Isolated macrodactyly of the foot: a review

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Abstract

Among the diseases of the locomotor system present at birth, isolated macrodactyly is one of the rarest. On its pathogenesis, researchers are increasing persuaded about a genetic base like mosaicism type. True macrodactyly occurs with the increase in size of all the tissues of the affectedtoe. The diagnosis must exclude other types of diseases that lead to the uncontrolled growth of individual tissues and the choice of surgical treatment must consider the patient's age and the injury features. The authors outline the most common guidelines dictated by the experiences reported in the literature.

Key words: macrodactyly, foot congenital deformity, mosaicism.

Riassunto

Tra le affezioni dell'apparato locomotore presenti alla nascita la macrodattilia isolata rappresenta una delle più rare. Alla base della sua insorgenza c'è sempre più la convinzione di una base genetica ricollegabile a mutazioni somatiche con distribuzione a mosaico. La vera macrodattilia si presenta con l'incremento delle dimensioni di tutti i tessuti che costituiscono il dito colpito. La diagnosi deve escludere altri tipi di affezioni che comportano la crescita incontrollata di singoli tessuti e la scelta del trattamento chirurgico deve tener conto dell'età del paziente e del tipo di lesione. Gli autori delineano gli orientamenti terapeutici più comuni dettati dalle esperienze riportate in letteratura.

Parole chiave: macrodattilia, deformità congenita del piede, mosaicismo

Introduction

The increased size of a single finger or toe, caused by abnormal tissues growth, with changing proportions compare to the other fingers or toe, has been studied for a longtime and it is still studying.
In 1865 Annadale[1] first describe finger "congenital hypertrophy" as an exaggerated increase of the physiological size of the finger at birth, with hasten growing compare to the natural condition as the child grow. The terminology about this disease has evolved, and has been enriched with the observations of the authors dealing with it.
In the pathogenesis of the "local gigantism" of the fingers, Inglis[2] assigns a decisive role to the abnormal function of the district innervation. Barsky[3] distinguished the "true macrodactyly" from the pathological forms, which, even though they are different nosological entities, mimic some features that may initially mislead the clinician, such as hemangioma, fibrolipomatous hamartoma, lymphangio-matosis, Klippel-Trenaunay-Weber syndrome, Ollier disease, Maffucci syndrome[4].
Barsky identifies two types of true macrodactyly: the static and the progressive. In the first type (static) finger size is increased at birth due to excessive uniform development of all the tissues, but do not increase in disharmonic way during the growth of the patient. In the second type (progressive), the already disproportionate increase in size of the finger shows speeded up growth compared with a natural model during the age, with a particular development of adipose tissue next to the affected district. Partial acromegaly, dactylomegaly, limited gigantism and macrodystrophia lipomatosa are other definitions that indicate this malformation[5,6].
Regarding the frequency of these diseases, Upton[7] in 1990 reports that 300 cases of macrodactyly of the hand and 60 cases of macrodactyly of the foot were described in literature. 53% of cases were women while 47% were men. In 10% of cases, macrodactyly is bilateral, in 54% the right side is involved[8]. According to Kalen et al[9], the

second is the most often affected ray in the foot followed by the third ray. Hardwicke et al[10] report that macrodactylia represents 0.9% of all congenital anomalies of the upper limb and macrodactyly of the foot has an incidence of 1/18 000[11]; syndactyly can be associated with macrodactyly in 10% of cases[12].

Clinical and anatomopathological features

Isolated macrodactyly of the foot can display itself early, already during intrauterine life: Yüksel[13] describe a case of isolated macrodactyly of the second toe diagnosed ultrasound scan at 24 weeks pregnant.

In early childhood, the toe volume increase is clinically evident, with soft tissue thickening and toe elongation with asymmetry of the anatomical region compare with contralateral side (Fig. 1), with preservation of passive range of motion. The X-ray scan shows quicker growth with increased skeletal age and early appearance of the epiphyseal ossification centers of the distal phalanges (Figure 2). The presence of plentiful adipose tissue causes displacement of the toes. In adulthood, but also early in late childhood, osteophytes or osteocartilaginous masses may appear around the joints with signs of osteoarthritis[14,15]. Arteriography highlights the hypertrophy of digital vessels. static macrodactyly, which occur at birth and grow proportionally to the rest of the limb, is less common than progressive macrodactyly: the last is already present at birth and increase hastily and reaching a peak of growth with puberty. This clinical type is often the most troubling for the surgeon as it causes a disproportionate growth in length and width. If the skeletal development stops at the end of the patient growth, soft tissue enlargement may continue even after reaching adulthood. In order to establish the most suitable treatment for the patient and the right time to start surgery, it would be desirable to early distinguish the progressive type from the static one. This distinction is difficult to achieve at birth: according to Pearn et al.[16] checking the growth rate of the tissues we can recognize the static and progressive type within the sixth month of life. Macrodactyly tissues are poorly vascularized,

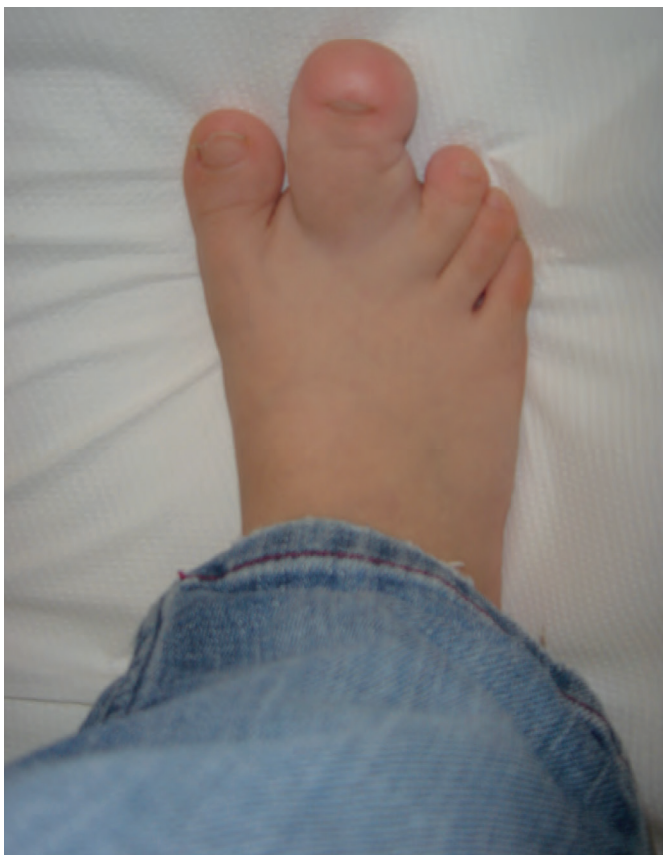

Figure 1
Macrodactyly of the second toe in a female child three years old: a clinical factures.

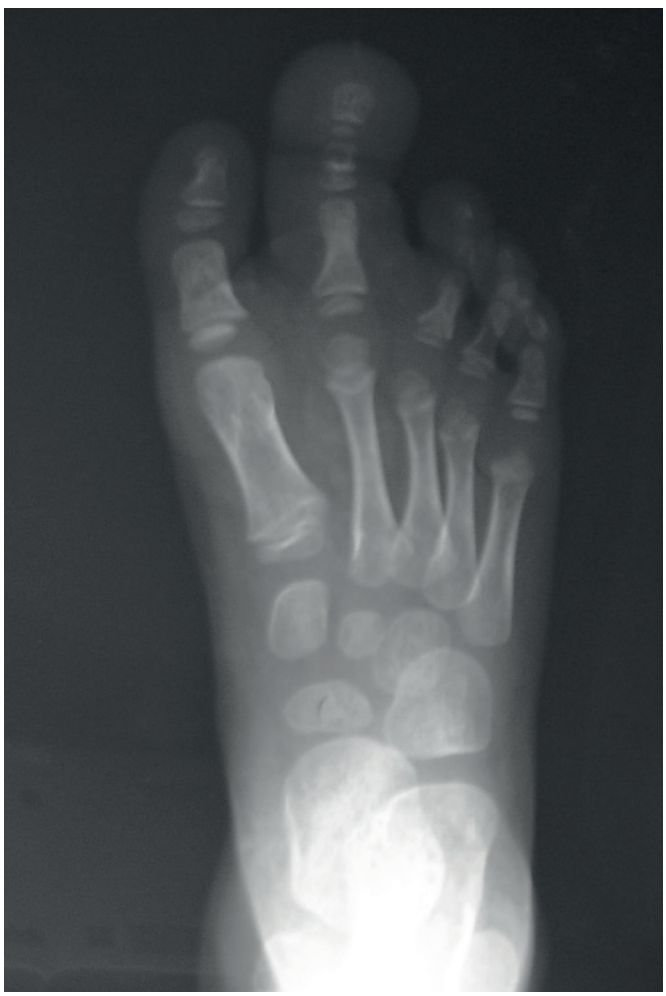

Figure 2
Macrodactyly of the second toe in a female child three years old: x-ray scan.

the digital nerves sometimes shows adipose tissue infiltration. The endoneurium and the perineurium shows fibrotic changes. Although deformed, the axons are of normal size. The ossification centers do not show changes while an increasing periosteum fibroblastic activity can be observed[17]. In this tissue, there are several nodules of hyaline cartilage with sometimes cartilage and bone formation. Many osteoblasts and osteoclasts cells explain a quickening remodeling.
Magnetic resonance is a complementary exam to X-ray exam to define the anatomical structures changes to focus the goals to considered in surgery planning. For the same reason, angiographic and lymphographic examinations are also useful, which allow detecting anomalous arterial and lymphatic vessels[18].

Pathogenic hypotheses
Familiarity is not a factor associated with macrodactyly. According to Natividad et al.[19] a negative event during organogenesis determines a defect of sensitivity to the growth stimulus, therefore a function loss of factors that inhibit growth thus the affected part grows in an uncontrolled way. Certainly, macrodactyly as well as segmental macrosomies are characteristic manifestations of some congenital diseases that have in common a somatic mutation during embryogenesis[20]. It would be the formation of mutated cell lines with mosaic distribution the pathogenetic basis of the onset of macrodactyly. The best known of these diseases is the Proteus disease. The name that takes its cue from the assimilation of these pathological forms with the peculiarity of the Greek of the sea to mutate acquiring different appearance and shape. The classification of these diseases is continuously updated with the identification of mutations. The common clinical manifestation of these diseases is the asymmetric growth of tissues that causes malformations cause impairment of the function of organs apparatuses and varying degrees of disability of the affected individual. The character and distribution of overgrowth areas, which are intertwined in the context of normal anatomical regions, is a consequence of genetic mosaicism. Through unknown mechanisms the combination of the type and timing of the mutation and the cell of origin, determines the biological characteristics of the lesions. The multiplicity of combinations determines a variability of the phenotype and a clinical overlapping[22] with other overgrowth syndromes: this entails a considerable difficulty in the clinical differential diagnosis between different mosaicisms. Segmented overgrowth phenotypes caused by mutations in the PIK3CA gene is fibroadipose overgrowth (FAO)[23]. The diagnostic difficulty is represented by the limited number of cells with mutation that can be found inside the lesions.

Surgical planning
Disease progression, the affected foot ray, and the extent of tissue involvement to adapt the surgery strategy case-by-case basis to ensure the best functionality of the result, with regard to walking and aesthetics. Procedures can range from simple removal of tissue mass to part or full ray amputation[24].
It is not clear at what age, or in what clinical evolution stage, it is more proper for surgery: a general rule to de termine the ideal time for surgical treatment is difficult to formulate. According to some authors, it would be advisable to intervene surgically at the end of the growth; other authors recommend surgery before gate developing[25,26]. Turra et al.[27] still support the opportunity to wait until the patient is 3 or 4 years old and in that phase of body development judging the pathological tissues growth. Hop et al.[28] recommend early surgical treatment, before the patient takes an erection and starts walking, to minimize the negative effects of deformity on the physiological gait development. As reported by Nativitad et al.[19], a very early treatment can prevent long lasting psychological stress and allow a reduction of symptoms as early as possible, but it can lead to the need for further treatments in the course of life. For this reason, in the absence of serious aesthetic concerns, it would be sensible to intervene in adulthood when the patient is able to make his decisions.
The aim of the surgical reduction for macrodactyly is to achieve satisfactory aesthetic results, a foot that can adapt to the shoe and the development of a normal gait[28].
The longitudinal plantar incision.

A whole ray amputation, which allows an aesthetic result well accepted by the patient, in progressive macrodactyly sometimes may represent the ideal solution to avoid repeated hospitalizations and interventions[10,19].
When macrodactyly affects the first ray, the amputation should be avoided because the big toe plays an important role in walking at the end of the support phase[15]. For reduction of the soft and skeletal parts Hardwicke et al[10]. use a side-by-side approach for each singular finger, facing one side at a time with an interval of a few months between each surgery procedure.
Among the surgical complications, there is a greater risk of wounds infection and necrosis associated to high incidence of lacking vascularization.

In conclusion, the unknown nature of isolated foot macrodactyly, and the unpredictable disease evolution involve surgical plan individualization without predicting the therapy duration, and the number of surgical treatment to which the patient must undergo. The young age of these patients and the psychological stress that can result from several hospitalizations to undergo surgery involve agreeing a surgical treatment program to the patient and his family members. Explaining in detail all treatment problems allow to improve the understanding to get close cooperation. Amputation must be considered, especially when macrodactyly does not involve the big toe.

The identification of possible genetic mutations could allow in the future to associate the clinical manifestations and the rate of progression of asymmetric growth to the mutated gene. In this way the surgeon will be able to establish behavioral rules to approach every single case and avoid unnecessary suffering to the patient.

In the future, genetic mutations identification will allow to associate the clinical expressions and the rate of progression with the mutated gene. Thus the surgeon will be able to find out behavioral rules to approach every single case and avoid unnecessary suffering to patient.

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