were heterogeneous and based on subjective institutional experience. Responses were not linked to patient-level outcome data. The survey therefore provides descriptive contextual information on current practice patterns rather than evidence of clinical efficacy.

In our study cohort, the average cast flexion was 41.3°, aligning with the most frequently reported range, suggesting a preference for moderate flexion to balance immobilisation efficacy and comfort. Nevertheless, the variability in practice highlights the need for standardised guidelines to optimise outcomes in paediatric distal radius fractures.

Overall, the present study provides structured observational data on a widely used technique in paediatric trauma care. Given the methodological limitations inherent to the retrospective design, prospective randomised studies are required before any comparative or practice-changing conclusions can be drawn. The findings relate exclusively to short-term radiographic alignment and do not allow conclusions regarding long-term functional benefit or superiority of one immobilisation technique over another.

CRediT authorship contribution statement

Sandra Hackl: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Aybike Hofmann:** Writing – review & editing, Writing – original draft, Visualization, Formal analysis. **Christian Knorr:** Writing – review & editing, Resources. **Hans J. Schlitt:** Writing – review & editing, Project administration. **Christoph Matissek:** Writing – review & editing. **Thomas Franz Krebs:** Writing – review & editing. **Markus Denzinger:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Resources, Methodology, Investigation, Conceptualization.

Declaration of competing interest

The authors declare no conflict of interest.

References

[1] I. Marzi, Kindertraumatologie, Springer, Berlin, Heidelberg, 2016. ISBN 978-3-642-44996-3.

[2] Distal Radius Fractures - Pediatric - Pediatrics - Orthobullets Available online: https://www.orthobullets.com/pediatrics/4014/distal-radius-fractures–pediatric (accessed on 11 March 2024).

[3] J.C. Cheng, W.Y. Shen, Limb fracture pattern in different pediatric age groups: a study of 3,350 Children, J. Orthop. Trauma 7 (1993) 15–22, https://doi.org/10.1097/00005131-199302000-00004.

[4] H. Khan, F. Monsell, S. Duffy, A. Trompeter, A. Bridgens, Y. Gelfer, Paediatric distal radius fractures: an instructional review for the FRCS examination, Eur. J. Orthop. Surg. Traumatol. 33 (2023) 2169–2172, https://doi.org/10.1007/s00590-022-03409-6.

[5] C. Konrads, C. Gonser, C. Bahrs, Frakturen des distalen radius, Z Orthop. Unf. 159 (2021) 217–231, https://doi.org/10.1055/a-1042-0567.

[6] A.R. Poublon, A.E. van der Windt, J.J.W. Ploegmakers, J.W. Colaris, Chapter 25 - pediatric distal radius fractures, in: J. Jupiter, M. Chammas (Eds.), Distal Radius Fractures, Elsevier, 2021, pp. 277–290. ISBN 978-0-323-75764-5.

[7] CME-Artikel: Distale Radiusfrakturen im Kindesalter – Sinn und Unsinn in der Versorgung Available online: https://www.bdc.de/cme-artikel-distale-radiusfrakturen-im-kindesalter-sinn-und-unsinn-in-der-versorgung/ (accessed on 22 January 2024).

[8] R. Kraus, Distale radiusfraktur im wachstumsalter, Trauma Berufskrankh. 16 (2014) 53–60, https://doi.org/10.1007/s10039-013-1932-y.

[9] Traumatologie im Kindesalter: OP-Indikation bei häufigen Frakturen - BDC|Online Available online: https://www.bdc.de/traumatologie-im-kindesalter-op-indikation-bei-haeufigen-frakturen/ (accessed on 14 March 2024).

[10] NITEP » Wrist Fracture Study Available online: https://nitep.eu/en/trials/wrist-fracture-study/ (accessed on 2 April 2024).

[11] A.C. Lynch, P.R. Lipscomb, The carpal tunnel syndrome and colles' fractures, JAMa 185 (1963) 363–366, https://doi.org/10.1001/jama.1963.03060050041018.

[12] K. Wintges, J. Schultz, R. Rausch, B. Schoof, M. Sahin, A. L, H. J, E. M, B. B, F. G, et al., Immobilization in a schede cast as a treatment option for distal forearm fractures in children and adolescents: findings on efficacy and safety, Dtsch. Arztebl. Int. (2025) 112, https://doi.org/10.3238/arztebl.m2025.0084.

[13] Dresing, D.K. Leitlinie distale radiusfraktur des erwachsenen.

[14] H. Towfigh, R. Hierner, M. Langer, R. Friedel, Frakturen und Luxationen der Hand, Springer, Berlin, Heidelberg, 2014. ISBN 978-3-642-40468-9.

[15] Kispi-Wiki Gipsen INS Available online: https://www.kispi-wiki.ch/interdisziplinare-notfallstation-ins/medikamente-ins/script-type-text-javascript-ConcreteAssetLoader-loadCSS-application-css-hideBlocks-css-ccm_nocache-b07a9175dd5c87ae12bd0dee74c9-4/gipsen-ins (accessed on 2 April 2024).

[16] Keßler, M. Häufige frakturen des ober- und unterarms bei kindern und jugendlichen 2007.

[17] L.M. Hove, C. Brudvik, Displaced paediatric fractures of the distal radius, Arch. Orthop. Trauma Surg. 128 (2008) 55–60, https://doi.org/10.1007/s00402-007-0473-x.

[18] D. Stark, M. Denzinger, L. Ebert, R. Brandl, C. Knorr, Therapeutic approaches of diametaphyseal radius fractures in children, Arch. Orthop. Trauma Surg. 144 (2024) 1179–1188, https://doi.org/10.1007/s00402-023-05118-z.

[19] A.P. Aitken, Fractures of the epiphyses, Clin. Orthop. Relat. Res. 41 (1965) 19–23.

[20] J.-J. Sinikumpu, Y. Nietosvaara, Treatment of distal forearm fractures in children, Scand. J. Surg. 110 (2021) 276–280, https://doi.org/10.1177/1457496920983104.

[21] E.M. Hedström, O. Svensson, U. Bergström, P. Michno, Epidemiology of fractures in children and adolescents, Acta Orthop. 81 (2010) 148–153, https://doi.org/10.3109/17453671003628780.

[22] S. Amilon, C. Bergdahl, E. Fridh, T. Backteman, J. Ekelund, D. Wennergren, How common are refractures in childhood? Bone Jt. J. 105-B (2023) 928–934, https://doi.org/10.1302/0301-620X.105B8.BJJ-2023-0013.R1.

[23] B. Han, Z. Wang, Y. Li, Y. Xu, H. Cai, Risk factors for refracture of the forearm in children treated with elastic stable intramedullary nailing, Int. Orthop. 43 (2019) 2093–2097, https://doi.org/10.1007/s00264-018-4184-4.

[24] L. von Laer, C. Hasler, Spontankorrekturen, wachstumsstörungen und posttraumatische deformitäten nach frakturen im bereich des vorderarms am wachsenden skelett, Handchir. Mikrochir. Plast. Chir. 32 (2000) 231–241, https://doi.org/10.1055/s-2000-10931.

[25] C.B. Corsino, R.A. Reeves, R.N. Sieg, Distal radius fractures. StatPearls, StatPearls Publishing, Treasure Island (FL), 2024.

[26] A.S. Shah, R.H. Guzek, M.L. Miller, M.C. Willey, S.T. Mahan, D.S. Bae, Pediatric distal radius fracture (PDRF) study group descriptive epidemiology of isolated distal radius fractures in children: results from a prospective multicenter registry, J. Pediatr. Orthop. 43 (2023) e1–e8, https://doi.org/10.1097/BPO.0000000000002288.

[27] A. Gupta, The treatment of colles' fracture. Immobilisation with the Wrist Dorsiflexed, J. Bone Jt. Surg. Br 73 (1991) 312–315, https://doi.org/10.1302/0301-620X.73B2.2005163.

[28] M. Grle, M. Miljko, I. Grle, F. Hodžić, T. Kapidžić, Early results of the conservative treatment of distal radius fractures-immobilization of the wrist in dorsal versus palmar flexion, Med. Glas. 14 (2017) 236–243, https://doi.org/10.17392/888-17.

[29] S. Rajan, S. Jain, A. Ray, P. Bhargava, Radiological and functional outcome in extra-articular fractures of lower end radius treated conservatively with respect to its position of immobilization, Indian J. Orthop. 42 (2008) 201–207, https://doi.org/10.4103/0019-5413.40258.

[30] M. Ax, A. Reito, T.P. Hevonkorpi, V. Palola, J. Kukkonen, T. Luokkala, M. K. Laitinen, A.P. Launonen, V.M. Mattila, A comparison of the functional results and costs of functional cast and volar-flexion ulnar deviation cast at 2-year follow-up in 105 patients aged 65 and older with dorsally displaced distal radius fracture: a randomized controlled trial, PLoS. One 18 (2023) e0283946, https://doi.org/10.1371/journal.pone.0283946.

[31] C. Weiß, Epidemiologische Studien, in: C. Weiß (Ed.), Basiswissen MedizinischeStatistik, Springer, Berlin, Heidelberg, 2013, pp. 219–240. ISBN 978-3-642-34261-5.
[32] A.G. McQuinn, R.L. Jaarsma, Risk factors for redisplacement of pediatric distal forearm and distal radius fractures, J. Pediatr. Orthop. 32 (2012) 687–692, https://doi.org/10.1097/BPO.0b013e31824b7525.
[33] D.S. Wendling-Keim, B. Wieser, H.-G Dietz, Closed reduction and immobilization of displaced distal radial fractures. Method of choice for the treatment of children? Eur. J. Trauma Emerg. Surg. 41 (2015) 421–428, https://doi.org/10.1007/s00068-014-0483-7.
[34] D. Großmann, W. Barthlen, Dislozierte distale Unterarmfraktur im Kindesalter, Trauma Berufskrankh. 16 (2014) 197–201, https://doi.org/10.1007/s10039-013-2012-z.
[35] J. Lieber, D.W. Sommerfeldt, Die diametaphysäre Unterarmfraktur im Kindesalter: Pitfalls und Empfehlungen in der Behandlung, Unfallchirurg 114 (2011) 292–299, https://doi.org/10.1007/s00113-011-1962-5.
[36] Gipskeilung bei sekundär dislozierten Frakturen, Rosenfluh Publikationen AG, 2021.
[37] Gipskeilung bei pädiatrischen Frakturen Available online: https://www.universimed.com/de/article/orthopaedie-traumatologie/gipskeilung-frakturen-297655 (accessed on 3 February 2025).
[38] L. von Laer, R. Kraus, 34 Komplikationen bei der Behandlung von Verletzungen im Wachstumsalter, 2010th ed., Thieme Verlag, 2010.