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Trochlear Development in Children From One Month To 10 Years Of Age

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Summary:
Trochlear morphology comparing osseous to cartilaginous development using MR imaging was studied in 22 pediatric cadaver knees (age 1 month–10 years). Our sample suggests: 1) a tendency for females to have less trochlear depth, 2) differences in development between the lateral and medial trochlea in both sexes, and 3) incongruity between osseous and cartilaginous shape during development

Abstract:
Purpose: To study trochlear morphology during maturation in children using MR imaging.

Methods: The study population consisted of 22 knees (11 M/11 F) from pediatric cadavers, aged 1 month to 10 years (provided by Allosource, Inc.) An IRB waiver approval applied.

MR Sequence: 3D-GRE sequence for Susceptibility-Weighted Magnetic Resonance Imaging: a non-invasive technique allowing precise distinction between cartilage vs. osseous morphology.

For each sample, the MRI biometric analysis was conducted on the axial/sagittal/coronal views analyzing three slices; the most proximal slice corresponded to the location of full cartilage trochlear groove coverage. Patellar measurements were not performed due its absence in many specimens. Biometric analysis included lateral/media/central trochlear height, cartilaginous sulcus angle (CSA), osseous sulcus angle (OSA), trochlear depth (TD), and trochlear facet length asymmetry.

Sex comparisons were considered when one or more specimens from both sexes of the same age were available; 12 knees total spanning 4 age groups (ages 1, 3, 4 and 7 years).

Results: Four samples were excluded due to low quality images.

Morphology: Both lateral and medial condylar height increased by 12% from distal slices to proximal slices; lateral trochlear height > medial trochlear height at all ages.

There was a discrepancy between lateral and medial trochlear facet length which was more evident in older samples (lateral > medial). The thickest cartilage was present on the lateral condylar facet in the younger specimens. Comparative trends between male/females: Female samples had a shallower cartilaginous sulcus (CSA) and osseous sulcus (OSA) than males.

Development of osseous and cartilaginous trochlear contour: A cartilaginous sulcus is present in the 3 month old specimen and continues to deepen up to the age of 4 years. The shape of the osseous center evolves from round (1 month), to oval (9 month), to square (2 years), with no distinct bony trochlear sulcus, although a well formed

cartilaginous sulcus already is in place. At 5 years the shape of the osseous center resembles aviator glasses, with the first evidence of a sulcus forming. The bony contour of the adult distal femur resembles the cartilaginous contour at 7-8 years.

Discussion: From the earliest stage of the development, the female trochlea is flatter with less groove depth than that of males. The development of the shape of the OSA does not follow that of the CSA, suggesting that other forces (possibly from the patella) dictate the contour of the mature bony trochlear groove.

Conclusions: Our sample suggests: 1) a developmental tendency for females to have shallower (i.e., more dysplastic) grooves; 2) the lateral trochlea is higher (trochlear height) and wider (trochlear facet length) during growth than the medial in both sexes; and 3) The development of the osseous sulcus shape lags behind the development of the cartilagenous sulcus shape in our sample population. The anatomic findings are consistent with clinical studies on trochlear dysplasia in females, and suggests that trochlear development differences may play a critical role in patella instability.