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Clinical Implications of Psychosocial Factors on Pediatric External Fixation Treatment and Recommendations

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Abstract

Background Pediatric limb reconstruction using circular external fixation is a prolonged treatment that interrupts patients' daily function. Patient personality characteristics and expectations may interfere with planned treatment, making complicated medical procedures more challenging. The aims of this study are to identify factors impacting treatment outcome and recommendations for preoperative evaluation and planning.

Questions/purposes (1) Are there group differences between patients with and without a preexisting mental health condition(s) in terms of unplanned reoperations? (2) Does the number of surgical procedures before current external fixator placement correlate with the number of unplanned readmissions, unplanned reoperations, and days spent in circular external fixation? (3) Are there group differences between single- compared with two-parent households in terms of inpatient narcotic doses, length of inpatient stay, number of unplanned readmissions, length of readmission(s), and/or unplanned outpatient clinic visits? (4) Does patient age at the time of surgery have an impact on treatment duration, postoperative complications, and treatment outcome?

Methods This is a retrospective chart review of pediatric patients who underwent limb reconstruction between 2008 and 2012. Patients with limb length discrepancy > 4 cm or severe angular deformity and who agreed to intervention were treated with circular external fixation. Sixty-seven patients were included; 16 patients were excluded. Statistical analyses included Pearson r correlation and t-test.

Results Patients who reported preexisting mental health diagnosis (13%) had more unplanned reoperations than patients who did not (no mental health diagnosis; 87%) (mental health diagnosis 3.4 ± 10.3 versus no mental health diagnosis 0.2 ± 0.5 reoperation[s], $p = 0.022$). Number of previous surgical procedures correlated with number of unplanned reoperations ($r = 0.448$, $p < 0.001$), number of unplanned readmissions ($r = 0.375$, $p < 0.001$), and number of days in an apparatus ($r = 0.275$, $p = 0.018$). Compared with patients from two-parent households, patients from single-parent households received a greater number of inpatient narcotic doses (single-parent 129 ± 118 versus two-parent 73 ± 109 doses, $p = 0.039$), longer length of inpatient stay (single-parent 73 ± 63 versus two-parent 40 ± 65 days, $p = 0.036$), more unplanned readmissions (single-parent 0.4 ± 0.1 versus two-parent 0.2 ± 0.2 readmission, $p = 0.024$), longer hospitalization when readmitted (single-parent 5 ± 11 versus two-parent 1 ± 3 day(s), $p = 0.025$), and fewer unplanned outpatient visits (single-parent 0.2 ± 0.8 versus two-parent 0.9 ± 1.1 visit, $p = 0.005$). Apparatus applications with successful outcome had higher average age than those with poor outcome (successful outcome 16 ± 3 versus poor outcome 13 ± 4 years old, $p = 0.011$). Age at time of apparatus application correlated with

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Each author certifies that his or her institution approved the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research.

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number of prescribed antibiotics ($r = 0.245$, $p = 0.036$) and number of days in an apparatus ($r = 0.233$, $p = 0.047$).

Conclusions As a result of the inherent challenges of limb reconstruction, surgical candidates should be preoperatively assessed and mitigating psychosocial factors managed to maximize successful treatment outcome.

Level of Evidence Level IV, therapeutic study.

Introduction

Circular external fixation in pediatrics has advantages and disadvantages. The advantages include: axial loading of the long bone segment to allow for better bone formation and consolidation, fixation of small and/or osteopenic bone fragments, high degree of adaptability, and ability to extend the apparatus across joints to address instability or subluxation during lengthening [18, 21, 22, 29, 30, 43, 50]. In contrast, the degree of interference with activities of daily living (ie, clothing, mobility), the intimidating nature of the device, and the fastidious attention to soft tissue swelling to prevent contact between rings and the skin are perceived disadvantages. Institutionally, we have seen patients and/or their families experiencing depression, sleep deprivation, inability to function academically, relapse into drug/alcohol abuse, and at least one incident each of pyromania (as an escape mechanism) and maternal abandonment. We have also learned that orthopaedic surgeons are not particularly interested in or the best qualified at delving deeply into preexisting psychosocial issues that can impact positive outcome with our recommended treatments or result in coping mechanism failures under the inevitable stressors prolonged, often painful treatment in children can produce for the patient and family alike. We have therefore learned that it is in all parties' best interest to engage in educated, neutral, "third-party" professional psychosocial screening before initiating these protracted and complex orthopaedic reconstructive procedures.

Limb lengthening and deformity correction using external fixators is a long and complicated process [28]. Successful limb lengthening and reconstruction requires a team approach, because patients undergoing limb lengthening and reconstruction may require assistance with rehabilitation and daily maintenance [3, 4, 39, 45, 58]. As such, a poor support system and familial and/or environmental problems may compromise postoperative self-care, rehabilitation, and outcome [36, 47, 52]. Undergoing limb lengthening and reconstruction also requires mental stability, resilience, and good coping skills to manage increasing pain, limited mobility, and treatment fatigue [10, 11, 15, 19, 35, 41, 58]. This is crucial, because unaddressed psychological, emotional, and behavioral disturbances have been shown to complicate rehabilitation [2, 20, 38, 40]. Furthermore, potential complications (eg, pin site infection, device-related failure, fracture and refracture, delayed union, incomplete arrest/angular deformity) can make a challenging intervention even more arduous. In fact, past studies have noted complication rates as high as 97%, leading to extended hospital stay, increased outpatient visits, unplanned readmissions and reoperations, and prolonged disruption of normalcy [1, 7, 8, 12, 13, 15, 16, 23, 54, 55].

Despite complication rates, contributing factors are not well understood. An interdisciplinary preoperative approach is essential for positive outcomes. Preexisting medical, psychosocial, and environmental challenges such as orthopaedic diagnosis, number of previous operations, age at the time of surgical procedure, presence of mental health symptoms, family system, and pain management impact treatment [14, 20, 26, 44, 53]. Specifying these factors, elucidating the effects on treatment outcome, and recommendations for implementing presurgical psychological intervention as part of an interdisciplinary treatment planning team are the aims of this study.

We therefore investigated the following specific questions: (1) Are there group differences between patients with and patients without a preexisting mental health condition(s) in terms of unplanned reoperations? (2) Does the number of surgical operations before current external fixator placement correlate with the number of additional unplanned reoperations, unplanned readmissions, and days spent in circular external fixator? (3) Are there group differences between single- and two-parent households in terms of inpatient narcotic doses, length of inpatient stay(s), number of unplanned readmissions, length of readmission stay(s), and/or unplanned outpatient visits? (4) Does patient age at the time of apparatus application have an impact on treatment duration, complications, and outcome?

Patients and Methods

This is a retrospective chart review of complicating factors affecting outcome of limb lengthening and reconstruction using circular external fixation at a pediatric orthopaedic hospital in Dallas, TX, USA. This treatment was recommended for patients diagnosed with congenital limb inequality, trauma-related acquired deformity and nonunion, hip fusion, equinovarus foot correction, radial deficiency, and knee flexion deformity. Patient medical records were crossreviewed by multiple investigators (HMR, DCN, SDR) to maximize accuracy of collected data. A predetermined list of variables was collected and

categorized for subsequent data analysis: demographics, mental health status, number of previous surgical operations, type of and reason for treatment, daily inpatient pain medication use, length of inpatient stay, return-to-school rate, number of unplanned outpatient visits, number of unplanned readmissions and reoperations, prescribed medication for sleep disturbance, medical complications, and rate of accomplished treatment goals.

Sixteen patients were excluded from the final list as a result of incomplete medical records, application of intramedullary device, and/or rare and unusual cases of external fixation such as major deformity or infected pseudoarthrosis of the spine. The final patient sample, identified through an in-house Health Information Management system, consisted of 67 patients (35 of 67 [52%] males and 32 of 67 [48%] females from 38 of 67 [57%] two-parent and 29 of 67 [43%] single-parent households) with an average age of 13 ± 3 years old (range, 2–19 years old) at the time of fixator application (Table 1) undergoing 73 separate surgical procedures (17 of 73 [23%] were treated with femoral fixators, 36 of 73 [49%] tibial fixators, six of 73 [8%] upper extremity fixators, eight of 73 [11%] pelvic fixators, five of 73 [7%] tibial-foot fixators, and one of 73 [1%] knee fixator) between 2008 and 2012 for limb reconstruction (22 of 73 [30%] for lengthening, 42 of 73 [58%] deformity correction, five of 73 [7%] hip stabilization, and four of 73 [6%] bone transport).

Nine (nine of 67 [13%]) patients reported preexisting mental health diagnosis (three of 67 [5%] diagnosed with attention deficit hyperactivity disorder, one of 67 [1%] major depressive disorder, one of 67 [1%] dissociative disorder, one of 67 [1%] mental retardation, and three of 67 [5%] multiple mental health diagnoses), whereas six (six of 67 [9%]) patients reported new mental health symptoms (four of 67 [6%] reported symptoms of depression, two of 67 [3%] anxiety) during the course of treatment. Half of the patient sample (37 of 73 [51%]) returned to school within 2 weeks after inpatient discharge for 37 of 73 (51%) fixator applications, whereas 36 of 73 (49%) reported absenteeism greater than 2 weeks. Sleep medication was prescribed during the course of treatment to reduce discomfort and improve sleep for 26 of 73 (36%) fixator applications.

Selection, transfer, and assessment biases were mitigated by efforts to ensure the patient sample fit study aims, to include all complete medical records within the specified time, and to ascertain that all patients included in the study met surgery candidacy criteria, respectively.

Statistical analyses included measure of central tendency, Pearson r correlation, and t-test. A p value of 0.05 was used to determine statistical significance.

Results

Of 67 patients included in this study, patients who reported a preexisting mental health diagnosis (nine of 67 [13%]) had more unplanned surgical procedures than patients who did not (58 of 67 [87%]) (mental health diagnosis 3.4 ± 10.3 reoperations versus no mental health diagnosis 0.2 ± 0.5 reoperation, $p = 0.022$; Table 2). Findings from this study showed that patients with a preexisting mental health diagnosis experienced more complications than their counterparts, suggesting that all patients should be screened for preexisting mental health symptoms and these symptoms should be well managed before surgery planning.

Fifty seven (57 of 67 [85%]) patients reported having at least one surgical procedure (average, 3; range, 1–16) before fixator application, whereas 10 of 67 (15%) patients reported no previous surgical procedure. Pearson r correlational analysis revealed that the number of previous surgical procedures correlated with the number of unplanned reoperations ($r = 0.448$, $p < 0.001$), the number of unplanned readmissions ($r = 0.375$, $p < 0.001$), and the number of days in a fixator ($r = 0.275$, $p = 0.018$; Table 3). Having a moderate to high number of previous surgical operations may be indicative of a complicated medical condition, and, in this study, patients with higher number of previous surgical operations also had more complications. Each patient's medical history should be reviewed and incorporated into candidacy selection, education, and subsequent surgery planning decisions.

Patients from single-parent households had a greater number of average narcotic doses while inpatient (single-parent 129 ± 118 doses versus two-parent 73 ± 109 doses, $p = 0.039$), longer length of inpatient stay (single-parent 73 ± 63 days versus two-parent 40 ± 65 days, $p = 0.036$), more unplanned readmissions (single-parent 0.4 ± 0.1 readmission versus two-parent 0.2 ± 0.2 readmission, $p = 0.024$), longer hospitalization when readmitted (single-parent 5 ± 11 days versus two-parent 1 ± 3 day, $p = 0.025$), and fewer unplanned outpatient clinic visits (single-parent 0.2 ± 0.8 visit versus two-parent 0.9 ± 1.1 visit, $p = 0.005$; Table 4) than patients from two-parent households, indicating that patients from single-parent households required more inpatient narcotics, spent more days in the apparatus, and had more complications. Perhaps patients from single-parent homes require more education and social support regarding pain management, postoperative self-care, and rehabilitation.

Seventy-one (71 of 73 [97%]) surgical procedures had at least one complication: patients received antibiotics at least once for 65 of 73 (89%) procedures (Type I complication), had an alteration of treatment plan but still achieved treatment goal for 21 of 73 (29%) procedures (Type II

Table 1. Demographics (n = 67)

35 males				32 females			
15 SPHs		20 TPHs		14 SPHs		18 TPHs	
3 no PSs	12 PSs	3 no PSs	17 PSs	3 no PSs	11 PSs	1 no PS	17 PSs

SPH = patients from single-parent household; TPH = patients from two-parent household; no PSs = patient without any previous surgeries; PSs = patients with one or more previous surgeries.

Table 2. Contributory effect of mental health conditions on number of surgery-related outcomes

Variable	MHD (n = 9/67)			No MHD (n = 58/67)			p value
	Mean ± SD	95% confidence interval	Range	Mean ± SD	95% confidence interval	Range	
Number of unplanned surgeries	3.4 ± 10.3	0–11.4	0–31	0.2 ± 0.5	0.1–0.4	0–2	0.022

MHD = patients who reported preexisting mental health diagnosis(es); no MHD = patients who did not report preexisting mental health diagnosis(es).

Table 3. Correlates of previous surgical procedures with surgery-related outcomes

Variable	Pearson r	p value
Number of unplanned surgeries	0.448	< 0.001
Number of unplanned readmissions	0.375	< 0.001
Number of days in frame	0.275	0.018

Table 4. Contributory effects of household status on surgery-related outcomes

Variable	SPH (n = 29/67)			TPH (n = 38/67)			p value
	Mean ± SD	95% confidence interval	Range	Mean ± SD	95% confidence interval	Range	
Average number of inpatient narcotics (in doses per inpatient stay)	129 ± 118	85–173	2–458	73 ± 109	39–106	4–601	0.039
Length of inpatient stay (days)	73 ± 63	49–97	4–213	40 ± 65	20–60	2–301	0.036
Number of unplanned readmissions	0.4 ± 0.1	0–0.7	0–5.0	0.2 ± 0.2	0–0.1	0–1.0	0.024
Length of hospitalization when readmitted (days)	5 ± 11	0–9	0–47	1 ± 3	0–1	0–20	0.025
Number of unplanned outpatient visits	0.2 ± 0.8	0–0.4	0–3.0	0.9 ± 1.1	0.6–1.3	0–4.0	0.005

SPH = patients from single-parent household; TPH = patients from two-parent household.

complication), did not achieve treatment goal but had no sequelae for 11 of 73 procedures (15%) (Type IIIA complication), and did not achieve treatment goal and had other sequelae for five of 73 (7%) procedures (Type IIIB complication; Table 5). Procedures with successful outcome (Type I and/or Type II complications only) had a higher average age per group than procedures with poor outcome (Type IIIA and/or Type IIIB complications) (successful outcome 16 ± 3 years old versus poor outcome 13 ± 4 years old, p = 0.011; Table 6). Age at the time of fixator application also correlated with the number of prescribed antibiotics (r = 0.245, p = 0.036) and the number of days in the fixator (r = 0.233, p = 0.047; Table 7). Preoperative education and treatment planning as well as perioperative and postoperative support managing treatment challenges and recovery expectations may need to be individualized based on the patient's age and developmental status.

Table 5. Types of postoperative complications

Type	Definition
Type I	Complications were considered expected/anticipated occurrences and were corrected within treatment plan
	No change to original treatment plan
	Treatment achieved desired outcome
	Example: pin site infection, slight joint contracture resolvable with physical therapy, mild allergic reactions, etc
Type II	Complications required modification of treatment plan or development of new treatment plan
	Modified (or new) treatment achieved desired outcome
	Example: joint contracture requiring intensive physical therapy, delayed consolidation, device-related complications, etc
Type IIIA	Complications led to failure to achieve desired outcome
	Example: recurrence of deformity after treatment
Type IIIB	Complications led to failure to achieve desired outcome
	New pathology/diagnosis created
	Patient's condition is worse than before treatment
	Examples: regenerate defect/fracture; joint subluxation/dislocation; severe flexion contracture, etc

Table 6. Age difference in treatment outcome

Variable	SO (n = 57/73)			PO (n = 16/73)			p value
	Mean ± SD	95% confidence interval	Range	Mean ± SD	95% confidence interval	Range	
Age (years)	16 ± 3	14–15	7–19	13 ± 4	10–14	2–17	0.011

SO = patients with successful treatment outcome; PO = patients with poor treatment outcome.

Table 7. Correlates of age at the time of frame application with surgery-related outcomes

Variable	Pearson r	p value
Number of prescribed antibiotics	0.245	0.036
Number of days in frame	0.233	0.047

Discussion

Background and Rationale

The external circular fixator is a device involving long and complicated orthopaedic treatment, which has inherent advantages and disadvantages. Limb lengthening and reconstruction requires patients' and families' complete commitment for many months, sometimes up to a year. Such treatment has also been known to have high complication rates, although the contributing factors have not been evaluated. Some factors may be amenable to appropriate presurgical interdisciplinary treatment assessment, planning, and intervention to maximize treatment outcome. Surgeons and patients/families must acknowledge and address the fact that complex reconstructive orthopaedic procedures interfere with activities of daily living, sleep, academic progress, and other family members' obligations. Findings from a non peer-reviewed published work indicated that patients and families experienced significant stress while undergoing extensive, prolonged external fixation treatment [31]. Consequently, professional preoperative assessment of patients being considered for complex limb reconstruction can be beneficial. Anecdotal experience shows it to be of particular value in the presence of preexisting family or personal history of drug and/or alcohol abuse, psychiatric illness, and nonnuclear families. The current study demonstrated similar experience and report, thus reaffirming the value of careful candidacy evaluation and selection before embarking on such treatment courses.

Table 8. Recommendations for preoperative evaluation [5, 11, 17, 24, 25, 27, 37, 42, 46, 48, 49]

Key points	Specific objectives
Psychiatric symptoms	Rule out complicating mental health condition(s)
	Stabilize mental health condition(s)
	Refer for appropriate psychological and psychiatric interventions, if needed
	Assess patient and family ability to cope with long-term medical treatment
Preoperative education	Assess what patient and family learned from other team members
	Provide repeated and consistent education regarding all aspects of treatment
	Set realistic expectations
Pain management	Refer to patient's previous surgical procedures and related challenges for baseline information
	Understand patient's ability to cope with pain and how he or she communicates to medical team and family
	Teach pain management strategies, including proper analgesic use, at an age-appropriate level
Family support	Verify family's commitment and support to patient
	Identify primary caretaker(s) and discharge plan
	Teach appropriate responses to patient's pain complaints
	Account for other family stressors
Adherence	Assess patient's and family's ability to follow directions, maintain appointments, and follow up with scheduled appointments
Goals of treatment	Ascertain that patient and family goals are the same as the medical team's goals, including expectation of setbacks
Logistics	Evaluate potential interferences to long-term treatment such as work, school, and siblings
	Assist with planning and accommodations
Sleep hygiene	Refer to patient's previous surgical procedures and related challenges for guidelines
	Understand patient's preexisting sleep schedule and how treatment might interfere with sleep habits
	Teach age-appropriate sleep hygiene and habits

This study identified group differences between patients with and without a preexisting mental health condition, a positive correlation between the number of previous surgical procedures and unplanned reoperations, unplanned admissions, and days in the external fixator. It also demonstrated group differences between pediatric patients from single- and two-parent households as it relates to inpatient narcotic doses, length of inpatient stay(s), number of unplanned readmissions, length of readmission stay(s), and/or unplanned outpatient visits. Lastly, the impact of age at the time of external fixator placement on treatment duration, complications, and outcome was evaluated.

There are limitations and biases in this study. This includes selection bias, because only patients who underwent limb lengthening and reconstruction with circular external fixation were sampled and included for retrospective data analysis. Researchers specifically aimed to examine preexisting factors that complicated outcome in patients who had already completed medical treatment using external fixators. It is unknown how many patients were considered for circular external fixators but did not undergo treatment. Transfer bias also exists. Sixteen patients were excluded from the final patient sample as a result of rare and unusual cases of external fixation, intramedullary lengthening, or incomplete medical records. It is unclear how inclusion of patients with missing medical records would have altered these findings. No patient was lost before minimum followup. Assessment bias is another bias potentially present in this study. Specific criteria based on the operating surgeons' expertise in this area were set for patient selection for surgical intervention. Those criteria included: a limb length discrepancy of 4 cm or greater, severe limb or angular deformity with either shortening or soft tissue compromise that jeopardize acute correction options, and agreement of both the patient and family to undergo limb lengthening and deformity by circular external fixation. Patients included in this study met the clinical indications of limb lengthening and deformity correction and agreed to proceed. This study was designed to demonstrate associations of potential factors as it affects treatment.

For patients undergoing limb lengthening and reconstruction, having a mental health condition positively correlated with unplanned reoperations, making a challenging medical intervention with a psychiatrically fragile child more complicated. Other research has indicated that the presence of elevated psychological symptoms may complicate treatment and may alter outcome [24, 25, 27, 32, 42, 56]. That is not to say that those with a mental health diagnosis should not be considered for elective limb lengthening and reconstruction surgery. Rather, all patients

should be screened for the presence of psychiatric symptoms and appropriate management of these symptoms should be required before planning surgical intervention of this magnitude (Table 8). As the lead team member, the surgeon should be aware of the patient's preexisting mental health condition and the potential impact during treatment.

Many patients in our study sample had surgical operations before circular external fixator placement during this time period. The number of surgical operations before apparatus placement correlated with the number of unplanned readmissions, reoperations, and length of time in the device. It is likely that an overall complicated medical history may contribute to challenges during extended intervention [32, 49, 51]. Surgeons should, therefore, account for this when considering appropriate patients for external fixation by properly educating patients and families about potential increased risk of complications and expectations throughout treatment (Table 8).

Parental marital status also demonstrated an impact on outcomes. Patients from single-parent households required greater number of narcotics, longer inpatient stay, and more unplanned readmissions. Patients from two-parent households, however, had more unplanned outpatient clinic visits. Perhaps the inherent stress of a single-parent household may contribute to a greater allocation of postoperative care to the child, thus requiring extended hospitalization, more support from the medical team, and reliance on medication for pain management. Conversely, patients from two-parent households have greater presumed family support, which may include a stay-at-home parent who is overly attentive to perceived changes and inclined to seek medical attention. The dynamics of a patient's household seemed to play a role in postoperative management in our study, which is consistent with existing literature examining home life, family support, and the quality of home care provided after a medical procedure [9, 11, 37, 57]. These findings support the importance of preoperative assessment of social support and teaching pain management strategies to patients and caregivers (Table 8).

Older patients achieved treatment goal with fewer complications compared with younger patients. Older patients also spent longer time in the apparatus and required a greater number of antibiotics. Many factors could have accounted for these findings, including medical indication for external fixation, goal(s) of treatment, knowledge of and adherence to postoperative care, and developmental stage as it impacts physical growth, cooperation, and postoperative self-care [33, 41, 57]. Appropriate education regarding these findings will establish reasonable expectations of treatment duration and potential challenges.

Although many patients did not report a mental health diagnosis before treatment, 9% developed symptoms of anxiety or depression during treatment. Whether the patients had a predisposition to psychological symptoms before apparatus placement is hard to say. It is likely that the stress, limitations, and pain of prolonged external fixation were beyond the coping abilities of these patients and contributed to symptom onset [34]. Our study also showed that more than half of patients undergoing limb lengthening and reconstruction returned to school within a 2-week period. Current literature on this topic is limited; therefore, it is unclear whether our study patients had a high or low return-to-school rate. Additionally, one-third of our patients reported sleep disturbance postoperatively. This is consistent with other studies, which noted moderate to high rates of patient-reported sleep difficulty after major surgical intervention [6]. Still, poor sleep quality has been shown to affect healing and recovery and therefore should be managed to maximize outcome (Table 8).

Ensuring proper understanding of medical treatment and goals, cooperation, familial agreement, and other relevant psychosocial factors is imperative for successful outcomes when managing limb length discrepancy or deformity in the pediatric population and perhaps with adult patients as well. Preoperative psychological intervention as part of an interdisciplinary team and identification of barriers are keys to choosing the appropriate surgical candidate for limb lengthening and reconstruction intervention. It is essential that the patient, family, and involved medical staff work as a collaborative team with the same goals of treatment established before fixation placement as well as reasonable expectations of challenges and duration of medical intervention. Patients who have the identified factors are shown to have a more complicated treatment course. It is therefore recommended that if not all patients are screened preoperatively, then at least those who have a preexisting mental health condition and psychosocial challenges should undergo appropriate management before planning the surgical procedure. An interdisciplinary, presurgical, proactive approach to patient education, selection, and treatment should be an integral part of treatment planning for a successful outcome in this population. Understanding the strengths and barriers of individual surgical candidates may ultimately improve patient care by reducing complications, readmissions, narcotic dosages, unplanned reoperations, and decreasing length of stay. Research evaluating long-term, quality of life, and function is underway at our institution. Validating preoperative, interdisciplinary intervention will also be an important future direction. Psychological preoperative and posttreatment assessment will likely better inform pediatric orthopaedic surgeons about which factors to consider when selecting surgical candidates and, perhaps, mitigate some of the complications and challenges during treatment.

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