ORIGINAL PAPER

Remarks on the etiopathogenesis and diagnosis in Osgood-Schlatter and Sever-Haglund diseases based on the Doppler ultrasound of apophyses

Uwagi na temat etiopatogenezy i diagnostyki w chorobie Osgood-Schlatter oraz Haglunda-Severa w świetle wyników badań USG z Dopplerem apofiz

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Abstract
Assuming the mechanical significance of injuries in the etiopathogenesis of Osgood-Schlatter and Sever-Haglund diseases, it should be recognized that the areas susceptible to damage in growing apophyses are the growth zones and the newly formed bone. The SMI Doppler ultrasound (visualization of microvascular flows) helps to determine the precise location of the lesion, i.e. the area of the greater vascular microflow within the involved apophyses. The ultrasound examination revealed increased microflows within the growth zones of painful apophyses. On the “healthy” side, no microflows were observed. Relief of pain in the tibial tuberosities and the heel correlated with a marked reduction in the vasculature of the previously painful outgrowths. The authors suggest that as regards the imaging studies in Osgood-Schlatter and Sever-Haglund diseases, in the future, the most crucial method may be with Doppler ultrasound with microvascular visualization.

Key words: Osgood-Schlatter disease, Sever-Haglund disease, Doppler ultrasound, microflows, growth zones in apophyses

Streszczenie
Przyjmując znaczenie mechaniczne urazów w etiopatogenezie choroby Osgooda-Schlattera oraz Haglunda-Severa należy uznać, że miejscami podatnymi na uszkodzenia w rosnących apofizach są strefy wzrostowe i nowopowstała kość. Badanie USG Doppler z funkcją SMI (wizualizacja mikroskopijnych przepływu) umożliwia precyzyjne umiejscowienie uszkodzenia, czyli obszaru większego mikroprzepływu krwi w obrębie zajętych apofiz. W badaniu USG zwiększone mikroprzepływy występowaly w obrębie stref wzrostowych bolesnych odrostków. Po stronie „zdrowej” nie obserwowano mikroprzepływów. Ustanie dolegliwości bólowej guzowatości piszczeli i pięty korelowało z wyraźnym zmniejszeniem ukwienia poprzednio bolesnych odrostków. Autorzy sugerują, że w diagnostyce obrazowej choroby Osgooda-Schlattera oraz Haglunda-Severa największe znaczenie w przyszłości może mieć badanie ultrasonograficzne z funkcją Dopplera i możliwością badania mikroprzepływów.

Słowa kluczowe: choroba Osgood Schlattera, choroba Haglunda-Severa, USG Doppler, mikroprzepływy, strefy wzrostowe apofiz

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**Introduction**

Osgood-Schlatter and Sever-Haglund diseases are the characteristic disorders of apophyses (outgrowths) in adolescents whose diagnosis is based primarily on history taking and physical examination.

In children reporting pain symptoms typical for these diseases, laboratory tests and a radiograph of the heels and proximal tibia are performed, primarily to exclude other diseases [1, 4, 7, 8, 11, 12].

Treatment of children and adolescents with Sever-Haglund disease is exclusively non-surgical, and relieving the heel by lifting it with a soft, gel pad (used on both sides) is usually effective.

However, persistent and long-lasting pain of tibial tuberosity often requires surgical intervention. The importance of PRP (platelet rich plasma) in treatment efficacy is currently critically evaluated in osteogenesis.

However, many authors favor the administration of PRP in reducing pain, including in Osgood-Schlatter disease.

In the Department, we apply PRP injections to tibial tuberosity in painful places, marked precisely before administering general anesthesia.

Currently, before the administration of PRP to tibial tuberosity in children diagnosed with Osgood-Schlatter disease, we perform a bilateral Doppler ultrasound of the tibial tuberosity. Preliminary results of our research suggest the importance of the growth zones in tibial and calcaneal tuberosities and changes in their vasculature in the etiopathogenesis of Osgood-Schlatter and Sever-Haglund diseases.

**Growth zones of the apophyses (tibial and calcaneal tuberosities)**

In 1941 Siegling was most likely the first to convincingly state that the basic part of the articular cartilage is solely responsible for the growth of the epiphysis. He excluded any significance of the epiphyseal cartilage in this process, because the newly formed bone is a metaphysis (the epiphyseal cartilage builds the metaphysis) [10].

Similarly, an apophysis grows from its external surface, which is usually the muscle attachment site. The activity of growth zones, causing the bone to grow within the epiphyses and apophyses is much lower compared to the epiphyseal cartilage.

The epiphyseal cartilage is a well-researched structure both in terms of morphological structure, function, damaging factors and growth disorders. It is responsible for creating a new immature bone in the metaphysis and longitudinal bone growth. This type of cartilage also occurs in apophyses (at their bases) in both tibial and calcaneal tuberosities [2] (Fig. 2).

Pain in adolescents in Osgood-Schlatter and Sever-Haglund diseases is located in the tibial and calcaneal tuberosities which are apophyses. Apophyses, unlike epiphyses, do not form joints, but are usually muscle attachment sites; tibial tuberosity is the attachment for the patellar tendon and the calcaneal tuberosity for the calcaneal tendon, it also bears loads during standing and walking.

In contemporary textbooks on orthopedics, when bone growth zones and their blood supply are described, they are usually accompanied with drawings of the proximal femur, as in the textbook by Wiktor Dega – “Orthopedics and Rehabilitation” [5, 6].

When considering the etiopathogenesis of these two diseases of adolescence, it seems essential to discuss the growth zones of apophyses, similarly located growth zones of epiphyses. The schematic drawing below present the growth zones as well as layers of newly formed, immature spongy bone of tibial tuberosity (Fig. 1) and calcaneal tuberosity (Fig. 2).
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The presence of growing zones causes the formation of an immature bone which remolds into the mature spongy bone. What should also be considered is the mechanical strength of the analyzed bone areas and growth zones when exposed to forces related to mechanical forces connected with loading (body weight transfer), direct or indirect injuries (avulsion injuries).

In the case of slipped capital femoral epiphysis or traumatic epiphysiolysis, the fissure of the lesion goes through the layer of hypertrophic cells (the central part of the epiphyseal cartilage). It can be assumed that this part of cartilage at the base of apophysis (outgrowth) is also mechanically the weakest, as in the case of epiphyseal cartilage.

In addition to the growth cartilage at the base of apophyses, there is also mature spongy bone of the outgrowth and the immature, newly formed bone in the immediate vicinity of the two growth zones.

The results of experimental studies of blows to femoral heads of calves have been described (fig. 3).
When considering the mechanical forces in the tibial and calcaneal tuberosities, damage mechanisms and their location can be analyzed. Such analysis would only be theoretical, were it not for the highly advanced Doppler ultrasound. The device used in the study had the SMI function - Superb Micro-Vascular Imaging (an imaging technique allowing the visualization of microvascular flows) and Advance Dynamic Flow™ (imaging of microflows which yields highly precise images of vessels).

**Initial results of Doppler ultrasound**

For almost a year, we have been conducting research in cooperation with the Department of Pulmonary and Pediatric Rheumatology of the Medical University of Lublin using the device described above, pinpointing the exact location of the lesion, i.e. the location of a larger microflow.

In repeated ultrasound examinations in children with Osgood-Schlatter and Haglund’s diseases, a constantly recurring image of increased blood supply to apophysis was visualized. These layers correspond to the location of growth cartilages and immature bone. In the case of Osgood-Schlatter disease, increased microvasculature was observed to varying degrees, but just below the attachment of the patellar tendon – the superficial part of apophysis or part of the epiphyseal cartilage in contact with the tibial metaphysis was observed.
The location of increased vasculature at the level of the growth cartilage of the tibial tuberosity indicates the site of their primary damage (growth zone of apophysis). The avulsion mechanism causes the tearing of the growth cartilages, contributing to the disturbance in the ossification of tuberosity. On the “healthy” side, there was no increase in blood supply observed.

Fig. 6A. An X-ray of the calcaneal tuberosity, the enlarged image corresponds to the examined ultrasound area.

Fig. 6B. Growth cartilage of the calcaneal tuberosity with features of increased blood supply on ultrasound image.

Fig. 5B. An enlarged X-ray image of the tuberosity corresponds to the ultrasound examination site; cartilage of tibial tuberosity with features of increased blood supply visible on ultrasound.
In the case of Sever-Haglund disease, the increased blood supply occurred primarily in the vicinity of the apophyseal cartilage – near the Achilles tendon attachment. Less blood supply was observed on the apophyseal surface (area of contact between the heel and the ground). On the "healthy" side, no vascularization was observed in this study.

In subsequent ultrasound examinations, with the disappearance of pain in the tibial or calcaneal tuberosities, the vasculature of the apophyses was significantly reduced or even invisible.

Ultrasound examination with the assessment of blood supply is also important in the differential diagnosis of Osgood-Schlatter and Sever-Haglund diseases, described in the paper, with inflammation of the attachments of patellar and Achilles tendons. Enthesitis located in the lower limbs may be the first symptom of inflammatory spondyloarthritis in children (juvenile idiopathic arthritis and reactive arthritis), most often in boys of school age.

Joint research with the Pediatric Rheumatology Department of the Medical University of Lublin is continued. The clinical material will be analyzed and presented in a separate publication.

Summary

The views on etiopathogenesis, diagnostics and monitoring of the course of Sever-Haglund and Osgood-Schlatter diseases in the light of the presented preliminary results of Doppler ultrasound (with the possibility to visualize microvascular flows) should be, in the authors’ opinion, verified. They also require verification and extended to other centers.

In imaging diagnostics of Osgood-Schlatter and Sever-Haglund diseases the most important aspect may be using Doppler ultrasound with microflow visualization.

The limitation is the cost of a technically advanced ultrasound equipment and its scarce availability in Poland. Such devices are still found only in highly specialized rheumatology centers in Poland.

References