

The Role of Bracing in Pediatric Orthopaedics

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Abstract: The Pediatric Orthopaedic Society of North America (POSNA), the American Academy of Orthopaedic Surgeons (AAOS) and the American Academy of Pediatrics (AAP) all have analogous guidelines regarding the use of orthotics for benign lower limb pathologies, but it is unknown whether clinicians adhere to these guidelines. We provide a contemporary perspective for the use of orthotics in common benign lower limb conditions [flexible metatarsus adductus (MA), painless flexible flatfeet (PFF), internal tibial torsion (ITT) and femoral anteversion (FA)] and Blount disease. In order to build on literature review, an anonymous survey was also distributed to POSNA members. From this we learned 83% of members reported “never” prescribing orthotics for FA, 75% never do for ITT, 48% don't for PFF, and 35% don't for MA. Members without pediatric orthopaedic fellowship training are more likely to “always” or “almost always” prescribe orthotics for PFF than fellowship-trained clinicians (14.3% vs. 0.6%; $p < 0.001$). Physical therapists were the most common prescribers for MA, ITT, and FA, and podiatrists for PFF. Most POSNA members adhered to the recommended guidelines for orthotics prescription for the conditions surveyed. Adherence to recommendations were less common among long practicing members and non-pediatric orthopaedic fellowship-trained providers.

Key Points:

- Bracing in benign lower limb conditions including flexible metatarsus adductus, painless flexible flatfeet, internal tibial torsion, and femoral anteversion are not recommended by the AAOS, POSNA, or the AAP.
- Bracing is more likely to be prescribed for painless flexible flatfeet by non-fellowship trained orthopaedic surgeons.
- Physical therapists were the most common brace prescribers for flexible metatarsus adductus, internal tibial torsion, and femoral anteversion, and podiatrists for painless flexible flatfeet.
- Although most POSNA members adhered to the recommended guidelines for orthotics prescription for the conditions surveyed, adherence to recommendations were less common among members who were farther out from fellowship training, indicating a possible teaching or paradigm shift in bracing for these benign conditions.
- Bracing for infantile Blount disease has some support in the literature for Langenskiöld grade I and II, but these studies are mostly low power or do not have a non-braced cohort; further study is warranted.

Introduction

Many pediatric conditions of the lower extremity are self-limiting and have no known long-term prognostic effects. Four of the most common benign lower limb conditions are flexible metatarsus adductus (MA), internal tibial torsion (ITT), femoral anteversion (FA), and painless flexible flatfeet (PFF). Patients often present to their regular pediatrician first for these issues. They are all common causes for referral to specialists, including orthopaedic surgeons, podiatrists, and physical therapists.

Metatarsus adductus (MA) is the most common foot deformity of infancy, appearing in about 1/1000 births.¹ MA involves medial deviation of the forefoot on the hindfoot and is usually mild, flexible, and self-correcting. Most of these cases do not require treatment and resolve around age 3 to 4 years,³ though passive stretching exercises are sometimes recommended.¹ Feet that are only partly-flexible or inflexible may benefit from manipulation and serial casting or bracing at age 6 months and 1 year.⁴ Surgical treatment is rarely indicated.¹

Internal tibial torsion (ITT) is the most common cause of intoeing in children up to 3-4 years.⁵ The fetal tibia develops in an internally rotated position, and external rotation occurs throughout development.⁶ ITT is typically first noticed around age 12 months when children begin standing, and the physiologic infantile external rotation hip contracture is starting to resolve. Orthotics and splinting of ITT is ineffective and tends to add to parents' frustration, and surgical intervention is only indicated in patients with severe, persistent functional limitations.^{5, 7, 8}

Femoral anteversion (FA) is physiologic and defined by the angle of the femoral neck in relation to the femoral condyles, which is greatest in infancy and decreases throughout development.⁹ Often noticed when the child first begins to walk, parents seek evaluation of their children due to an intoeing gait that has not resolved or

causes tripping. Most children with FA will outgrow their intoeing without intervention.^{10, 11} There is no evidence that nonoperative treatment has any effect on FA and surgical intervention is only indicated in patients with severe, persistent disability.¹²

Flexible flatfoot (pes planovalgus) affects nearly 20%-40% of the population, though many patients are asymptomatic and do not seek or require medical attention.^{13, 14} Flexible flatfoot is driven by ligamentous laxity leading to medial longitudinal arch collapse and resultant hindfoot valgus and forefoot abduction and supination. Parents often seek evaluation of their children with flexible flatfeet due to concern that a foot deformity may cause pain and disability later in life. Treatment is only indicated in symptomatic patients and not in those patients with painless flexible flatfeet (PFF).^{13, 15} Nonoperative treatments such as medial heel wedges, arch supports, and orthoses have no effect.^{15, 16} Surgery is only indicated when pain and disability interfere with activities of daily living.¹⁵

Infantile Blount disease (tibia vara) is a condition that causes a varus deformity about the knee in young children. The condition was described by Langenskiöld in 1952 with a radiographic classification system based on the deformity present in the proximal tibia.¹⁷ Blount discussed this condition in 1966 and also provided guidelines for treatment based on Langenskiöld's staging system.¹⁸ At the time, he recommended bracing of children who were stage I or II, and possible surgical correction for stages III and above with a goal of slight overcorrection to minimize Hueter-Volkman related physeal compression on the medial side.

Despite the benign, self-limited nature of the first 4 above lower limb conditions, there is still much confusion amongst practitioners regarding the role bracing plays in treating these conditions. The following will review the current guidelines regarding bracing in MA, ITT, FA, and PFF from the AAOS, POSNA, and the AAP. We will then compare these guidelines with

results from a survey exploring bracing habits in these conditions amongst POSNA members. We hope that this discussion will instill confidence in clinicians regarding the recommended treatment modalities of these common lower limb deformities.

Bracing Recommendations

According to the AAOS OrthoInfo website, MA improves by itself most of the time by 6 months, and only rigid deformities that persist past 6 months may benefit from casts or bracing.¹⁹ The POSNA study guide for clinicians gives similar recommendations, noting most cases of MA with flexible deformity will spontaneously correct without treatment, and serial casting or bracing is only reserved for inflexible feet.¹ The AAP's Healthy Children website agrees, stating most infants with MA will outgrow it, and only those with rigid deformities should be referred to a pediatric orthopedic surgeon for casting.²⁰

In regard to ITT, the AAOS OrthoInfo website reports the deformity almost always improves without treatment and splints, special shoes, and exercise programs do not help.¹⁹ POSNA's study guide explains ITT resolves spontaneously and, though shoes and braces have been used in the past, they are no longer recommended.²¹

The AAOS' OrthoInfo website explains that FA spontaneously corrects in most children as they grow, and special shoes, braces, and exercises do not help.¹⁹ While the POSNA study guide for FA agrees, adding braces, special shoes, and bars have shown no benefit and may have a negative psychological impact later in life.²¹

The AAP's Healthy Children website explains night braces have not been proven as an effective treatment for intoeing due to ITT and FA despite their past use.²⁰ They also state it is important to avoid corrective shoes, twister cables, daytime bracing, exercises, shoe inserts, and back manipulations as they do not correct the

problem and may be harmful because they interfere with normal play or walking.

MA, ITT, and FA are all on the spectrum rotational deformities which lead to in-toeing gait. In a joint statement between the AAP Section on Orthopaedics and POSNA, they advise: "Do not order radiographs or advise bracing or surgery for a child less than 8 years of age with simple in-toeing gait."²² They explain that mild in-toeing is a physiologic phenomenon reflecting ongoing maturation of the skeleton, and simple monitoring is adequate until age 7-8 years unless there is severe tripping, falling, or asymmetry. They also note, "It is not possible to alter the natural evolution using physical therapy, bracing or shoe inserts."²²

Discussing PFF, the AAOS' OrthoInfo website reports most children eventually outgrow the flatfoot deformity without any residual problems in adulthood.²³ If the deformity does not cause pain or discomfort, they do not recommend treatment. While POSNA's study guide on flexible flatfoot adds that most nonoperative interventions, including bracing, have no treatment effect or result in permanent elevation of the arch.¹³ The AAP's Healthy Children website agrees, adding that shoe inserts do not help children develop an arch and may cause more problems.²⁴

The AAP Section on Orthopaedics and POSNA concluded, "Do not order custom orthotics or shoe inserts for a child with minimally symptomatic or asymptomatic flat feet."²² While painful or rigid flat feet require further work-up, they recommend PFF be managed with observation or over the counter orthotics. They stress PFF is a normal physiologic variant, and custom orthotics do not aid in the development of the arch.

Regarding infantile Blount disease, there is significant equipoise on whether or not bracing is relevant and effective for nonoperative treatment.²⁵ Many patients who have tibia vara as an infant will resolve

spontaneously before 4 years of age, regardless of metadiaphyseal angle or radiographic measurement. Also, many of those patients resolve completely and have no long term sequelae.²⁵ Thus, the recommendation of bracing for patients with Langenskiöld stage I or II is based on retrospective studies with no comparison to a non-braced cohort and has not been validated with either a randomized trial or large patient population.^{26, 27, 28} In spite of this, the AAOS OrthoInfo page recommends early surveillance of the condition and recommends treatment with a brace.²⁹ POSNA's Physician Education Study Guide outlines these same recommendations but also indicates that risk factors for failure may include bilateral pathology, instability, obesity, and delayed bracing, again based on studies that do not have the comparison groups listed above.^{30, 31, 32} Thus, this is an area in which a future study may help to guide our treatment paradigm. We are aware of no studies that show positive results for bracing in Langenskiöld stage III or above, as these children were likely to progress unless treated surgically with either guided growth, acute correction via osteotomy, or gradual correction via osteotomy with a fixator frame.^{33, 34} Thus, it is unclear if bracing truly helps patients with idiopathic tibia vara, as the patients with mild disease may correct spontaneously, and the patients with severe disease require surgical management to correct their deformities.

In summary, the guidelines from the AAOS, POSNA, and the AAP are unanimous and clear in their recommendations against bracing in MA, ITT, FA, and PFF. There still exists equipoise regarding bracing in patients with infantile Blount disease, particularly patients with Langenskiöld stage I or II, even strong data does not exist regarding their use; due to that equipoise, we did not query about bracing for Blount's disease in this study. The clear guidelines for MA, ITT, FA, and PTT should guide clinicians to correct treatment of these common lower limb deformities. But in reality, many clinicians still choose to brace despite this consensus.

Survey of POSNA Members

We conducted a study to assess whether or not the above guidelines are adhered to by members of POSNA in real clinical practice. In addition, we sought to evaluate the reasoning and the frequency of why POSNA members were prescribing braces to patients with MA, PFF, ITT, and FA.

Methods

An anonymous online questionnaire was sent to all POSNA members (N=1402) via SurveyMonkey. Demographic information about the members were collected as well as their brace prescribing habits as related to the four benign lower extremity conditions were queried.

We used SPSS statistical package (IBM, Armonk, New York) to analyze our data. Simple linear regression was used to compare years in practice to the likelihood of prescribing orthotics for each condition. Pearson's chi-squared test was used to compare fellowship training to the likelihood of prescribing orthotics. Fisher's exact test was used to compare type of practice to the likelihood of prescribing orthotics. A p value of <0.05 was considered significant for all tests.

Results

The online questionnaire was sent to all POSNA members (N=1402 members) via their email address registered with POSNA. The response rate was 26.1 % (n=366 responses). Pediatric orthopaedic fellowship trained members comprised of 87.4% (320) of the respondents. The experience of responders was fairly evenly distributed. Three hundred and thirty-two responders (74.6%) described themselves as pediatric orthopaedic surgeons—222 members (61.5%) treated only children and 109 members (13.1%) treated children and adults. Two hundred and twenty-five responders (61.5%) were part of academic or university affiliated groups, while 48 (13.1%) members were part of a pediatric only orthopaedic surgery group. A majority of

Response	n(%)			
	MA	PFF	ITT	FA
Always	7(1.9)	1(.3)	2(.5)	2(.5)
Almost always	6(1.6)	3(.8)	1(.3)	-- ^a
Sometimes	62(16.9)	44(12)	9(2.5)	3(.8)
Almost never	128 (35)	103(28.1)	41(11.2)	18(4.9)
Never	127(34.7)	176(48.1)	275(75.1)	304(83.1)

Table 1. Frequency for prescribing orthotics for the treatment of flexible metatarsus adductus (MA), painless flexible flatfeet (PFF), internal tibial torsion (ITT) and femoral anteversion by POSNA survey respondents.

Note. n = size of the sample from the sampled population. Sample sizes and percentages for each condition was derived from 366 POSNA survey respondents.

^a No respondents reported “almost always” bracing for Femoral Anteversion cases.

responders stated that they have been in practice for 21-30 years or longer. Responders included all POSNA members ranging from orthopaedic surgeons, pediatricians, physical therapists, and podiatrists.

More POSNA members reported “never” prescribing orthotics for FA (304; 83%) than any of the other conditions—275 (75%) for ITT, 176 (48%) for PFF, and 127 (35%) for MA (Table 1). Few respondents reported “always” or “almost always” prescribing orthotics for any of the benign conditions; 13 (3.6%) for MA, 4 (1.1%) for PFF, 3 (0.8%) for ITT, and 2 (0.5%) for FA.

Table 1 shows frequencies in bracing by survey respondents for the treatment of flexible metatarsus adductus (MA), painless flexible flatfeet (PFF), internal tibial torsion (ITT) and femoral anteversion (FA) by POSNA survey respondents. No respondents reported “almost always” bracing for Femoral Anteversion cases. Members without pediatric fellowship training are more likely to “always” or “almost always” prescribe orthotics for PFF than fellowship-trained providers (14.3% vs. 0.6%; $p < .001$) but not for MA, ITT, or FA. POSNA

members who have been in practice longer are more likely to prescribe orthotics for ITT ($p < .001$, $B = .068$) and FA ($p = .009$, $B = .034$) but not for MA ($p = .180$, $B = .038$) or PFF ($p = .842$, $B = .005$). Members in solo private practice are more likely to “always” or “almost always” prescribe orthotics for MA (27.8%; $p = .002$), ITT (11.1%; $p = .045$), and FA (11.1%; $p = .007$) than providers in academic and private group settings.

Table 2 summarizes the reasons why providers prescribed orthotics for each condition. “Patient/parent desire” was the most common

reason for orthotic prescriptions for MA, PFF, and ITT, while “learned in residency/fellowship” was the most common reason for prescribing orthotics for FA.

If the patient had been prescribed orthotics by another provider, many of these were by non-physicians (Figure 2). Physical therapists were the most common previous prescribers for MA, ITT, and FA, and podiatrists were the most common previous prescribers for PFF.

Discussion

The purpose of our review was to assess whether members of POSNA are following the guidelines regarding the use of orthotics and bracing in MA, PFF, ITT, and FA as published by AAOS and POSNA. Our findings also give us some insight into the prescribing habits of POSNA members and can help us to understand what factors are involved when patients do receive braces for these conditions. Of the 4 conditions we explored, members were most likely to deviate from the guidelines when treating MA. Only 35% of responders reported “never” prescribing orthotics for MA, while 3.6% reported “always” or “almost always”

Bracing Reason	Flexible Metatarsus Adductus	Internal Tibial Rotation	Femoral Anteversion	Painless Flexible Flatfeet
<i>Patient/parent desire</i>	104 (58%)	26 (55%)	6 (27%)	109 (74%)
<i>Learned in residency/fellowship</i>	44 (25%)	17 (36%)	11 (50%)	17 (11%)
<i>Community standard</i>	14 (8%)	3 (6%)	1 (5%)	11 (7%)
<i>Evidence in literature</i>	16 (9%)	1 (2%)	4 (18%)	11 (7%)

Table 2. Variations in the bracing reason for the treatment of flexible metatarsus adductus (MA), painless flexible flatfeet (PFF), internal tibial torsion (ITT), and femoral anteversion by POSNA survey respondents.

prescribing orthotics. There was no association between the likelihood of bracing and pediatric fellowship training or the number of years a member had been in practice. Members in our study cited patient or parent desire as the most common reason to brace, and this was a common trend with all four conditions in our study. While our study specified “flexible” MA, there is a role for manipulation and serial casting or bracing in partly flexible or inflexible MA.⁴ This may have influenced some of our responders.

Pediatric orthopaedic fellowship training was associated with member bracing habits for PFF. Though the vast majority of responders to our questionnaire were pediatric orthopaedic fellowship-trained, there was an association with bracing for PFF and not having completed a fellowship. Patient/parent desire was the most common reason to brace regardless of whether the member had fellowship training. Despite non-fellowship trained providers being more likely to brace, the second most common reason to brace was providers having learned it in their fellowship or residency. Previous studies have highlighted the importance of fellowship training on clinical decision making, including bracing, in other orthopaedic sub-specialties.³⁵

The amount of time POSNA members have been in practice affects their bracing habits of ITT and FA. Learning it in fellowship or residency was the most common reason for providers to prescribe braces for FA, while this was the second most common reason cited for bracing ITT. As the providers who have practiced longer were more likely to brace for ITT and FA, this may suggest a change in teaching on treating these two conditions over time.

Practice setting affects POSNA members’ bracing habits of MA, ITT, and FA. Solo private practitioners were more likely to prescribe braces for MA, ITT, and FA than members in any other practice setting. These results suggest that solo private practice may not benefit from the continuing educational environments of academic and private group practices. This may also signal that pressure from peers plays a role in resisting patient and parent desire and adhering to guidelines.

When patients had been previously prescribed orthotics, it was often initiated by non-orthopaedic surgeons. This suggests that there is a dichotomy in teaching and practice between surgeons and non-surgeons. Other physicians such as pediatricians as well as non-physician

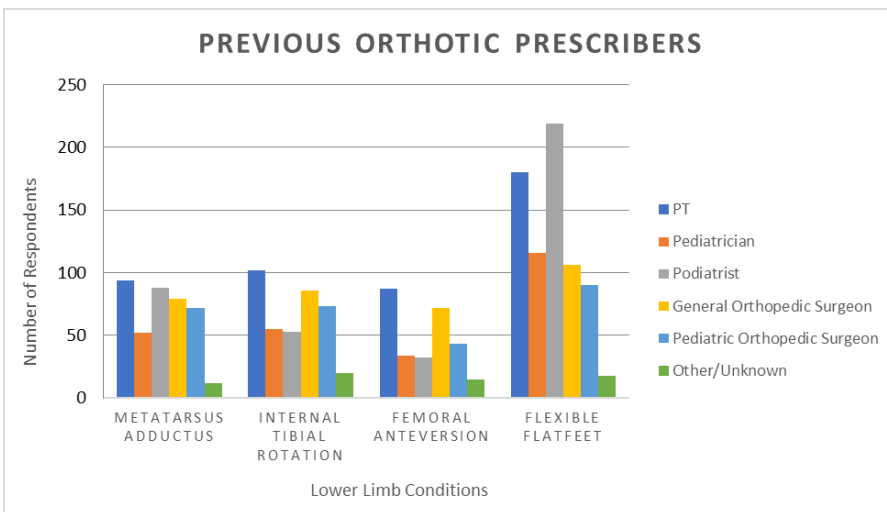


Figure 2: The Distribution of Previous Orthotics Prescriber

practitioners, such as physical therapists and podiatrists, were common previous prescribers of braces in our study. Our results highlight the need for more communication between all practitioners who treat these conditions to standardize treatment and ultimately provide the best care possible for patients.

Asitha et al. have shown training courses have helped to increase practitioner's adherence to standard Ponseti method protocol in treating clubfoot.³⁶ Similar training courses targeted towards all pediatric practitioners could help increase adherence to the bracing guidelines for MA, PFF, ITT, and FA.

Although most POSNA providers adhere to the AAOS, POSNA, and AAP bracing guidelines for the four conditions we surveyed, some providers did not, and many made occasional exceptions. Providers who were farther removed from fellowship were more likely to prescribe orthotics for ITT and FA than more recent graduates. Non-pediatric orthopaedic fellowship-trained providers were more likely to prescribe orthotics for PFF than fellowship-trained pediatric orthopaedic providers. Solo private practitioners were more likely to prescribe orthotics for MA, ITT, and FA than those in academic or private group settings. The most common reason for

these exceptions was patient/parent desire, but provider education during residency and/or fellowship was the second most common reason. This highlights the need for consistent education for all orthopaedic surgery residents, pediatric orthopaedic fellows, and nonsurgical providers.

Conclusion

The AAOS, POSNA, and AAP all recommend against bracing in MA, ITT, FA, and PFF. It is unclear if bracing truly helps patients with idiopathic Blount disease, as patients with mild disease may correct spontaneously, and patients with severe disease require surgical management

to correct their deformities. Still, many practitioners still fail to follow these guidelines and continue to treat these benign, self-limited deformities with braces. Better adherence to these bracing guidelines cannot only save money and better utilize resources but also decrease unwanted psychosocial strains on children and better manage families' expectations.

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