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Editorial

Toward Standardized Ultrasound Measurements of Cartilage Thickness in Children





In the past decade, musculoskeletal ultrasound (US) has become well established as a diagnostic method in adult rheumatology. B-mode (or greyscale) US has been shown to be an excellent tool, equally as effective as magnetic resonance imaging (MRI), to assess joint effusions and synovial thickening[1]. Power Doppler US detects slow flow in small vessels, which is part of the pathological process in synovitis[2]. In addition, cartilage thickness can be assessed with US[3]. As one of the cardinal features of inflammatory arthritis is cartilage loss, and joint space narrowing is increasingly recognized as a factor in work disability and poor quality of life[4], US might play an important role in the monitoring of patients with chronic arthritis.

The clinical utility of musculoskeletal US is likely to be at least as important in pediatric rheumatology as it is in adult rheumatology. The longterm consequences of insufficiently treated and therefore persistently active juvenile arthritis are enormous given the young age of the patients[5], and a recent review has outlined the impact on health related quality of life, physical function, and visual outcome[6].

The exact assessment of joint disease activity as well as the assessment of joint damage in the form of cartilage loss is therefore very important and has become ever more crucial with improvements in treatment. The induction of permanent remission is now possible for an increasing percentage of children but cannot always be reliably demonstrated on clinical examination alone[7,8].

US has many advantages over other imaging techniques, especially in pediatrics, as it is relatively cheap, time efficient compared with MRI, and does not require sedation in younger children.

With regard to cartilage assessments, the traditional radiographic assessment of structural damage in juvenile idiopathic arthritis (JIA) is challenging. To apply adult-designed radiographic scoring systems to evaluate the progression of JIA may not be feasible because ossification is incomplete and the thickness of articular cartilage varies among children of different ages. US, in contrast, might very well offer a valuable alternative to assess cartilage in children. As cartilage consists predominantly of water, it can be readily assessed by US as an anechoic structure with hyperechoic bone inferiorly and hypoechoic soft tissue superiorly (Figure 1). High frequency transducers with a resolution of around 0.1 mm now permit accurate measurements. Indeed, quantitation of cartilage thickness has been described in a few studies[3], and linear measurements can be made from standard scans. US has been shown to be superior to plain radiographs in the detection of erosions in patients with rheumatoid arthritis (RA), but overall there have been only a few studies on the use of US for evaluating cartilage damage in RA. One study has shown that US of the metacarpophalangeal (MCP) joints in children with JIA can demonstrate cartilage thinning, bone erosions, and pannus vascularity[9].

Despite the huge potential of US and its increasing use in daily pediatric rheumatology practice, the number of scientific studies supporting and guiding its use is significantly lower than for adult rheumatology. Even more important than the low number of studies comparing clinical and US assessments in patients with JIA is the lack of studies documenting US anatomy in healthy children and adolescents. In order to interpret findings in patients, a clear understanding of normal US anatomy of joints is needed. For example, there are only limited data available on greyscale anatomy in healthy children[10], and virtually no data on blood flow measured by Doppler. The same lack of normative data affects the ability to assess joint cartilage in children with US, which at the same time can be particularly challenging. While the adult skeleton is mostly ossified, and cartilage is only found at the joint surface, the situation in pediatrics is very different. Depending on the age, large parts of the epiphyseal bone forming the joints are not ossified yet. While this can present specific challenges in the discrimination between cartilage and joint effusions, it is also important for the determination of cartilage thickness itself.

The development of normal standard reference values

See US measurements of joint cartilage thickness in healthy children, *page 2595*

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Figure 1. Cartilage of wrist joint in 6-year-old boy (dorsal view).

for cartilage in children, therefore, has clear utility in the field of JIA.

In this issue of *The Journal*, Spannow and colleagues have taken an important first step in delineating normal ranges of cartilage thickness in healthy children[11]. In nearly 400 individuals aged between 7 and 16 years, 3940 joints were assessed by US. EULAR (European League Against Rheumatism) standard (adult) scans were performed on knees, ankles, wrists, MCP joints, and proximal interphalangeal joints. The aim in their study was to determine age- and sex-specific normal ranges for cartilage thickness. This will help to understand some of the changes observed in children with a disease like JIA. In their cross-sectional study, they found significantly thicker cartilage measurements in boys compared with girls, and reduction in cartilage thickness with age in both sexes. They further describe a complex statistical analysis to calculate sex-specific cartilage thickness at different ages, extrapolating their measurements across the age range examined. They base their calculations on a linear model of the relationship between age and cartilage thickness. It might be interesting to analyze their data using other methods for data analysis, such as least mean squares[12], as this may help fit the normative data to the statistical curve.

Another aspect relevant in future analysis of these data is that cartilage thickness will also be largely affected by maturation and pubertal stage. Finally, height, weight, and body mass index might influence cartilage thickness, especially in children, in whom bone and cartilage can adapt — much more than in adults — to different forces acting upon them. Anthropometric differences between the sexes might well explain the difference in cartilage thickness that the authors found between boys and girls. Interestingly, they did not detect differences between left and right sides for any of the imaged joints.

The authors have used previous publications to describe the exact positioning of the probe and have been meticulous in assessing the inter- and intraobserver variability[13]. This earlier publication shows that generally the interobserver variation was low, except for joints such as the wrist, where inter- and intraobserver variability was fairly high. In the practical application of this normative data, it will therefore be important to consider that for some joints a significant variation for different observers has to be taken into account before reaching firm clinical judgments in comparing a patient's results with the published normative data.

Altogether, Spannow and colleagues' normative data on US assessments of cartilage in children[11] and normative data on other US features such as greyscale and power Doppler are important and will form the basis for any study looking into pathology in inflammatory and noninflammatory joint diseases, as well as for decisions in routine clinical practice.

The developing skeleton (cartilage and bone) in children poses unique challenges, but these should not preclude physicians and scientists using the technique of ultrasonography. It simply means that the specific aspects of a developing articular or cartilaginous joint need to be taken into account when drawing conclusions on measurements. In fact, as outlined above, musculoskeletal US has great potential in pediatric rheumatology, and more studies on normal anatomy are needed to form the basis for application of this technique.

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Dr. Larche has received honoraria and speakers' fees relating to ultrasonography from Abbott, Schering, and BMS. Dr. Roth has received honoraria from Abbott and Schering.

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