REVIEW ARTICLE

Etiology and Treatment of Congenital Vertical Talus: A Clinical Review

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Abstract

Congenital vertical talus is a rare rigid flat foot deformity. Although the cause of the congenital vertical talus is heterogeneous, recent researches strongly support a genetic cause linking the genes expressed during early limb development. If remain untreated, it causes a lot of disability like pain and functional limitations. Traditional treatment for vertical talus involves extensive surgeries, which are associated with short and long complications. A minimally invasive approach involving serial manipulation and casting will produce excellent short-term results with regard to clinical and radiographic correction. To achieve correction without extensive surgery leading to more flexible and functional foot, a long-term research study is required.

Keywords: Clinical, Congenital, Limb, Talus.

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Introduction

The ankle joint complex involves articulation of talus with tibia and fibula.[1] The movements of the ankle joint are plantar flexion and dorsiflexion in sagittal plane and abduction and adduction in the coronal plane.[2] Talus also articulates with plantar calcaneonavicular ligament and calcaneus to form talocalcaneonavicular joint.[3] Congenital vertical talus is a rare foot deformity, which is characterized by hindfoot valgus and equinus, with associated midfoot dorsiflexion and forefoot abduction caused by a fixed dorsal dislocation of the navicular bone on the head of the talus.[4] It has rigid flatfoot or rocker bottom foot deformity with forefoot dorsiflexed and hindfoot plantar flexed.[5–7] Congenial vertical talus was named first by Rocher[8] in 1913 as foot in piole. Henken in 1914[9] published the first clinical case of congenital vertical talus. Other terminologies used for this condition were pied plat valgus congenital, reversed club foot, vertical talus, and congenital convex pes valgus[9–11] and also named as congenital valgus flat foot and rocker bottom foot.[12,13] Congenital convex pes valgus is the term, which is currently most commonly used.[14] Its incidence is 1 in 100,000 live births with no sex predilection,[15,16] but according to Marcinko and Schwartz,[17] it is more common in males than females. About 50% of the children showed bilateral involvement.[16] The exact cause of congenital vertical talus remains unidentified. It occurs either as an isolated deformity in approximately half of the cases and is associated with neuromuscular and genetic disorders in the remaining cases.[18] The other causes may be due to arrest in prenatal development of foot, or sometimes, paralysis and contracture of the soft tissue may be the cause.[19] The other parameters associated with congenital vertical talus are hypoxic birth injury, microcephaly, and cryptorchidism.[20] Without treatment, it leads to significant disability, including foot and ankle pain and medial plantar callus around prominent talar head.[21] In early times, surgical treatment of congenital vertical talus was intensive with a large number of short- and long-term complications.[22] Development of minimally invasive alternative approach has proved successful in providing correction and at the same time avoiding extensive soft tissue release.[23] The aim of the present study is to discuss various causative factors, associated congenital anomalies, and various treatment approaches of congenital vertical talus after reviewing the available literature.

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Epidemiology

Although the exact incidence of congenital vertical talus is unknown, the prevalence is estimated as 1 in 10,000 live births.[16] The estimated number is low because of difficulty in recognition of this condition in newborn. Furthermore, the condition is rare and large studies are lacking in various populations to determine its laterality or gender predilection.

Pathoanatomy

Congenital vertical talus is a foot deformity in which calcaneus is in equinus and the talus is plantar flexed associated with rigid irreducible dislocation of talonavicular joint with navicular bone articulating on the dorsolateral aspect of talar neck. It is associated with systemic involvement. The head of the talus produces a prominence on the medial side, and a rocker bottom on the sole of the foot is seen. Congenital vertical talus should be differentiated from other deformities of the foot like club foot in which displacement of the talonavicular joint is directed downward and medially, whereas in congenital vertical talus, it is directed upward and laterally. Another important difference is that

the elevated heel is not fixed in congenital vertical talus, while it is fixed in club foot.[24] Coleman et al.[7] gave the most widely used anatomical classification and described two types of congenital vertical talus. Type 1 deformity involves rigid dorsal dislocation of the talonavicular joint. In type II deformity, in addition to rigid dorsal dislocation of talonavicular joint, there occurs dislocation or subluxation of calcaneocuboid joint. Oblique talus is considered as milder form of congenital vertical talus based on clinical and radiographic examination. This condition requires treatment only in some cases despite its milder nature.[6] The muscles and soft tissues involved in marked equinus and valgus deformity seen in congenital vertical talus are contracture of the Achilles tendon and involvement of posterolateral part of ankle and subtalar joint capsules.[15] The midfoot and forefoot are dorsiflexed and abducted due to the contracture of tibialis anterior, extensor digitorum longus, extensor hallucis brevis, peroneus tertius, extensor hallucis longus tendon, and dorsal part of talonavicular capsules.[13] The ankle joint remains in dorsiflexed position due to anterior subluxation of tibialis posterior and peroneus longus. The navicular bone lying on the dorsal and lateral aspects of the head of talus becomes hypoplastic and wedge shaped.[25] Talar head and neck are now medially directed and are abnormal in shape. Due to the vertical position of talus bone, plantar soft tissues including calcaneonavicular or spring ligament become weak causing rocker bottom appearance. The calcaneus bone is in extreme equinus position causing dorsolateral subluxation or dorsal dislocation of calcaneocuboid joint.[15] The forced plantar flexion and forced dorsiflexion lateral radiographs will confirm the diagnosis and will differentiate congenital vertical talus from the oblique talus. The forced dorsiflexion lateral radiograph shows decreased tibiocalcaneal angle showing fixed hindfoot with persistent malalignment of the long axis of the talus in relation to the navicular bone. The forced plantar flexion lateral view depicts persistent malalignment of the long axis of the talus and first metatarsal bone[15] and is known as talus axis and metacarpal bone axis (TAMBA).[6] Also, associated underlying neuromuscular disease[4] or flexion contracture or ulnar deviation of hand or fingers, multiple malformations, and CNS defects or chromosomal defects should be ruled out.[7] It should be differentiated from the most common calcaneovalgus foot, posterior medial bowing of the tibia, and flexible flatfoot.[15]

Etiology and Associated Anomalies

The exact cause of congenital vertical talus is unknown. It is difficult to differentiate congenital vertical talus from other more common benign positional foot anomalies at the time of birth.[4] To make definite diagnosis, the navicular bone should be dislocated dorsally on the neck of talus when the foot is maintained in extreme plantar flexion.[6,7] Approximately half of the cases are idiopathic and half are associated with neuromuscular or genetic disorders. Congenital vertical talus occurs in both isolated and systemic forms. Therefore, in patients with apparently isolated forms of congenital vertical talus, it is important to rule out congenital vertical talus associated clinical features.[26,27] Rarely, congenital vertical talus is seen as a nonsyndromic condition.[4] Rather, it is associated with various syndromes like Cri du chat syndrome,[28] multiple pterygium syndrome,[29] muscle abnormalities like ischiocalcaneal band. The genetic conditions associated are Marfan syndrome and aneuploidy of chromosomes 13,15,18,[30,31] De Barsy Syndrome,[15] fetal brain abnormalities like microcephaly and migration anomalies, spinal abnormalities, such as scoliosis, myelomeningocele, and tethered cord,[32] and Cri du Chat syndrome.[28] Stern et al.[33]; Levinsohn et al.[34] gave transmission of congenital vertical talus by autosomal dominant trait with variable expression and incomplete penetrance. Genetic etiology of the congenital vertical talus is suspected in a child if any of these features are present. The features are various congenital anomalies, developmental delay and developmental regress, undeveloped secondary sexual characters, and ambiguous genitalia.[35] Other possible causes given are arrest in the rotational development of the foot in the second or third month of fetal life[36] or muscle imbalance[37] or increased intrauterine pressure and resultant tendon contractures or arrest in fetal development occurring 7th and 12th week of gestation[15] or intrauterine growth retardation.[38] Incidence of IUGR in the general population was given between 3 and 7% by Romeo et al.[39] and was 80% by Muhsin.[20]

Gene Sequencing

Cartilage-derived morphogenetic protein I (CDMP1)—Binding of CDMP1 with transforming growth factor-beta plays a role in the development of cartilage, joint, and growth of neuronal axons.[40,41] Mutations in CDMP1 cause severe upper and lower skeletal malformation and ultimately congenital vertical talus in some families.[41,42]

HOXD-II Gene

HOXD-II gene encodes a homeobox DNA-binding domain containing pro-HOXD II protein, which is involved in differentiation and limb development. Mutation in HOXD II gene is associated with isolated congenital vertical talus[4,34,43,44] as well as bilateral congenital vertical talus and Marie–Tooth disease.[45,46]

Gene Controlling Contractile Muscle Fibers

Muscle biopsy specimen from patients of congenital vertical talus showed small size of muscle fibers and abnormal fiber type.[47] Mutation in skeletal muscle contractile gene is common in distal limb defects like distal arthrogryposis[47] and congenital vertical talus.[48]

18q Deletion Syndrome

The deletion of the distal part of the long arm of chromosome 18 is known to cause the 18q deletion syndrome. Variation in the clinical features of the patients with distal 18q deletion is due to differences in the size of the deletion.[49,50]

Treatment

The main aim of the treatment is to resume the normal function of foot by correcting anatomical articulations between talus, navicular, and calcaneum bone. Commonly noninvasive treatment involves conservative treatment like manipulation and serial casting.[4] Early casting for congenital vertical talus is sporadic with unexpected mixed results unlike in club foot where early caste treatment proves a success.[51] But, this method is not successful in all the cases.[52,53] Invasive procedures mostly involve single-stage surgery for required correction.[54,55] Some surgeons initially do conservative plaster cast treatment to slowly reduce the talonavicular joint, followed by minimal surgical interventions giving early good results.[4,56] Surgical treatment is always preferred before the age of 2 years.[57] Most surgeons follow open reduction of the talonavicular joint with tendon lengthening and release procedures. Others involve tendon transfers or total excision of navicular or talus.[58]

If treatment gets delayed beyond 2 years of age, more aggressive procedures like navicular excision are required. Even older children require subtalar or triple arthrodesis as treatment.[59,60] Most children before 2 years of age operated by extensive release with tendon lengthening and fixation procedures showed the average success rate as 71%.[54,58,55] Extensive release with tendon transfer was the second most common surgical procedure, and the success rate was 74%.[61,58] The other procedures like naviculectomy are not used in this age-group.[12,62] The children older than 2 years of age showed best success rate of 73% with extensive release and tendon transfer,[63,58] while extensive release with tendon lengthening and fixation procedures showed success rate of 46%.[55,64] Naviculectomy with release procedures and tendon transfer was 73% at a mean age of 43.6 months at the time of surgery[65] and is 71% for subtalar/triple arthrodesis at a mean age of 75 months at surgery.[7] Excision of the navicular bone was only done in five feet.[66]

Conclusion

Congenital vertical talus is a rare foot deformity, which is misdiagnosed in newborn due to rigidity of foot deformity. A careful physical examination is needed as early recognition of the deformity leads to early treatment. Currently, the treatment involves serial manipulation and casting with minimally invasive approach. Additional research studies are needed to elucidate the etiology of congenital vertical talus, which will help the clinician to identify the congenital vertical talus at the time of presentation and to predict patient response to the treatment.

References

1. Deland JT, Morris GD, Sung IH. Biomechanics of the ankle joint. A perspective on total ankle replacement. Foot Ankle Clin 2000;5(4):747–759.
2. Brockett CL, Chapman GJ. Biomechanics of the ankle. Orthop Trauma 2016;30(3):232–238. DOI: 10.1016/j.mporth.2016.04.015.
3. Drake R, Vogl AW, Mitchell A. Gray's Anatomy, 2nd edition. Churchill Livingstone Elsevier; 2010.
4. Dobbs MB, Purcell DB, Nunley R, Morcuente JA. Early results of a new method of treatment for idiopathic congenital vertical talus. J Bone Joint Surg Am 2006;88(6):1192–1200. DOI: 10.2106/JBJS.E.00402.
5. Outland T, Sherk HH. Congenital vertical talus. Clin Orthop Relat Res 2010;468:2822–2824.
6. Hamanishi C. Congenital vertical talus: classification with 69 cases and new measurement system. J Pediatr Orthop 1984;4(3):318–326.
7. Coleman SS, Stelling III FH, Jarrett J. Pathomechanics and treatment of congenital vertical talus. Clin Orthop Relat Res 1970;70:62–72.
8. Rocher HL. Les raideurs articulaires congénitales multiples. I Med Bordeaux 1913;84:722.
9. Henken R. Contribution a *l'étude* des forms osseuses du pied plat valgus congénital. These de Lyon; 1914.
10. Marcinko DE, Azzolini TZ, Mariash SA. Enigma of pediatric vertical talus deformity. J Foot Surg 1990;29(5):452–458.
11. Griffin DW, Daly N, Karlin JM. Clinical presentation of congenital convex pes valgus. Foot Ankle Surg 1995;34:146–152. DOI: 10.1016/S1067-2516(09)80038-0.
12. Ellis JN, Scheer GE. Congenital convex pes valgus. Clin Orthop 1974;99:168–174. DOI: 10.1097/00003086-197403000-00020.
13. Tachdjian MO. Congenital convex pes valgus. Orthop Ciln North Am 1972;3(1):131–148.
14. Lamy L, Weissman L. Congenital convex pes valgus. J Bone Joint Surg 1939;21(1):79–91.
15. Alaee F, Boehm S, Dobbs MB. A new approach to the treatment of congenital vertical talus. J Child Orthop 2007;1(3):165–174. DOI: 10.1007/s11832-007-0037-1.
16. Jacobsen ST, Crawford AH. Congenital vertical talus. J Pediatr Orthop 1983;3(3):306–310. DOI: 10.1097/01241398-198307000-00007.
17. Marcinko DE, Schwartz NH. Congenital convex pes plano valgus deformity. In: McGlamry. Comprehensive Textbook of Foot and Ankle Surgery, vol 1. Baltimore: Williams and Wilkins; 1987. pp 466–482.
18. Ogata K, Schoenecker PL, Sheridan J. Congenital vertical talus and its familial occurrence: an analysis of 36 patients. Clin Orthop Relat Res 1979;139:128–132.
19. Drennan JC, Sharrard WJ. The pathological anatomy of the convex pes valgus. J Bone Joint Surg Br 1971;53(3):455–461.
20. Muhsin E. Common anomalies associated to congenital vertical talus: a single center experience. Int J Foot Ankle 2018;2(2):1–4.
21. Harris RL, Beath T. Hypermobile flat-foot with short tendo achillis. J Bone Joint Surg Am 1948;30A(1):116–140.
22. Zorer G, Bagatur AE, Dogan A. Single stage surgical correction of congenital vertical talus by complete subtalar release and peritalar reduction by using the Cincinnati incision. J Pediatr Orthop B 2002;11(1):60–67. DOI: 10.1097/00009957-200201000-00010.
23. Chalayon O, Adams A, Dobbs MB. Minimally invasive approach for the treatment of non isolated congenital vertical talus. J Bone Joint Surg Am 2012:94(11):e73. DOI: 10.2106/JBJS.K.00164.
24. Eyre-Brook AL. Congenital vertical talus. J Bone Joint Surg Br 1967;49(4):618–627.
25. Drennan JC. Congenital vertical talus. Instr Course Lect 1996;45:315–322.
26. Gurnett CA, Alaee F, Desruisseau D, et al. Skeletal muscle contractile gene (TNNT3, MYH3, TPM2) mutations not found in vertical talus or club foot. Clin Orthop Relat Res 2009;467(5);1195–1200. DOI: 10.1007/s11999-008-0694-5.
27. Aroojis AJ, King MM, Donohoe M, et al. Congenital vertical talus in arthrogryposis and other contractural syndromes. Clin Orthop Relat Res 2005;434:26–32. DOI: 10.1097/01.blo.0000163491.75592.01.
28. Khader A, Huntley JS. Congenital vertical talus in Cri du Chat Syndrome: a case report. BMC Res Notes 2013;6:270. DOI: 10.1186/1756-0500-6-270.
29. Konya MN, Elmas M, Ozdemir C. Analysis of musculoskeletal dysmorphic abnormalities of 20 fetuses. Eklem Hastalik Cerrahisi 2017;28(2):114–120. DOI: 10.5606/ehc.2017.52020.
30. McKie J, Radomisli T. Congenital vertical talus: a review. Clin Podiatr Med Surg 2010;27(1):145–156. DOI: 10.1016/j.cpm.2009.08.008.
31. Green NE, Lowery ER, Thomas R. Orthopaedic aspects of Prune belly syndrome. J Pediatr Orthop 1993;13(4):496–501. DOI: 10.1097/01241398-199307000-00014.
32. Rubio EI, Mehta N, Blask AR, et al. Prenatal congenital vertical talus (rocker bottom foot): A marker for multisystem anomalies. Pediatr Radiol 47(13):1793–1799. DOI: 10.1007/s00247-017-3957-z.
33. Stern HJ, Clark RD, Stroberg AJ, et al. Autosomal dominant transmission of isolated congenital vertical talus. Clin Genet 1989;36(6):427–430.
34. Levinsohn EM, Shrimpton AE, Cady RB, et al. Congenital vertical talus in four generations of the same family. Skeletal Rdiol 2004;33:649–654. DOI: 10.1007/s00256-004-0851-1.
35. Hunter AGW. Medical genetics: 2. The diagnostics approach to the child with dysmorphic signs. CMAJ 2002;167(4):367–372.
36. Bohm M. Der foetale Fuss. Beitrag zur Entstehung des pes valgus und plano valgus. Z Orthop Chir 1932;57:562.
37. Duncan RD, Fixsen JA. Congenital convex pes valgus. J Bone Joint Surg Br 1999;81(2):250–254. DOI: 10.1302/0301-620x.81b2.8980.
38. Salam RA, Das JK, Bhutta ZA. Impact of intrauterine growth restriction on long term health. Curr Opin Clin Nutr Metab Care 2014;17(3):249–254. DOI: 10.1097/MCO.0000000000000051.
39. Romeo A, Carceller R, Tobajas J. Intrauterine growth retardation (IUGR): epidemiology and ideology. Pediatr Endocrinol Rev 2009;6(Suppl 3):332–336.
40. Shum L, Coleman CM, Hatakeyama Y, et al. Morphogenesis and Dysmorphogenesis of the appendicular skeleton. Birth Defects Res C Embryo Today 2003;69(2):102–122. DOI: 10.1002/bdrc.10012.

41. Thomas JT, Kilpatrick MW, Lin K, et al. Disruption of human limb morphogenesis by a dominant negative mutation in CDMPI. Nat Genet 1997;17(1):58–64. DOI: 10.1038/ng0997-58.
42. Basit S, Naqvi SK, Wasif N, et al. A novel insertion mutation in the cartilage derived morphogenetic protein-1 (CDMP1) gene underlies Grebe type chondroplasia in a consanguineous Pakistani family. BMC Med Genet 2008;9:102. DOI: 10.1186/1471-2350-9-102.
43. Everman DB, Bartels CF, Yang Y, et al. The mutational spectrum of brachydactyly type C. Am J Med Genet 2002;112(3):291–296. DOI: 10.1002/ajmg.10777.
44. Faiyaz-UI-Haque M, Ahmed W, Zaidi SHE, et al. Mutation in the cartilage-derived morphogenetic protein-1(CDMP1) gene in a kindred affected with fibular hupoplasia and complex brachydactly (DuPan syndrome). Clin Genet 2002;61(6):454–458. DOI: 10.1034/j.1399-0004.2002.610610.x.
45. Alvarado DM, McCall K, Hecht JT, et al. Deletions of 5′ HOXC genes are associated with lower extremity malformations, including clubfoot and vertical talus. J Med Genet 2016;53(4):250–255. DOI: 10.1136/jmedgenet-2015-103505.
46. Shrimpton AE, Levinsohn EM, Yozawitz JM, et al. A HOX gene mutation in a family with isolated congenital vertical talus and Charcot-Marie-Tooth disease. Am J Hum Genet 2004;75(1):92–96. DOI: 10.1086/422015.
47. Merrill IJ, Gurnett CA, Connolly AM, et al. Skeletal muscle abnormalities and genetic factors related to vertical talus. Clin Orthop Relat Res 2011;469(4):1167–1174. DOI: 10.1007/s11999-010-1475-5.
48. Davidson AF, Siddiqui FM, Lopez MA, et al. Novel deletion of lysine 7 expands the clinical, histopathological and genetic spectrum of TPM2 related myopathies. Brain 2013;136(Pt 2):508–521. DOI: 10.1093/brain/aws344.
49. Wilson MG, Towner JW, Forsman I, et al. Syndromes associated with deletion of the long arm of chromosome 18(del (18q)). Am J Med Genet 1979;3(2):155–174. DOI: 10.1002/ajmg.1320030207.
50. Gay CT, Hardies LJ, Rauch RA, et al. Magnetic resonance imagig demonstrates incomplete myelination in 18q-syndrome: evidence for myelin basic protein haploinsufficiency. Am J Med Genet 1997;74(4):422–431. DOI: 10.1002/(sici)1096-8628(19970725)74:4<422::aid-ajmg14>3.0.co;2-k.
51. Laaveg SJ, Ponseti IV. Long-term results of the treatment of congenital club foot. J Bone Joint Surg Am 1980;62(1):23–31.
52. Hart ES, Grottkau BE, Rebello GN, et al. The newborn foot: Diagnosis and management of common conditions. Orthop Nurs 2005;24(5):313–321. DOI: 10.1097/00006416-200509000-00004.
53. Becker-Anderson H, Reiman I. Congenital vertical talus. Reevaluation of early manipulative treatment. Acta Orthop Scand 1974;45(1):130–144. DOI: 10.3109/17453677408989131.
54. Walker AP, Ghali NN, Silk FF. Congenital vertical talus: the results of staged operative reduction. J Bone Joint Surg Br 1985;67(1):117–121. DOI: 10.1302/0301-620X.67B1.3968130.
55. Sticker SJ, Rosen E. Early one-stage reconstruction of congenital vertical talus. Foot Ankle Int 1997;18(9):535–543. DOI: 10.1177/107110079701800902.
56. Bhaskar A. Congenital vertical talus: treatment by reverse Ponseti technique. Indian J Orthop 2008;42(3):347–350. DOI: 10.4103/0019-5413.41860.
57. Yen CC, Haung SC. Surgical treatment of congenital convex pes valgus. J Formos Med Assoc 1997;96(6):424–428.
58. Wirth T, Schuler P, Griss P. Early surgical treatment for congenital vertical talus. Arch Orthop Trauma Surg 1994;113(5):258–253. DOI: 10.1007/BF00443812.
59. Lombardi CM, Silver LM, Silhanek AD, et al. Treatment of congenital convex pes valgus with navicular excision and subtalar arthroreisis: a case study. J Foot Ankle Surg 2001;40(3):166–171. DOI: 10.1016/S1067-2516(01)80083-1.
60. Bosker BH, Goosen JHM, Castelein, Mostert AK. Congenital convex pes valgus (congenital vertical talus). The condition and its treatment: a review of literature. Acta Orthop Belg 2007;73(3):366–372.
61. Jacobs M. Congenital vertical talus. Tex State J Med 1963;59:864–867.
62. Robbins H. Naviculectomy for congenital vertical talus. Bull Hosp Joint Dis 1976;37(2):77–97.
63. Osmond-Clarke H. Congenital vertical talus. J Bone Joint Surg Br 1956;38-B(1):334–341. DOI: 10.1302/0301-620X.38B1.334.
64. Napiontek M. Congenital vertical talus: a retrospective and critical review of 32 feet operated on by peritalar reduction. J Pediatr Orthop B 1995;4(2):179–187.
65. Colton CL. The surgical management of congenital vertical talus. J Bone Joint Surg Br1973;55(3):566–574.
66. Clark MW, Ambrosia RD, Ferguson AB. Congenital vertical talus: treatment by open reduction and navicular excision. J Bone Joint Surg Am 1977;59(6):816–824.