

Wassel Type IV Thumb Duplication A Case Report and Literature Review

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Abstract: Thumb polydactyly, also known as radial polydactyly, is the prevailing manifestation of polydactyly. Its existence has been documented in the hand literature from Digby's initial description in 1645. Preaxial polydactyly, specifically bifid thumb, has been extensively observed, with a frequency ranging from 0.08 to 1.4 per 1000 live births. Traditionally, radial polydactyly is classified into three distinct categories: severe hypoplasia, partial duplication, and entire duplication, which can sometimes be mistaken for pseudo duplication. The classification system developed by Wassel has emerged as the widely accepted standard for the categorization of thumb polydactyly. The classifications of surgical treatment procedures are associated with variations. Thumb duplication is categorized as a "duplication" (group 3) in the International Federation of Societies for Surgery of the Hand (IFSSH)/Swanson classification of congenital malformations of the hand and upper limb. The objective of surgical reconstruction is to achieve a thumb that is both stable and mobile, while also possessing appropriate dimensions and form. The prevailing method of reconstruction often involves the excision of the minor digit followed by the subsequent reconstruction of the major digit. Surgical procedures aim to rectify issues pertaining to deviation, instability, and insufficient dimensions. Moreover, it is worth noting that a significant proportion of instances will necessitate an additional intervention in order to enhance the cosmetic and/or functional result.

Keywords: Hand Surgery, Congenital Hand, Duplicated Thumb, Polydactyly, Duplication, Radial Polydactyly.

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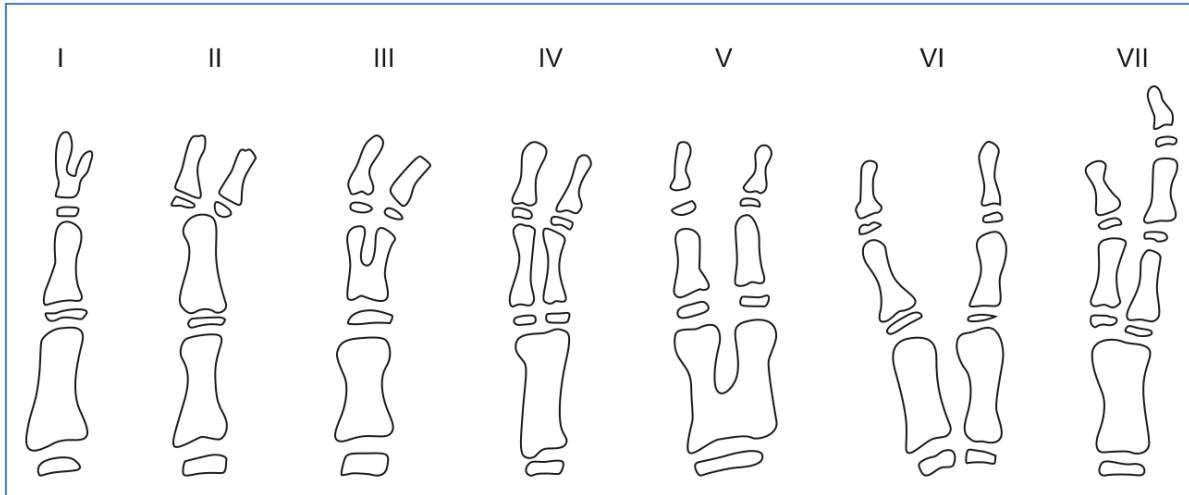
INTRODUCTION

Approximately 1 out of every 600 babies exhibit various types of upper limb abnormalities. The scientific community has dedicated significant efforts over the past few decades to investigate the intricate molecular pathways that regulate the process of limb development. Recent findings have contributed to a deeper understanding of the process and have provided information on how the disruption of multiple biochemical pathways is linked with distinct manifestations of upper limb abnormalities. Thumb duplication, also known as radial polydactyly, is a prevalent congenital abnormality affecting the hand. In

the United States, it ranks as the second most frequently observed congenital anomaly, following syndactyly. Radial polydactyly shows sporadic occurrence, with a prevalence of 8 per 100,000 individuals in both black and white ethnic groups. The majority of patients who have thumb duplication express a preference for surgical therapy, and the success of the initial surgical procedure is of special significance in order to prevent the need for more complex and difficult revision procedures in the future. Thumb duplication is categorized as a "duplication" (group 3) in the International Federation of Societies for Surgery of the Hand (IFSSH)/Swanson classification of congenital

malformations of the hand and upper limb. The types of polydactyly that are included in this classification include radial polydactyly, central polydactyly, ulnar polydactyly, and proximal duplications such as ulnar dimelia. While groups 1 and 2, namely "failure of formation" and "failure of differentiation," provide

somewhat vague indications on the etiology of a specific anomaly, the remaining categories in this classification, namely "duplication," "overgrowth," "undergrowth," and "constriction ring syndrome," are solely descriptive in nature.



1: Wassel's classification system

The method of classification developed by Wassel is now recognized as the widely used standard for the classification of thumb polydactyly. This system utilizes radiographic observations to describe the extent of bone duplication. The phalanges and metacarpals of the thumb are categorized as bifid, duplicated, or unaffected, based on their proximal-to-distal orientation. A Roman numeral is assigned to indicate the extent of bifurcation or duplication as it progresses proximally. Congenital hand surgeons are most familiar with this. The provided information lacks details regarding the dominance of the thumb, potential convergence or divergence at certain joint levels, joint stability, and the existence of any soft tissue anomalies. Type I is characterized by the presence of a bifid distal phalanx, whereas Type II is defined by complete duplication of the distal phalanx. Type III is characterized by the presence of a bifid proximal phalanx accompanied by duplication of the distal phalanx. On the other hand, Type IV is classified as complete duplication of both the proximal and distal phalanges. Type V is characterized by the duplication of both the proximal and distal phalanges, along with a bifid metacarpal. On the other hand, Type VI is classified as the total duplication of both the phalanges and metacarpal. Type VII is characterized by the presence of thumb duplication together with a triphalangeal component. The Wassel classification, despite its limitations, has contributed to our comprehension of the skeletal abnormalities in radial polydactyly and serves as the primary framework for future categorization systems. The primary shortcoming of this approach is in its failure to consider the intricate anatomical complexities associated with this congenital hand anomaly, such as deficiencies and redundancy in

soft tissue, deformities in the axial plane, instability in the joints, and impaired functionality.

CASE REPORT

A male newborn about 6 months old appears with a "extra thumb" for evaluation. The family who is reporting this was there when the baby was born. The child's health is fine in all other respects, and there is no history of congenital hand abnormalities in the family. Upon closer inspection, there are two thumbs that are fully developed, each of which has nail plates as well as flexion and extension creases located over the interphalangeal joint (IP). The metacarpophalangeal (MCP) joint is stable despite its appearance of being broad. It would indicate that the MCP joint of the more radial thumb is capable of active flexion, extension, and abduction. There does not appear to be any additional anomalies.

SURGICAL TECHNIQUES

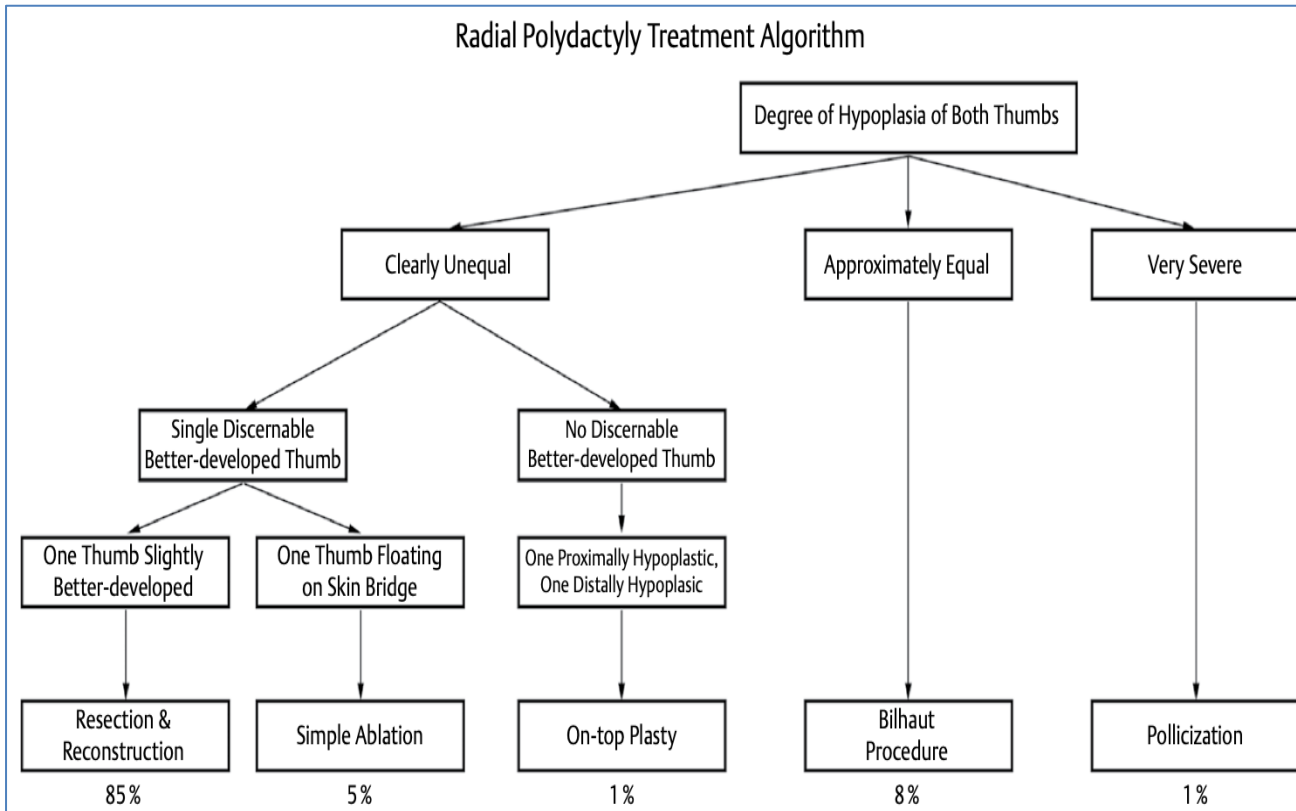
Most of the time, removal and reconstruction are the most popular ways to treat thumb duplication. But how hard the repair is will depend on how the dominant thumb performs. When there is no bone link to the digit to be kept and the joints of this digit are stable, a simple excision is the right choice. After removing the duplicated thumb's middle piece, the Bilhaut-Cloquet Procedure involves joining together equal amounts of bone, soft tissue, and nail tissue. Some people say that there is no reason to do the classic Bilhaut-Cloquet treatment because the side effects of limited joint movement and nail ridge are not acceptable. This may be true for most type I and type II thumb duplications, for which these methods can

usually control deviation and instability at the IP joint. This procedure can make a normal-sized thumb with a stable interphalangeal joint. However, it is hard to accurately join all of the bone segments, nail fold, nail bed, and articular surface, and there are often problems with the reconstructed thumb's physeal growth, joint stiffness, and/or nail plate. In the Modified Bilhaut-Cloquet Procedure, some of the fingers' long parts must be joined together. The nail and terminal phalanx of the better thumb are used, along with a part of the terminal phalanx of the lesser thumb. This may be the most usual combination. The hard part is matching the small piece of bone at the end to the strong end of the phalanx. In order to keep the collateral ligament, the bone must

have the epiphysis, the physis, and a piece of the metaphysis. Fixation is hard to do. Also, it is not unusual for this bone piece to come with a very small piece of nail bed. Patients with asymmetric bifid thumbs should not have the modified Bilhaut-Cloquet operation done. Instead, the smaller thumb should be cut off or only its soft parts should be used. Type I polydactyly doesn't need this modified method because the bifid distal phalanges can be fixed with the original technique without breaking the distal interphalangeal joint. When the metacarpophalangeal joint is involved, as it is in type IV and other polydactylies, the results of the combination operation are generally not good.

Thumb type	Operative technique	Timing
Types I, III, V	Bilhaut-Cloquet technique if angular deformity is present Leave bifid element intact to prevent angular deformity; bifid element may be removed at skeletal maturity	Surgery at 3 years old or older Earlier surgery has increased risk of physeal damage
Types II, V	Ablation of supernumerary thumb with collateral ligament reconstruction	Early surgical ablation
Type VII	Ablation of triphalangeal thumb Retain biphalangeal thumb even if rudimentary	Timing not discussed

2: Surgical management



3: Surgical Algorithm



4: Preop / 7 days post surgery

DISCUSSION

Three categories of hand polydactyly have been described; preaxial (thumb), central (index, long, and ring fingers), and postaxial (small finger) polydactyly [5]. Preaxial polydactyly is reported to be the most common category among white and Asian populations. The objective of surgical reconstruction is to achieve a thumb that is both stable and mobile, while also possessing appropriate dimensions and form. The concepts of stability and size are closely associated with strength, particularly in relation to grip and pinch capabilities. The range of motion of the thumb is mostly determined by the condition of the carpometacarpal (CMC) joint. In Wassel types I to IV, the CMC joint is often unaffected, however types V and VI may exhibit different levels of malformation or incomplete development. The range of motion at the metacarpophalangeal (MCP) and interphalangeal (IP) joints, while essential for optimal thumb functionality, may be somewhat less significant. The variability of normal MCP joint mobility include both the degree of flexion and the occurrence or non-occurrence of hyperextension. The impairment of tip pinch arises from the loss of flexibility in the interphalangeal (IP) joint. However, it is noteworthy that youngsters are able to efficiently adapt for this deficit without perceiving any discernible decline in functionality. When faced with a dilemma about the balance between stability and mobility, it is justifiable for the surgeon to prioritize joint stability over distal joint motion, provided that the carpometacarpal (CMC) joint remains undamaged. The aesthetic significance of the thumb's shape is a crucial aspect to consider. When devising surgical reconstruction strategies, it is imperative to consider the various aspects of thumb function that require careful consideration. It is readily apparent to the casual observer that there exists a dominant thumb. Nevertheless, it is possible that there are shortcomings in the preservation of the thumb. Parents are advised that the surgical procedure may encompass the rebuilding of the dominant thumb, rather than solely

entailing the excision of the lesser finger, typically referred to as the radial. A comparative analysis with the contralateral thumb reveals that the thumb intended for preservation exhibits reduced dimensions and potential absence of specific anatomical elements. Due to these rationales, certain individuals exhibit a preference for employing the term "split" thumb as opposed to thumb duplication. The clinical assessment evaluates various aspects including the soft tissue volume and configuration, the condition of the nail folds, the stability of collateral ligaments during radial and ulnar deviation, and the degree of hypermobility, specifically in the hyperextension plane of both interphalangeal (IP) and metacarpophalangeal (MCP) joints. The potential global instability of either one or both factors will significantly undermine their functionality. The occurrence of this condition frequently arises from extrinsic tendon anomalies affecting the flexor pollicis longus (FPL) and the extensors. These anomalies involve abnormalities in the origin and insertion of the tendons, which exert deforming stresses on unstable and underdeveloped joints.

The occurrence of divergence of proximal phalanges at the metacarpophalangeal (MCP) joint level and convergence at the interphalangeal (IP) joint level is frequently observed in Wassel type IV duplications, especially when the thumbs exhibit equal dimensions. These present challenging issues for the reconstructive surgeon. The primary objective is to effectively restore the retained thumb during the removal of the smaller finger, taking into consideration any anatomical irregularities that may hinder optimal functionality, namely those that contribute to instability and deviation-related issues. Typically, a basic radiological evaluation suffices in acquiring the further data required for surgical strategizing. Obtaining accurate posterior-anterior and lateral views of each duplicated thumb can provide challenges in certain cases. The findings of the clinical examination must be accompanied with their relevance. The utilization of an X-ray image of the

contralateral thumb becomes advantageous in the evaluation of bone dimensions and morphology, as well as in the examination of joint abnormalities. Magnetic resonance imaging (MRI) offers enhanced visualization and characterization of intra-articular cartilage structure. The utilization of ultrasonography or other investigative methods can aid in the evaluation of soft tissue anomalies, however their routine implementation is not common. The requirement of vascular investigations is definitely uncommon. Based on the comprehensive clinical examination findings and the radiological observations, the surgeon will make a determination regarding the optimal reconstruction approach for the primary thumb, selectively incorporating relevant components from the thumb to be excised. Occasionally, individuals may encounter a situation where neither thumb possesses sufficient dimensions, stability, mobility, or aesthetic qualities to enable an acceptable restoration. The Bilhaut-Cloquet method, a historical surgical technique, involves the amalgamation of equal longitudinal components from both thumbs. This procedure aims to enhance both the size and stability of the thumb, but resulting in a certain degree of compromised mobility. Variations of the Bilhaut-Cloquet process involve the adjustment of the amount of thumb utilized, either reducing or increasing its utilization. In order to preserve the authenticity of the eponymous nomenclature, it is necessary to consolidate the longitudinal components of the skeletal structure of each thumb

CONCLUSION

Recent discoveries give us a more comprehensive understanding of the process and a better idea of how different molecular pathways can be disrupted and lead to different kinds of upper limb anomalies. The most common type of polydactyly is Wassel type IV thumb duplication, and the most common abnormality that goes with it is a zigzag distortion. Even though the Wassel classification isn't perfect, it is the base for all classification systems that came after it. The most common ways to treat thumb duplication are removal and reconstruction. The complexity of the reconstruction will rely on the status of the dominant thumb.

CONFLICTS OF INTERESTS

The researchers have disclosed no conflicts of interest.

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