

Outcomes Following Surgical Correction of Toe Walking

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Abstract

Objective: The purpose of this study is to evaluate the outcomes and complications in children who underwent Tendo-Achilles lengthening (TAL) surgery for idiopathic toe walking (ITW).

Methods: A retrospective review of medical records was performed of one pediatric orthopaedic surgeon's practice from 2009-2015. Demographic information, prior treatments, consultations, and imaging studies were recorded. Post-operative follow-up, range of motion, return to activity, and complications were also tabulated.

Results: Thirty-seven total patients were studied (24 males and 13 females). The average age was 8.1 years (range: 2.5 - 16.25 years). Five children (14%) had a positive family history of toe walking. Five patients (14%) had autism. Prior to surgery, 5 (14%) had serial casting and 1 (3%) had Botox injections. Preoperatively, 24 patients (65%) had a neurology consult. MRI was performed in 21 (57%) patients to rule out neurological conditions (all of which were negative). All 37 patients had bilateral TAL's. The average follow-up post-surgery was 14 months. The average dorsiflexion increase after surgery was 23° and the average return to activity as tolerated after surgery was 6 months. Thirty-six of 37 (97%) patients were corrected by TAL. No infections, wound dehiscence, over-lengthening's, or nerve injury occurred.

Conclusion: Delay in referral for potential surgical correction of ITW is common due to an unfounded fear of surgery. In the current study, children younger than 10 years at surgical correction had greater increase in ankle dorsiflexion and quicker time returning to normal activity. TAL for toe walking is safe and is 97% effective.

Keywords: Idiopathic toe walking, ITW, Tendo-Achilles lengthening

INTRODUCTION

Idiopathic toe-walking has been described as bilateral persistent toe walking with or without fixed equinus contracture and without other discernable etiologic abnormalities in patients >2 years. [1] This phenomenon was first described by Hall in 1967, referring to toe walking caused by a shortened heel cord and no other obvious pathology. At the time it was termed congenital short tendo calcaneus but is now commonly referred to as ITW. [2] The affected child will predominately ambulate on their toes or forefoot, rather than typical heel-toe gait. Transient toe walking is common in children learning to walk. [3,4] Persistent toe walking is often concerning for parents

and prompts a visit to their pediatrician and often a referral to pediatric orthopaedics. Toe walking can be idiopathic or have a pathologic cause. Pathologies which can cause toe walking include: cerebral palsy, Duchenne muscular dystrophy, Charcot Marie Tooth, and others.

One report demonstrates ITW may spontaneously resolve by the age of 5 years and another has concluded toe walking may just be observed. [5, 6] If toe walking does not resolve, several treatment options have been utilized to correct the gait abnormalities seen in children with ITW. These include: physical therapy, serial casting, botulinum toxin A (BTA) injection, and surgical lengthening of the Achilles tendon. [1] Surgery is commonly undertaken after nonsurgical treatment

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is unsuccessful; however, surgical intervention for ITW has been shown to be the only intervention to have continued benefit and effect after 1 year. [7] Surgery has also been shown to have maintenance at 5 years' post-operative. [8]

The goal of this study is to review clinical outcomes in children who underwent surgical treatment for the correction of toe-walking. We also sought to investigate any demographic associations amongst our patient group. Lastly, we hoped to create a simplified algorithm for the initial work-up and treatment of children with ITW.

METHODS

A retrospective chart review approved by the School of Medicine's IRB. Data was collected from the senior author's surgical practice from 2009-2015. Inclusion criteria included Tendo-Achilles Lengthening for diagnosis of ITW. Participants must have been older than 2 years of age and younger than 18 years of age at time of surgery. Exclusion criteria included a diagnosis other than ITW and less than 6 months follow up.

Thirty-seven patients met inclusion criteria. Prior treatments, imaging, laboratory testing, consultations, referrals, and other diagnoses were recorded in addition to demographic information. Surgery consisted of Achilles lengthening. Patients were positioned supine, perioperative antibiotics dosed, and tourniquet placed. A semi-open Z-lengthening of the Achilles tendon was performed and side to side repair was utilized with ankles at neutral. Incisions were closed with running stitch and a cast was placed in neutral. Post-operative treatment included 6 weeks of casting, followed by full time 23-hour Cam walker boots for 6 weeks, followed by night time use for 6 months. Post-operative infections, complications, ankle dorsiflexion, time to return to activity as tolerated, overcorrection, and recurrence of toe walking were recorded.

Ankle dorsiflexion change was calculated with pre-operative and post-operative measurements using a goniometer. The delta between the values was then calculated and averaged across all patients and for specific age ranges (<6, 6-9, ≥10 years old). Patients with no pre- or post-operative measurement were not included in ankle dorsiflexion calculations. Time to

return to activity for patients was also averaged for all patients, as well as for the age ranges above.

RESULTS

This study included 37 surgical patients (24 males and 13 females) with the average age of 8.1 years (range: 2.5-16.3 years) at the time of surgery. Twenty-seven patients (73%) had treatment before surgery, including five (14%) having serial casting, one (2%) having Botox injections, and 21 (57%) undergoing physical therapy. Five children (14%) had a positive family history of toe walking. Five patients (14%) had the diagnosis of autism and six patients (16%) were found to have a penicillin allergy. Prior to surgery, 24 patients (65%) had a neurology consult, 21 (57%) had an MRI to rule out neurological conditions (all of which were negative), 4 (11%) had a developmental consult, and 24 (65%) had pelvic x-rays (all of which were negative). All 37 patients had bilateral Tendo-Achilles lengthening. Five (14%) of these patients were found to have a fixed popliteal angle of 45 degrees, without abnormal neurologic findings, and also underwent medial hamstring lengthening. Twelve children (32%) were 10 years of age or older at the time of surgery. The average follow-up post-surgery was 14 months (range 6-70 months).

Post-operative findings included an average dorsiflexion increase after surgery of 23.3 degrees for all patients, with decreasing values observed in older patients. Age ranges were <6, 6-9, and ≥10 years, and experienced increases in dorsiflexion of 26.4, 24.6, and 18.5 degrees respectively (Figure 1). The average return to activity as tolerated after surgery was 6 months for all patients, with increasing values observed in older patients (Figure 2). Return to play averaged 5 months in patients <6, 5.3 months in the 6-9 group, and 7.4 months in those 10 and older. In patients with a family history of toe walking, the return to activity was slower with average return by 8.6 months. Thirty-six of 37 (97%) patients were corrected by the protocol of TAL, casting, and bracing. One patient continued toe walking after completing the protocol. This patient was successfully treated with therapy and a night brace. No infections, wound dehiscence, over-lengthening's, nerve injury, or other surgical or rehabilitation complications occurred.

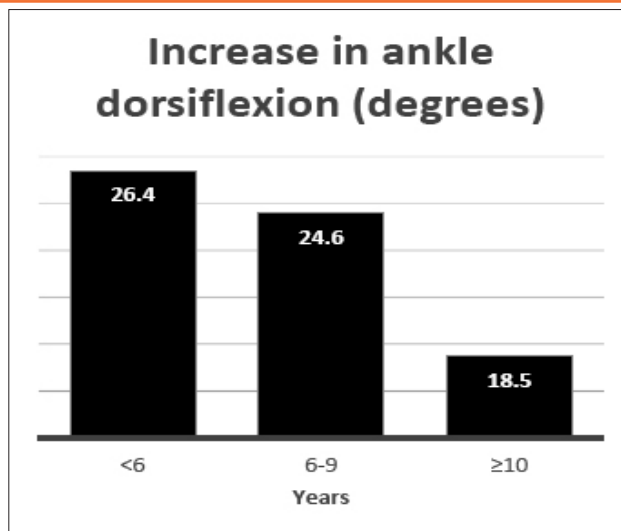


Fig1. Average increase in ankle dorsiflexion across different age groups

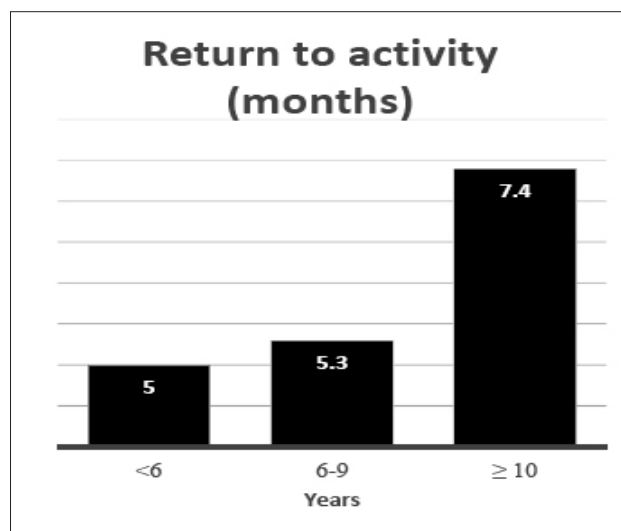


Fig2. Average return to activity as tolerated across different age groups

DISCUSSION

In our study, we found 97% success with TAL for idiopathic toe walking. There were no patients with surgical or rehabilitation complications. There was only one patient with recurrence, which was successfully treated with therapy and a night brace. This patient was 10 years of age at the time of surgery and initially only had a 15-degree increase in ankle dorsiflexion measured post-operatively. This patient's increase in ankle dorsiflexion was comparable to others in the age group ≥ 10 , which was lower compared to that of ages 6-9 as well as ages < 6 (18.5 vs 24.6 vs 26.4 degrees). Ankle dorsiflexion showed less improvement in the ≥ 10 -year age group and results were less predictable due to stiffness, decreased resilience in healing,

and the decrease in ankle dorsiflexion that occurs as children age. In addition, the time to return to activity was increased in patients ≥ 10 years of age by approximately 2 months compared to those from lower age groups. For best results, our outcomes suggest surgical intervention is indicated before age 10.

Our results compare favorably to other studies. [9, 10] For example, Hemo, et al. investigated surgical lengthening of the Achilles tendon in patient's ages 4 to 13 years old. They demonstrated surgery improved ankle dorsiflexion without causing weakening of the triceps surae muscles. [11] Similarly, Kogan and Smith, also reported no recurrence in 15 children treated with Achilles tendon lengthening for toe walking and had 100% parent satisfaction. [12]

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The typical heel-toe gait pattern is usually achieved by 24 months. [3] A child's gait matures to that of an adult by age 5. [13] By the age of 5 years, more than half of children diagnosed as toe-walkers may return to normal gait. [5] Toe-walking children have greater dorsiflexion at younger ages (1-2 years old), with a gradual decrease in dorsiflexion and an increase in ankle equinus in older children (6-15 years old). [14] Based on the current paper, after age 6, the longer a child toe walks, the less likely conservative therapy will be successful.

The majority (73%) of patients in our study had prior conservative treatment before surgery. All attempts at conservative treatment were unsuccessful. The costs of conservative treatment are substantial, including multiple doctor visits, cast or brace materials, and time commitment. Outcomes of conservative modalities including orthotics, serial casting, and BTA injections have been shown to provide no benefit compared to observation. [1, 11, 15, 16, 17, 18, 19] Prolonged conservative care often results in delays in surgical intervention.

In hopes of simplifying the diagnostic and treatment pathway for patients and their families, we have constructed an algorithm for use by primary care

providers when encountering a patient with toe-walking. Initially patients are identified as toe walkers. A thorough history is then obtained and physical exam performed. Screening questionnaires such as the *Toe Walking Tool*, described by Williams, can be used to help rule out pathologic causes of toe walking while taking the patient's history. [20] A careful neurological exam should also be performed. If the child's history, physical or neurologic exam are abnormal, their toe walking may be pathologic. A neurology referral is then warranted to evaluate for possible pathologic causes. If the toe walking has been present since onset of walking, examination is normal, and no other causes identified, the child is identified as an idiopathic toe walker. They are then stratified by age, starting at 6 years old. This age was chosen because as one aforementioned study demonstrated, more than half of children will spontaneously revert from toe-walking to a normal gait by this age. [5] We also noted a negligible difference between outcomes in the age groups <6 and 6-9 years old. Those children under the age of 6 may be observed or receive conservative treatment. Children 6 years or older, should be referred to orthopaedics for the protocol of TAL, casting, and bracing. The details of this algorithm are illustrated in Figure 3.

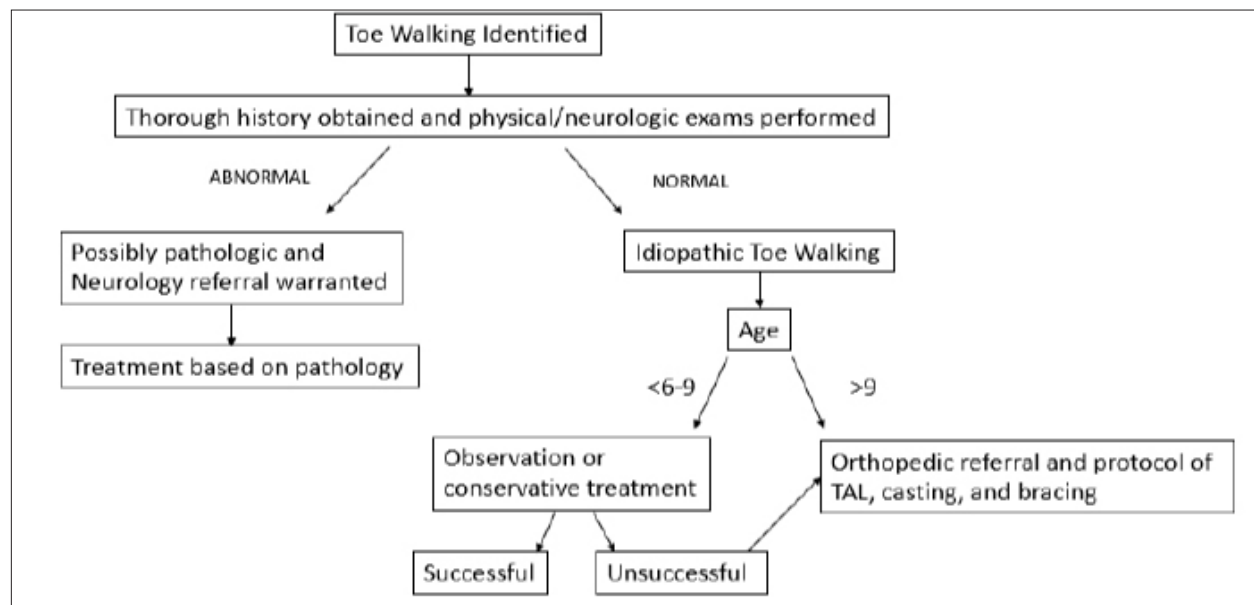


Fig3. Treatment Algorithm for Toe Walking Patient

Sixty-five percent of our patients were referred to a neurologist. Subsequent MRIs of the brain and/or spine were ordered by the neurologist in 57% of patients to ensure there was no neurological involvement contributing to the toe-walking. All

MRI's were found to be negative. In the current study neurology consults and MRIs were not fruitful. This suggests the need for more judicious use of neurology referral. The orthopaedic surgeon should perform a thorough physical and neurologic exam, including

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testing for upper motor neuron signs of spasticity, clonus, and positive Babinski. Lower motor neuron signs to examine for include muscle atrophy, cavus feet, absent deep tendon reflexes, and sensory abnormalities. [21] Evaluation for Gower's sign, calf size asymmetry, and inspection of lumbar spine for hair patches should also be performed. Referral to neurology would then be necessary based on abnormal history or physical examination. The neurologist should then decide on the need for MRI.

Autism is a neurodevelopmental disorder associated with toe walking. The prevalence of ITW in children after age of 5 years old with a neuropsychiatric diagnosis or developmental delays is 21%. [22] The prevalence of children affected with ASD is 2%. [23] In the present study, 14% of children indicated for TAL for toe walking had autism. The prevalence of patients with autism in the current study is slightly less than reported in the literature. [23, 24, 25, 26] The association between ASD and ITW can lead to evaluation for toe walking when autism is diagnosed or autism when toe walking is diagnosed. Children with suspected autism should be evaluated by a neurologist or developmentalist.

Fourteen percent of patients with ITW in our study had a family history of the toe walking. One author found individuals with a positive family history of ITW are more severely affected. [27] The present study demonstrated that in patients with a family history of toe walking, the average return to activity was approximately 3 months greater than patients without a family history (8.6 vs 5.7 months). Patients with ITW and a positive family history may require more time for rehabilitation and closer follow-up.

An additional interesting and unexpected observation in the current study was the presence of a penicillin allergy amongst our patient group (16%). The overall prevalence of penicillin allergy is 10%. [28] A review of the literature shows no studies showing a correlation between penicillin allergy and toe walking; and no correlation between autism and penicillin allergy. The association of penicillin allergy and ITW may be a future avenue in research. The limitations of the study include the retrospective nature, small sample size, single surgeon, and limited follow up.

CONCLUSION

Idiopathic toe walking is a diagnosis of exclusion. Delays in referral are common. Prolonged conservative treatments are can cause delays in surgical intervention. Surgery is often considered a last resort;

however, the results of the current paper suggest the fear of surgery is unwarranted. The younger the age of surgical intervention for toe walking, the greater the increase in ankle dorsiflexion and decreased time to return to activities. A reasonable age for surgery is younger than age 10. TAL for ITW is 97% effective with minimal complications.

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