Magnetic Resonance Imaging in Symptomatic Children With Hereditary Multiple Exostoses of the Hip

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Background: Magnetic resonance imaging (MRI) is useful in evaluating nontraumatic hip pain. It provides information about associated injuries like labral/chondral tears or ischiofemoral impingement (IFI). However, in hereditary multiple exostoses (HME) there has been no report about MRI findings in symptomatic children with hip involvement.

Methods: Records of children with HME and hip osteochondromas, who had hip MRI/magnetic resonance arthrography, were reviewed. The presence of chondral lesions and labral tears, as well the presence of IFI, was recorded. IFI was defined as edema or fatty replacement/atrophy in the quadratus femoris muscle or decrease of the space for this muscle between the ischium and the proximal femur. The measurements used to determine the space included the ischiofemoral space, the quadratus femoris space, and the minimum ischiofemoral space (MIFS). All measurements were performed on axial T1-weighted images.

Results: Ten children were included (4 males, 6 females). In 2 patients, MRI was unilateral, therefore a total of 18 hips were analyzed. The indication for MRI was hip pain. Mean age, when MRI was performed, was 11.7 years. Labral tears were found in 44% (8/18) and chondral lesions in 33% (6/18) of the hips. The mean ischiofemoral space was 17.2 mm (SD, 7.3), the mean quadratus femoris space was 14.9 mm (SD, 5.3), and the mean MIFS was of 12.8 mm (SD, 5.9). IFI was seen in 44% (8/18) of hips. Two patients had bilateral IFI. MIFS was <10 mm in all hips with IFI (8/8). Of these hips, 88% (7/8) had edema of the quadratus femoris muscle and 38% (3/8) had fatty replacement/atrophy in the muscle. Osteochondromas were seen in the lesser trochanter in all hips with IFI (8/8) and in the ischium in 50% of them (4/8).

Conclusions: In symptomatic children with HME of the hip, MRI is helpful in detecting the source of pain. A high percentage of these children have IFI and intra-articular lesions. These findings can play an important role in the indication and planning of the surgical approach.

Level of Evidence: Level IV—diagnostic study.

Key Words: hereditary multiple exostoses, hip osteochondromas, magnetic resonance imaging

(*J Pediatr Orthop* 2016;00:000–000)

Magnetic resonance imaging (MRI) of the hip provides valuable information in many clinical circumstances as it has high sensitivity for bone marrow, soft tissue, joint pathology, and tumor detection.[1,2] In presence of osseous tumors, MRI allows assessing the extent of bony, intramedullary, joint, and soft tissue involvement by the tumor.[3]

In the hereditary multiple exostoses (HME), where hip involvement is frequent[4–6]; the tumors are usually asymptomatic, especially in children.[4] HME-associated hip pain often occurs secondary to mass effect, fracture,[7] even malignant transformation[8,9]; as well as chondral/labral tears and ischiofemoral impingement (IFI).

The MRI is accepted as an excellent modality for the evaluation of nontraumatic hip pain.[2,10] Also, it is the most precise imaging method for symptomatic cases of bone masses as it can depict the exact morphology,[7,11] and provide delineation of associated pathology, like IFI and labral or chondral tears, among others. In HME cases, MRI can also show the cartilaginous cap, which in younger patients can be radiolucent.[12] However, as far as we know, there are no other studies detailing MRI findings in symptomatic children with HME of the hip.

The aim of this study is to describe the findings of MRI/magnetic resonance arthrography (MRA) for symptomatic children with HME and hip osteochondromas. The role of this imaging modality in surgical decision making is also assessed.

METHODS

After obtaining the approval of our Institutional Review Board, records of all patients with HME seen between 2003 and 2014 were retrospectively reviewed. Children with hip osteochondromas and hip MRI/MRA were identified. As the use of intra-articular contrast is required to obtain a precise diagnosis of the intra-articular pathologies,[13] all hip MRIs included in our study were MRAs. A preliminary review of the MRI was performed to assess whether the ischiofemoral space (IFS) was visible on the axial images as the presence of IFI

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The authors declare no conflicts of interest.

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could only be determined after the evaluation of this space.

Demographic and clinical data were obtained from the medical records. Subsequently hip MRI/MRA were evaluated for chondral lesions and labral tears, as well the presence of IFI. IFI was defined as quadratus femoris muscle (QFM) abnormalities (edema or fatty replacement/atrophy) and decrease of the space for this muscle between the ischium and the proximal femur. The measurements used to describe this space included were: (a) The IFS, defined as the smallest distance between the lateral cortex of ischial tuberosity and medial cortex of lesser trochanter[1,14–16] (Fig. 1A); and (b) the quadratus femoris space (QFS) defined as the smallest space for the passage of the QFM bordered by the superolateral surface of the hamstring tendons and the posteromedial surface of the iliopsoas tendon or lesser trochanter[14–16] (Fig. 1A). For these 2 measures, the narrowing threshold to suggest IFI is 15 mm for IFS and 10 mm for QFS.[16] The third measure is the minimum ischiofemoral space (MIFS) defined by the narrower space between the ischium/hamstring tendons and the proximal femur through which the QFM passed[16,17] (Fig. 1B). This last measure might be the most adequate in patients with hip osteochondromas because in these cases it is possible to find anatomic alterations that hinder the correct identification of the lesser trochanter.[17] This measure is considered as suggestive of IFI when it is < 10 mm.[17] All measurements were performed on axial T1-weighted images by a single orthopaedic surgeon.

Hips with MRI features suggestive of IFI (MIFS < 10 mm or QFM alterations) were subsequently identified,[17] and the presence of osteochondromas in the lesser trochanter and in the ischial tuberosity was determined in this group. A comparison of the 3 measurements was made between hips with QFM abnormalities and hips with no QFM abnormalities, using the independent *t* test (Using SPSS Software, Version 22, Chicago, IL).

RESULTS

Ten children were included in the study (4 males and 6 females). In 2 patients the hip MRI/MRA was unilateral, therefore a total of 18 hips were analyzed. In all cases the indication for the MRI was hip pain. The mean age, when MRI was performed, was 11.7 years (range, 6.0 to 18.6 y).

Labral tears were found in 44% (8/18) and chondral lesions in 33% (6/18) of the hips. In total, 39% of the hips (7/18) had QFM edema and 17% (3/18) had fatty replacement/atrophy as well. The mean of IFS was 17.2 mm (SD, 7.3), the mean QFS was 14.9 mm (SD, 5.3), and the mean MIFS was of 12.8 mm (SD, 5.9).

In 6 children (5 females and 1 male) MRI features suggestive of IFI were found (Table 1). In 2 of them the IFI was bilateral, therefore a total of 8 hips (44%) with MRI features suggestive of IFI were identified. The mean age of these 6 patients was 10.9 years (SD, 3.2). MIFS was < 10 mm in all of these hips (100%). In 7 hips (88%) we found edema, and in 3 hips (39%) fatty replacement/atrophy of the QFM. The mean IFS was 13.1 mm (SD, 5.0), the mean QFS was 11.7 mm (SD, 1.8), and the mean MIFS was 8.5 (SD, 1.2) in this subgroup. All hips with MRI features suggestive of IFI had osteochondromas in the lesser trochanter and 50% (4/8) in the ischial tuberosity. We did not find disruption of the QFM fibers, abnormalities in other muscles, subcortical geodes, or bursa-like formations in any hip.

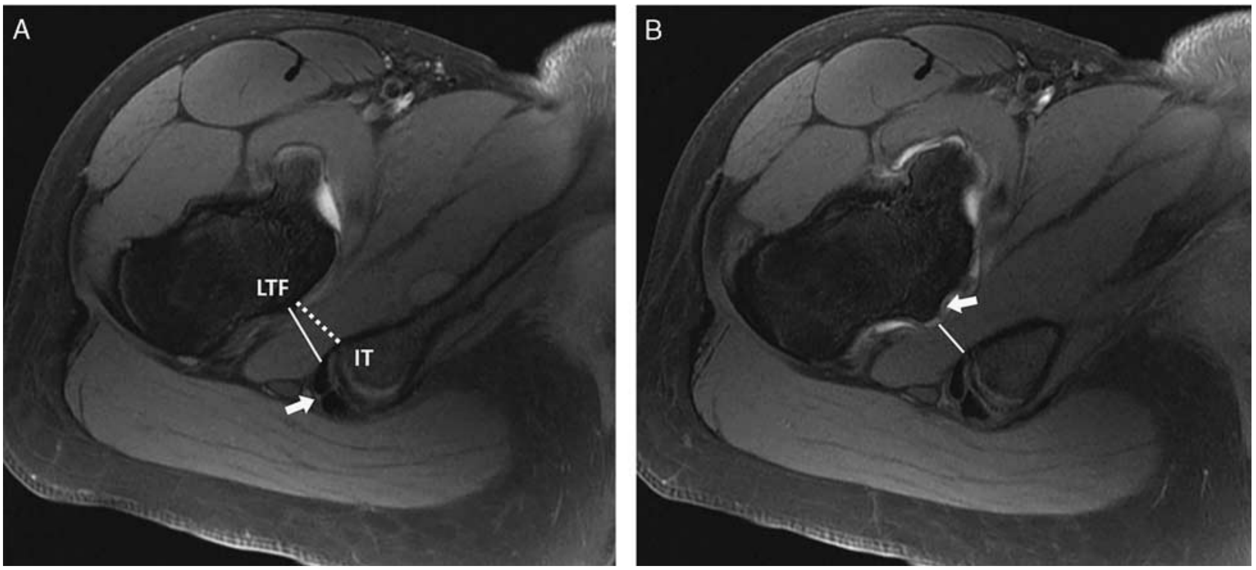

FIGURE 1. A and B, Sequential axial T1 magnetic resonance images of the right hip in an 11-year-old girl. A, The lesser trochanter of femur (LTF), ischial tuberosity (IT), hamstring tendons (arrow), ischiofemoral space (dotted line), and quadratus femoris space (solid line). B, The minimum ischiofemoral space (solid line) in presence of osteochondroma (arrow) due to distortion of the lesser trochanter.

TABLE 1. Hips With Ischiofemoral Impingement (8 Hips)

Sex	Age (y)	Side	MIFS (mm)	IFS (mm)	QFS (mm)	Edema QFM	Fatty Replacement of QFM or Atrophy	OC in Lesser Trochanter	OC in Ischial Tuberosity
Male	13.9	Left	9	11.5	14.3	Yes	No	Yes	No
Female	6	Right	8.7	9.6	11.6	Yes	No	Yes	Yes
Female	7.8	Right	7.6	13.9	11.3	Yes	Yes	Yes	No
		Left	6.4	7.1	10.4	Yes	Yes	Yes	Yes
Female	13	Left	9.9	23.9	14.2	Yes	Yes	Yes	No
Female	12.8	Right	7.4	14.5	9.3	Yes	No	Yes	Yes
		Left	9.9	13.5	10.5	Yes	No	Yes	No
Female	11.6	Right	8.9	10.4	11.7	No	No	Yes	Yes

IFS indicates ischiofemoral space; MIFS, minimum ischiofemoral space; OS, osteochondromas; QFM, quadratus femoris muscle; QFS, quadratus femoris space; OC, osteochondroma.

A significant difference ($P = 0.003$) was found in MIFS and in the QFS between the hips with QFM abnormalities (7 hips) and hips with no QFM abnormalities (11 hips). No significant difference was found in the IFS (Table 2).

DISCUSSION

Hip involvement is common in HME. Children are not frequently symptomatic, however, some children may have pain associated with osteochondromas around the hip. There are multiple potential sources of pain in patients with HME-soft tissue irritation by osteochondromas, malignant transformation, degenerative changes, IFI, labral, and chondral damage.

Despite this, only pelvic radiographs at time of diagnosis of HME are recommended[18]; the frequency of x-ray surveillance or the use of additional diagnostic imaging has not been established. Radiographs may not be sufficient to delineate the pathoanatomy and accurately pinpoint the source of pain.

Previous studies that have reported HME hip involvement were focused mainly on radiographic measurements.[12,18–20] Only some of these make mention of chondral lesions[18] or labral tears in isolated cases. These are thought to occur as a result of abnormal stresses imposed by the femoral head.[20] Other reports of labral and chondral injuries in hips focus on athletes without other pathologies.[21–23] Although MRI/MRA is an invasive procedure, it is considered a high yield imaging tool for the diagnosis of intra-articular pathologies, with excellent tolerance.[13] We found both labral tears (Fig. 2) and chondral lesions (Figs. 3A, B) in a high percentage of the hips. It is important to note that these are degenerative joint lesions in pediatric hips, and may indicate a worse prognosis. With increasing use of the surgical hip dislocation approach in these patients, our ability to address the intra-articular lesions (chondral and labral tears) has improved. Accurate identification of these as potential sources of pain is therefore important in deciding the most appropriate surgical intervention (resection of the osteochondroma/s alone vs. addressing concurrent cartilage damage).

Apart from the present study, only isolated cases of children with IFI associated with different etiologies have been reported.[14,24–26] IFI has been reported as an important cause of hip pain[14,24–29] in adult patients with osteochondromas.[17,27] However, as far as we know, only 1 series of patients with HME and IFI has been published,[17] which included 11 people with a mean age of 37 years (range, 13 to 72 y). Features of IFI (MIFS < 10 mm or QFM alterations) were reported in 62% of the hips. In our study we found features of IFI in 44% of the hips, but only children were included. It is conceivable that as we follow these children into adulthood, we may find a higher number of patients developing IFI.

The QFM abnormalities have been widely reported in relation to IFI,[14,17,30] since in theory, the narrowness of the space generates a mechanical factor that may eventually affect the muscle.[17] Although it is unclear whether the presence of muscle edema produces symptoms,[16,31] theoretically, the chronic inflammatory process may lead to muscular atrophy/fatty replacement,[16,32–35] occurring in cases of long-term impingement.[15] This

TABLE 2. Comparison of IFI Measurements Between Hips With and Without QFM Abnormalities (Edema or Fatty Replacement/Atrophy)

IFI Measurements	Muscle Abnormalities (7 Hips)	No Muscle Abnormalities (11 Hips)	P
Minimum ischiofemoral space (mm)	8.4	15.5	0.003*
Ischiofemoral space (mm)	13.4	19.6	0.061
Quadratus femoris space (mm)	11.7	17.0	0.013

Independent t test was used. Level of significance was set as 0.05.
IFI indicates ischiofemoral impingement.
*$P < 0.005$.

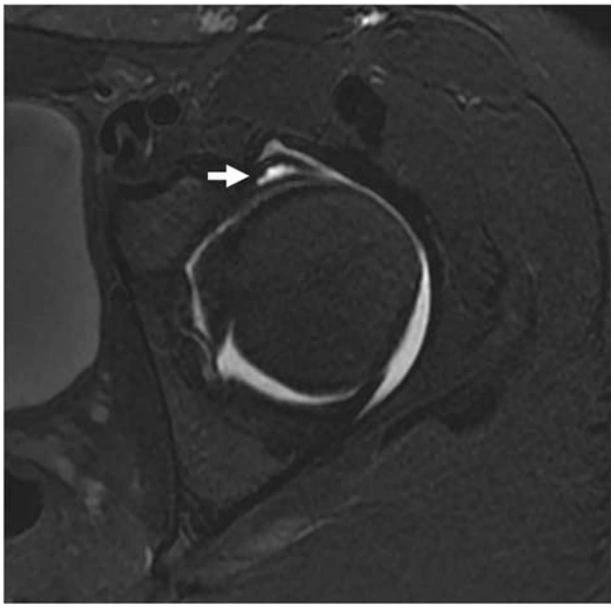

FIGURE 2. Axial T2 magentic resonance image of the left hip showing tear of anterior labrum (white arrow) in a 13-year-old girl with hereditary multiple exostoses of the hip.

relationship between the QFM abnormalities and the narrowing of the space between the ischium and the proximal femur allows determining the presence of IFI as the cause of symptoms. In our study, we found QFM abnormalities in 39% of the hips, in which no involvement of other muscles was observed. The most common alteration was the presence of edema, and only some patients with edema also showed muscle atrophy. There was no case of isolated muscular atrophy.

The normal values of measurements for IFI definition have variability on the literature[14–17,30,31,36]; however, we believe that in patients with HME, the MIFS < 10 mm is the most important measure, as it considers the bone deformity caused by osteochondromas (Fig. 1B). Anatomic alterations in HME may hinder the accuracy of measurements of the IFS and QFS.[17] In a previous publication with HME patients,[17] the authors found a significantly smaller MIFS in people with QFM abnormalities. In our study, we found a MIFS < 10 mm in all hips with muscle abnormalities, and in all of them were found osteochondromas compressing the QFM (Figs. 4, 5). In addition, when the comparison between hips with and without QFM abnormalities was made, a significant difference in the MIFS was found as well.

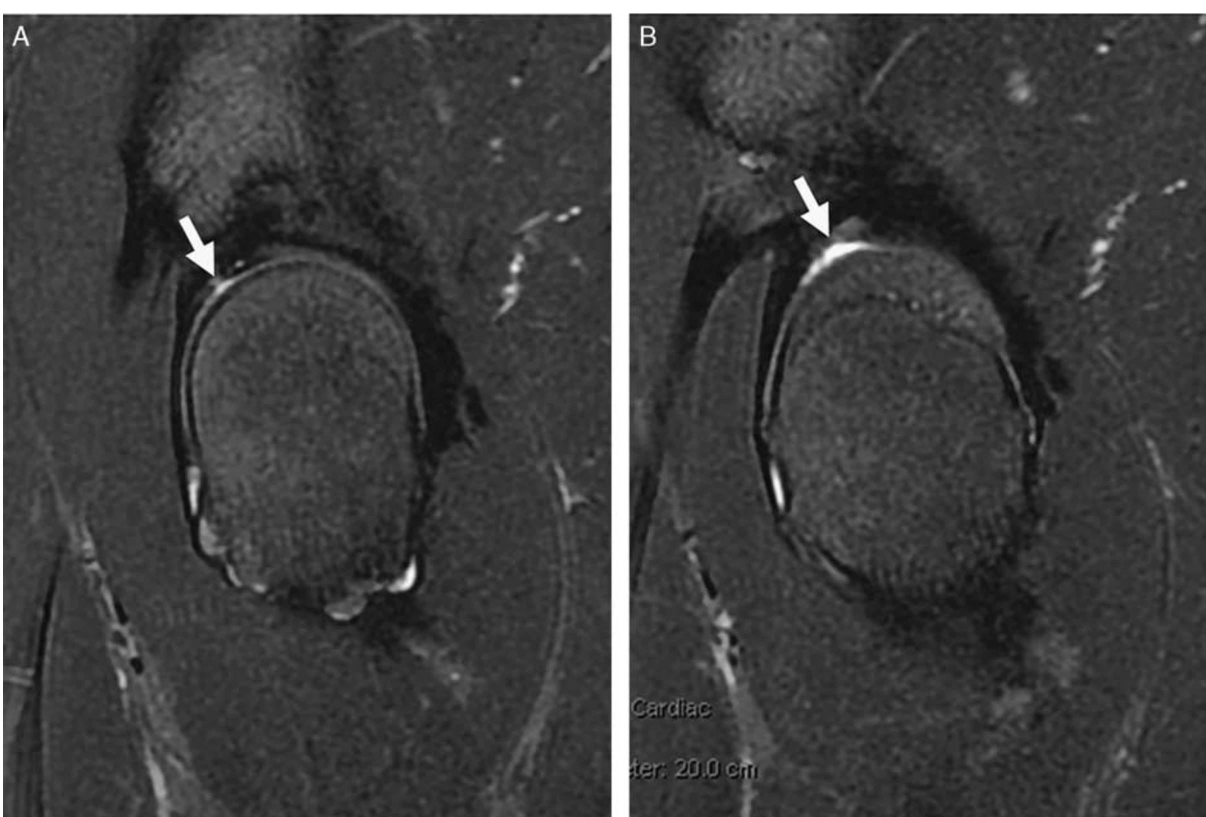

FIGURE 3. A and B, Sagital T2 magnetic resonance images of the right hip showing an acetabular chondral lesion (white arrow) in a 15-year-old boy with hereditary multiple exostoses of the hip.

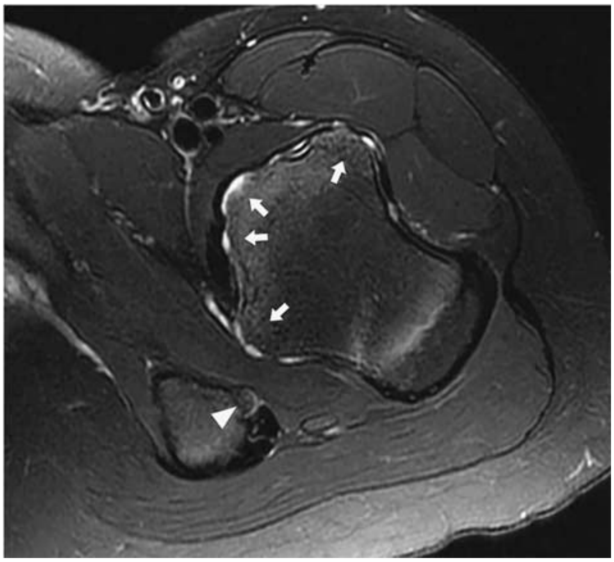

FIGURE 4. Axial T2 magnetic resonance image of the left hip showing osteochondromas in the proximal femur (arrows) and in the ischial tuberosity (arrowhead) in a 7-year-old girl with hereditary multiple exostoses.

The limitations of our study included its retrospective nature and the small number of patients. However, we only included symptomatic patients given the fact that MRI/MRA is an invasive and expensive procedure. In addition, values initially described for adult population were used in our study, as there is still no adequate information about IFI measurements in children. Larger series of cases with longitudinal follow-up would help in detecting changes over time.

In conclusion, in symptomatic children with HME of the hip, MRI/MRA is helpful in detecting the source/s of pain. A high percentage of these children have intra-articular lesions and IFI. These findings can play an important role in planning the surgical approach.

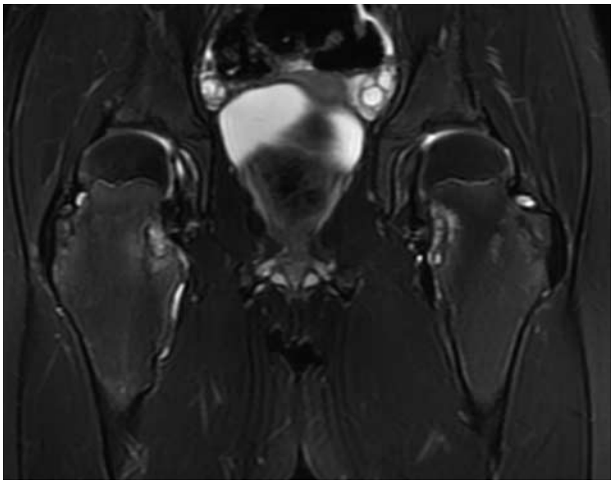

FIGURE 5. Coronal T2 magnetic resonance image showing symmetrical distribution of the osteochondromas in the lesser trochanter of the same patient.

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