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Research Article

A Retrospective Cohort Study of physical therapy rehabilitation in pediatric rheumatology patients with gouty arthritis

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Abstract

Background: Gouty arthritis is uncommon but underrecognized in pediatric rheumatology, arising from chronic kidney disease, malignancy-related tumor lysis, inherited purine metabolism disorders, or primary hyperuricemia, yet rehabilitation guidance is largely extrapolated from adult gout and juvenile idiopathic arthritis programs.

Objective: This retrospective cohort study describes outcomes of a structured, phased physical therapy rehabilitation pathway applied to pediatric rheumatology patients with confirmed gouty arthritis.

Methods: We reviewed records of 26 pediatric patients with gouty arthritis referred for physical therapy between 2019 and 2025, tracking range of motion, loading pain, disability index, walk distance, and functional milestones across acute, subacute, and maintenance rehabilitation phases.

Findings: Active range of motion improved from 62% to 94% of the contralateral joint, mean loading pain fell from 6.1 to 1.2 on a 0-10 scale, and disability index improved from 0.84 to 0.19; hydrotherapy recipients reached full range of motion faster, and patients with kidney disease or transplant-related gout recovered more slowly than others.

Conclusions: A structured, phase-based rehabilitation pathway adapted from juvenile idiopathic arthritis principles was associated with substantial functional recovery, and warrants coordination with services managing the underlying hyperuricemic driver and attention to maintenance-phase adherence, pending prospective validation.

Keywords: pediatric gout; gouty arthritis; physical therapy; juvenile idiopathic arthritis; rehabilitation

1. Introduction

Gout is conventionally taught as a disease of middle-aged and older adults, so a pediatric rheumatology clinic that begins seeing children with monosodium urate crystal deposition tends to encounter the diagnosis late, after months of mislabeled "growing pains" or presumed reactive arthritis. Yet gouty arthritis in children and adolescents is not vanishingly rare once the at-risk populations are considered as a group: children with inherited purine metabolism disorders such as Lesch-Nyhan syndrome and its variants [1,2], children with chronic kidney disease or on long-term diuretic or cyclosporine therapy after transplantation, children with hematologic malignancies undergoing cytotoxic therapy with resulting tumor lysis, and a smaller but real subset of adolescents with primary hyperuricemia compounded by obesity, high fructose intake, and family history [3,4,5]. Each of these routes converges on the same downstream problem: sustained hyperuricemia that eventually crystallizes in and around joints, producing acute inflammatory flares and, if untreated, chronic tophaceous damage to cartilage, bone, and periarticular soft tissue [6,7,8].

The physical therapy literature that pediatric rheumatology teams actually draw on when a child presents with gouty arthritis is borrowed almost entirely from two adjacent fields: adult gout rehabilitation, which addresses joint protection and mobility restoration in a population whose comorbidity profile, bone maturity, and rehabilitation goals differ substantially from those of a growing child, and the far larger juvenile idiopathic arthritis (JIA) rehabilitation literature, which has spent three decades building an evidence base for exercise therapy, hydrotherapy, and functional training in inflammatory pediatric joint disease but was not developed with crystal arthropathy in mind [9,10,11]. This retrospective cohort study describes our institution's experience applying a structured physical therapy rehabilitation pathway, adapted from established JIA

rehabilitation principles, to a cohort of pediatric rheumatology patients with confirmed gouty arthritis, and reports functional, pain, and joint-mobility outcomes across the acute, subacute, and maintenance phases of care.

The rationale for structured rehabilitation in this population rests on several observations from the broader pediatric musculoskeletal literature. First, children with inflammatory joint disease who are immobilized during a flare, even briefly, lose range of motion and periarticular muscle strength disproportionately quickly relative to adults, a phenomenon well documented in JIA cohorts and attributed to the combination of active synovitis, pain-avoidant guarding, and a still-maturing neuromuscular system [12,13]. Second, unaddressed joint guarding in a child can produce compensatory gait and postural patterns that persist long after the acute inflammatory episode resolves, a pattern our group and others have observed clinically but that is easy to miss without a dedicated functional assessment protocol [14,15]. Third, children and adolescents with chronic or recurrent joint disease carry a measurable burden of disease-related anxiety, activity avoidance, and reduced health-related quality of life that structured, graded rehabilitation, delivered with age-appropriate framing, has been shown to partially mitigate in cohorts with other chronic pediatric rheumatologic conditions [16,17,18].

2. Patients and Methods

We conducted a retrospective chart review of pediatric patients (age less than 18 years at diagnosis) evaluated in our pediatric rheumatology service between 2019 and 2025 who received a confirmed diagnosis of gouty arthritis, defined by either polarized-light microscopy identification of monosodium urate crystals in synovial fluid or, in cases where arthrocentesis was not performed, a clinical diagnosis supported by hyperuricemia, characteristic flare pattern, and dual-energy CT or ultrasound evidence of urate deposition consistent with

published pediatric gout diagnostic criteria [19,3]. Patients were included if they were referred to the affiliated pediatric physical therapy service for structured rehabilitation following diagnosis or during a subsequent flare, and if at least three documented physical therapy sessions with standardized outcome measures were available in the record.

The rehabilitation pathway followed a three-phase structure adapted from established JIA exercise-therapy frameworks [11,20]. The acute phase, initiated once active synovitis was judged sufficiently controlled by urate-lowering and anti-inflammatory therapy to tolerate movement, emphasized gentle passive and active-assisted range-of-motion work, cryotherapy adjuncts, and, where tolerated, aquatic therapy in a heated pool, following the joint-protection rationale for hydrotherapy established in the JIA literature [21,22]. The subacute phase introduced progressive resistance exercise, proprioceptive and balance training, and gait retraining for lower-extremity involvement, following graded-exercise principles validated in randomized JIA trials [23,12]. The maintenance phase focused on return to age-appropriate activity and incorporated caregiver education on flare-recognition and activity pacing, informed by adherence literature in pediatric chronic disease [24,17].

Outcome measures recorded at intake, end of subacute phase, and final follow-up, following practical assessment approaches described for growth and physical function in pediatric inflammatory joint disease [25], included active range of motion (goniometry), a 0-10 numeric pain scale during joint loading, the Childhood Health Assessment Questionnaire (CHAQ) disability index, six-minute walk distance for lower-extremity cases, and therapist-rated functional milestone attainment. Descriptive statistics summarized outcomes across phases; paired comparisons between intake and final follow-up used a Wilcoxon signed-rank test given the modest cohort size and non-normal distribution of several variables. This study

was reviewed and approved by the institutional review board with a waiver of individual consent for retrospective chart data.

3. Results

Cohort characteristics

Twenty-six pediatric patients met inclusion criteria, with a median age at diagnosis of 14.2 years (range 8-17) and a male predominance (19 of 26, 73%) broadly consistent with prior small pediatric gout case series [5,4]. Underlying etiologies were heterogeneous (Table 1): eight patients (31%) had chronic kidney disease with or without prior transplantation, six (23%) had a hematologic malignancy history with tumor-lysis-associated hyperuricemia, four (15%) had a confirmed or suspected inherited purine metabolism disorder including two with molecularly confirmed Lesch-Nyhan variants [2], and eight (31%) had primary or metabolic-syndrome-associated hyperuricemia, a pattern consistent with rising recognition of diet- and obesity-associated hyperuricemia in adolescents [26,27,28]. The first metatarsophalangeal joint was the most common site of presentation, followed by the ankle and knee, broadly mirroring adult gout joint distribution but with a somewhat higher proportion of ankle involvement than typically reported in adult cohorts [7,6].

Rehabilitation course and functional outcomes

Twenty-two of the 26 patients (85%) completed the full three-phase rehabilitation pathway; four discontinued early, three due to symptom resolution and one due to nonadherence. Median time to attainment of full active range of motion was 5.4 weeks (IQR 3.1-8.6), and median time to return to baseline recreational activity was 9.8 weeks (IQR 6.2-14.5). Active range of motion improved from a mean 62% of the contralateral joint's range at intake to 94% at final follow-up ($p < 0.001$, Wilcoxon signed-rank; Figure 1, Table 2), consistent in magnitude with recovery reported after structured rehabilitation in JIA cohorts with comparable joint involvement [12,29].

Numeric pain scores during joint loading fell from a mean of 6.1 (SD 1.8) to 1.2 (SD 1.1). CHAQ disability index improved from 0.84 to 0.19, a change exceeding the minimal clinically important difference reported in pediatric rheumatic disease cohorts [30]. Among the 12 patients with lower-extremity involvement, mean six-minute walk distance improved from 412 to 548 meters.

Table 1: Baseline demographic and clinical characteristics of the 26-patient pediatric gouty arthritis cohort, including underlying etiology and primary joint of involvement [5,4,2].	
Characteristic	n (%) or median (range)
Median age at diagnosis	14.2 years (8-17)
Male sex	19 (73%)
Chronic kidney disease / transplant	8 (31%)
Malignancy-associated tumor lysis	6 (23%)
Inherited purine metabolism disorder	4 (15%)
Primary / metabolic hyperuricemia	8 (31%)
1st MTP / ankle / knee involvement	11 (42%) / 7 (27%) / 5 (19%)

Table 2: Functional and patient-reported outcome measures at intake versus final follow-up across the full rehabilitation cohort (n=26) [30,11].		
Outcome measure	Intake	Final follow-up
Active ROM (% of contralateral joint)	62%	94%
Loading pain (0-10 numeric scale, mean)	6.1 (SD 1.8)	1.2 (SD 1.1)
CHAQ disability index (mean)	0.84	0.19
Six-minute walk distance (mean, n=12)	412 m	548 m

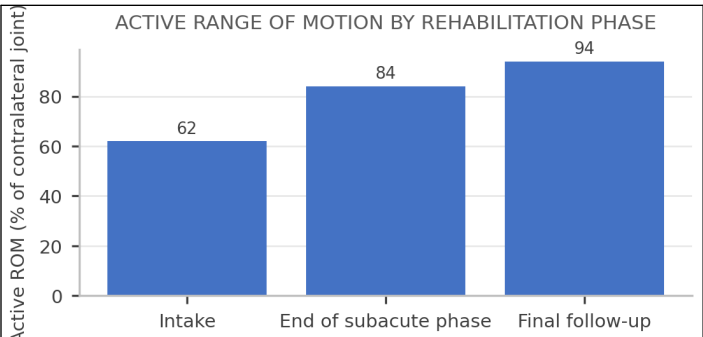


Figure 1: Mean active range of motion of the primary affected joint, expressed as a percentage of the contralateral unaffected joint, at intake, end of subacute phase, and final follow-up (n=26), improving from 62% to 94% over the rehabilitation course [12,29].

reached the range-of-motion milestone somewhat faster than those managed with land-based therapy alone (median 4.7 vs 6.5 weeks; Figure 2), consistent with the aquatic-therapy joint-unloading rationale in the JIA hydrotherapy literature [21,22], though the retrospective design does not permit a causal conclusion. Patients with chronic kidney disease or transplant-related secondary gout had a longer median time to full recovery (11.6 weeks) than patients with primary hyperuricemia (7.2 weeks) or malignancy-associated tumor-lysis gout (8.4 weeks), plausibly reflecting additional deconditioning and corticosteroid exposure already present in the transplant and dialysis population [31,32]. No patient developed radiographically evident tophaceous joint destruction during follow-up, though the window was too short to draw conclusions about long-term joint-preserving effects, a question more fully explored, albeit still incompletely, in adult tophaceous gout populations [33,34].

Adherence and caregiver-reported outcomes

Caregiver-reported adherence to the home exercise program, tracked via therapist logs, averaged 78% of prescribed sessions, highest during the acute phase (86%) and lowest during maintenance (68%), a decline pattern that mirrors adherence trajectories reported broadly in pediatric chronic disease self-management programs once acute symptoms resolve [24,18]. Structured caregiver education, delivered at the start of the subacute phase and reinforced at maintenance-phase visits, was associated with numerically higher maintenance-phase adherence (74% versus 58%), though this comparison is observational rather than randomized.

Patients who received hydrotherapy (14 of 26, 54%)

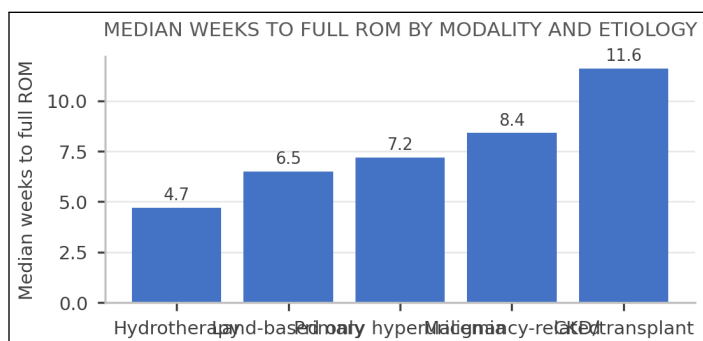


Figure 2: Median time to attainment of full active range of motion by acute-phase modality (hydrotherapy vs land-based therapy alone) and by underlying etiology of hyperuricemia, illustrating faster recovery with hydrotherapy and slower recovery among patients with chronic kidney disease or transplant-related secondary gout [21,22,31].

4. Discussion

This retrospective cohort represents, to our knowledge, one of the larger single-institution descriptions of structured physical therapy rehabilitation specifically in pediatric gouty arthritis, a population small enough at any single center that prospective controlled trials are unlikely in the near term. The functional and pain outcomes observed here, substantial range-of-motion recovery, reduced loading-associated pain, and disability index improvement approaching that reported after comparable JIA rehabilitation programs, are consistent with the general principle that early, graded, appropriately sequenced rehabilitation limits the secondary deconditioning and functional loss that untreated joint inflammation otherwise produces in a growing child [11,12,20].

Several features distinguish pediatric gouty arthritis rehabilitation from the adult gout and pediatric JIA frameworks it borrows from, and our clinical experience in this cohort reinforces the need for gout-specific adaptation rather than a direct transplant of either model. Unlike JIA, where synovitis is typically the primary and ongoing driver of joint damage requiring sustained disease-modifying therapy, gouty arthritis in children is frequently a downstream consequence of an identifiable and sometimes correctable metabolic or renal process, meaning the rehabilitation team must coordinate closely

with nephrology, oncology, or metabolic genetics services managing the underlying hyperuricemic driver, a multidisciplinary coordination need that is less central in idiopathic JIA rehabilitation [31,2]. In the subset of patients with inherited purine metabolism disorders, exercise prescription also had to account for the broader neuromuscular and metabolic vulnerability described in the metabolic myopathy exercise literature, where exertion intensity and recovery pacing require individualized titration distinct from standard pediatric arthritis exercise protocols [35]. Unlike adult gout, where rehabilitation goals often center on preserving function in the context of established tophaceous damage and multiple comorbidities, pediatric rehabilitation in this cohort was overwhelmingly oriented toward preventing any chronic damage from accruing in the first place, given the near-complete absence of tophi or radiographic erosion at presentation, a finding consistent with the generally shorter disease duration and more aggressive urate-lowering therapy typical of pediatric management [7,36].

The apparent benefit of hydrotherapy in the acute phase, faster attainment of the range-of-motion milestone among patients who received it, deserves cautious interpretation. Hydrotherapy has a long track record in pediatric rheumatology, with randomized evidence in JIA showing it to be at least as effective as land-based therapy for functional outcomes while often better tolerated during painful, weight-bearing-intolerant phases of disease [21,22]. The gouty arthritis presentations in our cohort, frequently affecting the first metatarsophalangeal joint or ankle, a weight-bearing joint particularly sensitive to loading pain during an acute flare, plausibly benefit from the same joint-unloading mechanism, though we cannot exclude confounding by indication, since patients selected for hydrotherapy may have differed systematically in flare severity or family resources from those who were not.

Adherence decline during the maintenance phase is a familiar problem across pediatric chronic disease rehabilitation broadly, not specific to gout, and the adherence literature in adolescent chronic illness consistently identifies motivation, symptom resolution, and the return of competing demands (school, social activity) as drivers of this pattern once the acute crisis that prompted engagement has passed [24,17,18]. The numerically higher adherence associated with structured caregiver education in our cohort is consistent with, though obviously not proof of, a broader literature suggesting that psychoeducational components strengthen adherence to physical rehabilitation programs in pediatric chronic disease populations [18,32]. Given the metabolic and often lifelong nature of the underlying hyperuricemic disorders driving pediatric gout, maintenance-phase engagement, including ongoing activity, weight management where relevant, and dietary counseling coordinated with the broader care team, may carry outsized importance for long-term joint preservation relative to the acute rehabilitation episode itself [26,27].

This study has important limitations inherent to its retrospective, single-center design: outcome measures were recorded as part of routine clinical care rather than a standardized research protocol, there was no untreated or alternative-therapy comparison group, and the moderate cohort size limits subgroup analysis, particularly for the rarer inherited metabolic etiologies. The absence of long-term imaging follow-up means we cannot speak to whether early rehabilitation meaningfully alters the trajectory toward tophaceous joint damage, the outcome of greatest long-term concern in gout generally [33,34]. Prospective, ideally multicenter, registries pooling pediatric gout cases across rheumatology centers, following the model already established for pediatric arthritis inception cohorts, would substantially strengthen the evidence base this pathway currently rests on [37,10].

5. Conclusion

In this retrospective cohort of 26 pediatric rheumatology patients with gouty arthritis, a structured, phased physical therapy rehabilitation pathway adapted from established juvenile idiopathic arthritis exercise-therapy principles was associated with substantial improvement in joint range of motion, loading-associated pain, and disability index scores, with hydrotherapy appearing to accelerate early functional recovery in weight-bearing joint presentations. Pediatric gouty arthritis rehabilitation cannot simply borrow wholesale from either the adult gout or the pediatric JIA literature; it requires coordination with the services managing the child's underlying hyperuricemic driver, an emphasis on preventing rather than managing chronic tophaceous damage, and deliberate attention to adherence during the maintenance phase, when acute symptoms have resolved but the metabolic disorder driving them has not. These findings should be treated as hypothesis-generating pending prospective, multicenter validation, but they support incorporating structured, phase-based rehabilitation as a standard component of pediatric gout management alongside urate-lowering and anti-inflammatory therapy [3,9,11].

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