Original Article

The impact of age and sex on the diagnosis of intrinsic rectus femoris masses: A single centre experience

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ARTICLE INFO

Keywords:

Rectus femoris masses
Trauma
Benign tumour
Soft tissue sarcoma
Infection

ABSTRACT

Various pathologies may affect the rectus femoris manifesting as an enlargement of the muscle belly. These include traumatic, inflammatory and neoplastic conditions. We did a retrospective study to provide simple guidelines that will serve as an aid for the clinician in order to diagnose lesions presenting as a mass in the rectus femoris. 81 patients with rectus femoris mass referred to tertiary oncology centre were included in the study. The most common lesions were traumatic and benign tumours. In males, traumatic was commonest (90%) and in female over 40 years, 60% were benign and traumatic.

1. Introduction

Various pathologies may affect the rectus femoris manifesting as an enlargement of the muscle belly. These include traumatic, inflammatory and neoplastic conditions.

Traumatic injuries are quite frequent at this level for two reasons: the muscle crosses two joints and has a high percentage of type II muscle fibres (features in common with the medial head of gastrocnemius and the hamstrings).¹

In addition, the anatomical architecture of the muscle represents a further issue. The rectus femoris is formed by the direct head, a unipennate muscle arising from the anterior superior iliac spine and the indirect head, a bipennate muscle arising from the acetabulum. The junction between the two heads is particularly prone to develop strains (Fig. 1). Therefore, even minor traumatic events, usually related to kicking or sprinting activities, can result in incomplete, intrasubstance tears.^{2,3}

The only clinical manifestation, that usually occurs within weeks from the trauma, is the development of a localised enlargement, described as a pseudotumoral appearance. This poses a significant challenge for the clinician, who tends to consider the presence of an unexplained mass as suggestive of neoplasia.

These cases are frequently referred to our musculoskeletal oncology unit as a suspected malignancy.

Clinical guidelines for the management of intrinsic rectus femoris masses are lacking and, even if on MR imaging the appearance of trauma,^{4–6} infection⁷ benign and malignant tumours^{8,9} may be non-specific. Additional clinical assessment may reduce inappropriate referrals to sarcoma centres, reducing patient anxiety and pressure on

oncology services.

Some authors stress the importance of the dimensional criteria, suggesting that a lesion reaching a certain size should raise the suspicion of malignant transformation and referred to an oncologic centre.^{10,11} However, the rectus femoris represents an exception, the length of its myotendinous junction is approximately 10 cm, and low grade strains can cause an extensive swelling of the muscle. This is well recognised in the radiologic literature as a pseudotumoral appearance.^{1,3,12}

The aim of this retrospective study is to provide simple guidelines that will serve as an aid for the clinician in order to diagnose lesions presenting as a mass in the rectus femoris.

2. Materials and methods

We performed a retrospective study identifying patients referred to our tertiary orthopaedic oncology unit from June 2007 to July 2016 with a suspected tumour involving the rectus femoris muscle alone.

Clinical details were obtained from the oncology database. All MRI studies were re-evaluated by an experienced MSK radiologist (MD). Only when the pathology was confined to the rectus femoris muscle patients were included in the study.

Diagnosis was obtained according to either a characteristic MRI appearance or histologic evaluation with US guided biopsy.

The retrospective data collection performed in this study received hospital review board approval.

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Fig. 1. anatomical structure of the rectus femoris muscle the direct unipennate head originating from the ASIS (indicated with 1) and the indirect bipennate head (2).

3. Results

In total 81 patients were included in the study, 61 males (75%) and 20 females (25%) presenting with a mass contained to the rectus femoris muscle mean age (range). Traumatic pathology was identified in 47% of the cases, the second most common cause were benign tumours 38%, malignant tumours represented 12% and infection 3%.

In patients under 40 years of age, trauma was diagnosed respectively in 88% of male patients and in 25% of female patients. Benign tumours were diagnosed respectively in 75% of the females and 12% of the males. Whereas for males over 40 years of age, 49% of cases were benign tumours, 38% trauma, 11% malignant tumours and 2% attributable to infection.

For females over 40 years of age, 44% were diagnosed as benign tumours, 38% malignant tumours, only 12% trauma and the remaining 6% infection. (Table 1)

Table 1

Pathologies diagnosed: trauma (blue), benign tumour (green), malignant tumour (red), infection (orange).

4. Discussion

It is generally accepted that imaging appearances of benign and malignant soft tissue masses can overlap. A large area of lesions of uncertain nature that represent a clinical challenge. However, all the benign soft tissue tumours included in our study (lipoma, myxoma, schwannoma and venous malformation) can have specific features on MRI.

In particular, the traumatic aetiology (muscle strain) is characterised by is the presence of intramuscular oedema between the muscle fibres, tendon avulsion, intramuscular haemorrhage along the interface between direct and indirect muscle bellies^{1, 3, 12} (Fig. 2).

Lipoma, the most common soft tissue neoplasm in general and the one we most frequently encountered at this site should be considered in the presence of a mass with signal intensity equivalent to adipose tissue (hyperintense in T1W and T2W sequences, homogeneous suppression on fluid sensitive sequences)^{13–15} (Fig. 3).

A benign peripheral nerve sheath tumour (BPNST) should be considered when an ovoid-like lesion shows high signal intensity on T2W/ fluid sensitive sequences with a central area of low signal intensity (target sign). The presence of a fine rim of fat surrounding it (split fat sign) and the visualisation of the nerve through the lesion supported the diagnosis.¹⁶ (Fig. 4)

Other differential diagnoses to be considered includes myxoma, that is suspected in particular when the lesion is intramuscular and with the presence of mild oedema of the muscle fibres in contact with the lesion.¹⁷

A mass containing dysplastic vessels surrounded by fat and sometimes small calcific foci (phleboliths) suggest the diagnosis of venous malformation¹⁸.

Aggressive features such as rapid growth, intralesional haemorrhage and displacement of the tendons and neurovascular structures are considered suggestive for malignant sarcoma (Fig. 5).¹⁹

The radiologic diagnosis should be considered an aid for the pathologist in order to address the histologic findings. ultrasound guided biopsy was performed in these cases.

Imaging has an important role in the evaluation of intrinsic rectus femoris muscle masses. Both ultrasound and MRI are sensitive and specific in many cases. Aggressive appearances on imaging are typical of sarcomas and infections, however, the two entities can usually be easily distinguished on MRI. The anatomical location of muscle strains is very typical as well as nonaggressive features of benign tumours have been widely described in the literature.

In addition, ultrasound can also be used to perform guided biopsies when appropriate.

In our experience of the last 9 years, the patients referred to our sarcoma centre with a suspect of a malignant sarcoma involving the rectus femoris only a small percentage (12%) of them were finally diagnosed with a malignant tumour. The great majority of the cases (88%) that underwent clinical-radiological assessment where diagnosed as benign.

We extrapolated from the data obtained several indications which can be useful for the clinical assessment of these lesions.

Patients under 40 years of age of both sexes were never diagnosed with a malignant tumour. Males in this age group had muscular injuries in 88% of the cases and only 12% of them had a benign tumour. Whereas 75% of the females were diagnosed with a benign tumour and 25% of the lesions were traumatic in origin. Therefore, in presence of a patient younger than 40 years of age presenting with mass involving the rectus femoris muscle. If female the clinician should consider that benign tumour would be the most probable diagnosis; if physically active, in particular sprinting and kicking activities, muscle sprain should be also considered. In a male of the same age group muscle injury will represent by far the most probable diagnosis.

In these cases, the “lump” should be evaluated with ultrasound which will promptly confirm the diagnosis. In our patients, the most

Fig. 2. the so called “degloving” injury of the rectus femoris muscle: hemorrhage (arrow) and oedema (void arrows) surrounding the tendon of the indirect head (arrowhead), the tendon of the direct head is attached (dashed arrow), retraction of the muscle belly (black double arrow).

Fig. 3. intramuscular lipoma PD axial(A), T2W fat sat axial(B) and coronal(C) typical MRI appearance of an intramuscular lipoma (arrow) showing homogeneous fat suppression (B and C).

Fig. 4. BPNST involving the rectus femoris: low signal intensity on T1W sagittal (A), the fat split sign is present (arrowheads), high signal intensity on T2W axial sequences (B) with saturation of fat, the target sign is visualized (void arrow).

common tumour at this site was lipoma a lesion that has echogenicity equal to fat tissue.

In case of uncertain diagnosis, the request of a targeted MRI would be appropriate. 4 different histologic type of benign lesions were found in our patients, each with specific imaging appearances on MRI and respectively Lipoma/Atypical Lipomatous Tumour ALT, Myxoma, Schwannoma and Venous Malformation.

The age group over 40 has shown a wider range of pathologies. The prevalence of malignancies in these patient was respectively 38% for females and 11% for males. Therefore, a pathologic enlargement of the rectus femoris in a female of more than 40 years of age should carefully assessed with ultrasound and MRI to exclude malignancy. Consequent referral to a sarcoma centre, for biopsy and clinical assessment would be appropriate. Trauma in this age group is rare in females (12%).

For men over 40 the most probable diagnosis is benign tumour (49%) followed by trauma (38%). However, sarcoma represents a possibility and should be carefully excluded. The diagnostic path to follow should include ultrasound, MRI and, when necessary, histological evaluation.

The small number of patients, in particular of females and the criteria for selection of the patients, referrals to a tertiary centre are the main limitations of this study. Nevertheless, we obtained useful information about the general behaviour of masses at this site. In particular, these are useful for the clinical management. We also created a user friendly algorithm (Table 2) to help clinical assessment. This provides the most common differential diagnoses for sex and age group

as well as the appropriate imaging modalities.

5. Conclusions

The aim of this study is to provide guidelines for the management of these patients in order to avoid unnecessary referrals to sarcoma centres.

Firstly, all masses contained in the rectus femoris muscle diagnosed in patients under 40 years of age are more likely benign.

Ultrasound would be appropriate in order to assess if the lesion is traumatic in origin ($M > F$) or a benign tumour ($F > M$). The latter requires follow up in six months with ultrasound.

Malignant features are unlikely to be present but, if detected further assessment with MRI is recommended.

Over 40 years, patient should be considered at risk of malignancy ($F > M$). The first appropriate action is to send the patient for an ultrasound scan followed by MRI. If malignant transformation is suspected ultrasound guided biopsy and referral to a sarcoma centre for discussion is advised.

Conflict of interests

None.

Fig. 5. soft tissue sarcoma T2W with saturation of fat axial (A) and coronal (B) large, aggressive lesion involving the rectus femoris with medial displacement of the tendon (arrow).

Table 2
Management of intrinsic masses of the rectus femoris.

Financial disclosures

None.

References

- Gyftopoulos S, Rosenberg ZS, Schweitzer ME, Bordalo-Rodrigues M. Normal anatomy and strains of the deep musculotendinous junction of the proximal rectus femoris: MRI features. *AJR Am J Roentgenol*. 2008;190(3):182–186.
- G BJ, Piotrowski G, P JJ, A WC. The kick: biomechanics and collision injury. *Am J Sport Med*. 1978;6(4):185–193.
- Hughes C, Hasselman CT, Best TM, Martinez S, Garrett WE. Incomplete, intrasubstance strain injuries of the rectus femoris muscle. *Am J Sports Med [Internet]* SAGE Publications. 1995;23(July (4)):500–506. Available from: <http://journals.sagepub.com/doi/abs/10.1177/036354659502300422>.
- MacMahon PJ, Hogan BA, Shelly MJ, Eustace SJ, Kavanagh EC. Imaging of groin pain. *Magn Reson Imaging Clin [Internet]*. Elsevier. 2017;17(May (4)):655–666. <http://dx.doi.org/10.1016/j.mric.2009.06.013>. Available from: .
- Pollock N, James SLJ, Lee JC, Chakraverty R. British athletics muscle injury classification: a new grading system. *Br J Sports Med [Internet]*. 2014;48(August (18)):1347–1351. Available from: <http://bjsm.bmj.com/content/48/18/1347.abstract>.
- Kavanagh EC, Koulouris G, Ford S, McMahon P, Johnson C, Eustace SJ. MR imaging of groin pain in the athlete. *Semin Musculoskelet Radiol*. 2006;10(3):197–207.
- Schulze M, Kötter I, Ernemann U, Fenchel M, Tzaribatchev N, Claussen CD, et al. MRI findings in inflammatory muscle diseases and their noninflammatory mimics. *Am J Roentgenol*. 2009;192(6):1708–1716.
- Kransdorf MJ, Murphey MD. Radiologic evaluation of soft-tissue masses. *Am J Roentgenol [Internet]* American Roentgen Ray Society. 2000;175(September (3)):575–587. <http://dx.doi.org/10.2214/ajr.175.3.1750575>. Available from: .
- Sundaram M, McLeod RA. MR imaging of tumor and tumorlike lesions of bone and soft tissue. *Am J Roentgenol [Internet]* American Roentgen Ray Society. 1990;155(October (4)):817–824. <http://dx.doi.org/10.2214/ajr.155.4.2119115>. Available from: .
- Nandra R, Forsberg J, Grimer R. If your lump is bigger than a golf ball and growing, think sarcoma. *Eur J Surg Oncol [Internet]* Elsevier. 2017;41(May (10)):1400–1405. <http://dx.doi.org/10.1016/j.ejso.2015.05.017>. Available from: .
- Grimer RJ. Size matters for sarcomas!. *Ann R Coll Surg Engl [Internet]* The Royal College of Surgeons of England. 2006;88(October (6)):519–524. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1963770/>.
- Temple HT, Kuklo TR, Sweet DE, Gibbons CLMH, Murphey MD. Rectus femoris muscle tear appearing as a pseudotumor. *Am J Sports Med [Internet]* SAGE Publications. 1998;26(April (4)):544–548. <http://dx.doi.org/10.1177/03635465980260041301>. Available from: .
- Kransdorf MJ, Bancroft LW, Peterson JJ, Murphey MD, Foster WC, Temple HT. Imaging of fatty tumors: distinction of lipoma and well-differentiated liposarcoma. *Radiology*. 2002;224(1):99–104.
- Murphey MD, Carroll JF, Flemming DJ, Pope TL, Gannon FH, Kransdorf MJ. From the archives of the AFIP: benign musculoskeletal lipomatous lesions. *Radiographics*. 2004;24(5):1433–1466.
- Brisson M, Kashima T, Delaney D, Tirabosco R, Clarke A, Cro S, et al. MRI characteristics of lipoma and atypical lipomatous tumor/well-differentiated liposarcoma: retrospective comparison with histology and MDM2 gene amplification. *Skeletal Radiol*. 2013;42(5):635–647.
- Murphey MD, Smith WS, Smith SE, Kransdorf MJ, Temple HT. From the archives of the AFIP. Imaging of musculoskeletal neurogenic tumors: radiologic-pathologic correlation. *Radiographics [Internet]*. 1999;19(5):1253–1280. Available from: <http://radiographics.rsnajnl.org/cgi/content/full/19/5/1253%5Cnpapers3://publication/uuid/91519818-1787-47B4-9BF7-DB6475455F8C>.
- Bancroft LW, Kransdorf MJ, Menke DM, O'Connor MI, Foster WC. Intramuscular myxoma: characteristic MR imaging features. *Am J Roentgenol*. 2002;178(5):1255–1259.
- Flors L, Leiva-Salinas C, Maged IM, Norton PT, Matsumoto AH, Angle JF, et al. MR imaging of soft-tissue vascular malformations: diagnosis, classification, and therapy follow-up. *RadioGraphics [Internet]*. 2011;31(5):1321–1340. <http://dx.doi.org/10.1148/rg.315105213>. Available from: .
- Chan WP. Magnetic resonance imaging of soft-tissue tumors of the extremities: a practical approach. *World J Radiol [Internet]*. 2013;5(12):455. Available from: <http://www.wjgnet.com/1949-8470/full/v5/i12/455.htm>.