research article

MRI of the Morel-Lavallée lesion – a case series

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Introduction. The aim of the study was to review the appearances of Morel-Lavallée (ML) lesions on magnetic resonance imaging (MRI).

Patients and methods. 14 patients diagnosed with the ML lesion on MRI were analysed retrospectively (mean age = 35 years). Mechanism of injury, time frame from injury to MRI, location, shape, T1 and proton-density fat-suppression (PDFS) signal intensity (SI), presence of a (pseudo)capsule, septations or nodules within the collection, mass effect and fluid-fluid levels were analyzed. The Mellado and Bencardino classification was utilized to classify the lesions.

Results. In most cases, mechanism of injury was distortion. Mean time frame between the injury and MRI was 17 days. Lesions were located around the knee in 9 patients and in the peritrochanteric region in 5 patients. Collections were fusiform in 12 patients and oval in 2 patients. 9 collections were T1 hypointense and PDFS hyperintense. 4 collections had intermediate T1 and high PDFS SI. 1 collection had intermediate T1 and PDFS SI. (Pseudo)capsule was noted in 3 cases. Septations or nodules were found in 4 cases. According to the Mellado and Bencardino, collections were classified as seroma (type 1) in 9, subacute hematoma (type 2) in 1 and chronic organizing hematoma (type 3) in 4 cases.

Conclusions. Characteristic features of ML lesion include a fusiform fluid collection between the subcutaneous fat and the underlying fascia after shearing injury. Six types can be differentiated on MRI, with the seroma, the subacute hematoma and the chronic organizing hematoma being the commonest.

Key words: Morel-Lavallée; soft-tissue injury; hematoma; magnetic resonance imaging

Introduction

Morel-Lavallée (ML) lesion has initially been presented by a French surgeon Victor Auguste Francois Morel-Lavallée in 1863, who described it as fluid collection which dissects the subcutaneous fat tissue.[1]

In most cases, it is a post-traumatic, closed, degloving soft-tissue injury caused by direct trauma or shearing forces, resulting in abrupt separation of skin and subcutaneous tissue from the underlying fascia.[2-4] Consequently, a dead space is formed, which can potentially fill with haemolymph, debris and fat, resulting in a formation of heterogeneous collection.[2-3,5-6,7-9]

Peritrochanteric region is particularly sensitive to this injury because of the increased mobility of the soft tissue in this area, the superficially located bone, strong underlying *fascia lata* attaching to the iliotibial band and a rich vascular plexus piercing the *fascia lata*.[5,7,8]

Clinically it usually presents as an enlarging painful swelling.[2] Clinical presentation and the imaging techniques are keys to a diagnosis. Ultrasound (US) is an excellent imaging modality for the evaluation of superficial soft tissues and collections. However, owing to both high contrast resolution and demonstration of deep tissues, magnetic resonance (MRI) is a gold standard for the identification and evaluation of the ML lesion.[2-4,6-8,10,11]

ML lesion can present with various shapes and signal intensities in standard MRI sequences due to the different stages and contents of the lesions. This can lead to underrecognition and misinterpretation of the ML lesions by the radiologists. In order to prevent complications such as infections or extensive tissue necrosis it is essential to diagnose and manage the lesion in a timely manner.[2-4,7,10]

In the literature, several forms of ML lesions have been described. In 2005, an extensive six-stage imaging-based classification on the shape of lesion, signal intensity (SI) on T1 and T2-weighted images, presence of the fibrous capsule, contrast enhancement and sinus tract formation capsule was proposed by Melado and Bencardino (Table 1).[11]

A type 1 ML lesion is a seroma, exhibiting fluid-like characteristics. It is seen as homogeneously hypointense on T1 and hyperintense on T2 MRI (Figure 1).[5,12] It can be acute or chronic and is mostly noncapsulated.[5,11]

A type 2 ML lesion is a subacute hematoma, which appears homogenously hyperintense on both, T1 and T2 MRI.[5,9,12] The cause of high T1 SI is the presence of methaemoglobin. In the early subacute hematoma, the methaemoglobin is first observed in the periphery. With time it becomes more homogeneously distributed.[5,11,13] These lesions mostly have a hemosiderin-rich capsule on T1- and T2-WI. From time to time internal inhomogeneity can be seen, due to the fluid-fluid levels, internal septations and entrapped fat globules.[5,13]

Occasionally, patchy internal enhancement after intravenous contrast administration can be observed due to the presence of capillaries, which can lead to false interpretation of the lesion as a soft-tissue tumour. The subacute hematomas can be further divided in early and late subacute hematomas. The early ones are more homogeneous, while the late ones often present with a fibrous capsule and are seen as heterogeneous.[5,14]

A type 3 ML lesion is a chronic organizing hematoma, with hypo- or intermediate SI on T1 and as heterogeneous intermediate on T2 sequences. The heterogeneous signal is seen due to the content of the lesion: hemosiderin granulation tissue, necrotic debris, fibrin and blood clots (Figure 2).[11] Because of neovascularization and granulation tissue, patchy internal and peripheral enhancement can be seen on post-contrast MRI.[5,12] These types of lesions may be surrounded by a hemosiderin-rich fibrous capsule.[5,14]

Type 4-6 ML lesions are the chronic ones, often presenting atypically. A type 4 ML lesion is a closed fatty tissue laceration with a perifascial dissection. It can be associated with or without a serous/haemorrhagic collection.[5,11] The collection is seen with low T1 SI and high T2 SI. It is not surrounded by a capsule and it enhances variably.[5,14]

A type 5 ML lesion is located perifascially and has a pseudonodular appearance. Occasionally, a peripheral enhancement and skin retraction are seen.[5,11]

A type 6 ML lesion is an infected lesion, it often presents with a thick capsule, internal septations, peripheral fluid leakage, inflammation of the adjacent fat tissue and fascia and sometimes even with an associated sinus tract.[5,11] The aim of our study was to retrospectively analyse the series of patients with ML lesions based on the Mellado-Bencardino classification and evaluate its presentations on MRI.

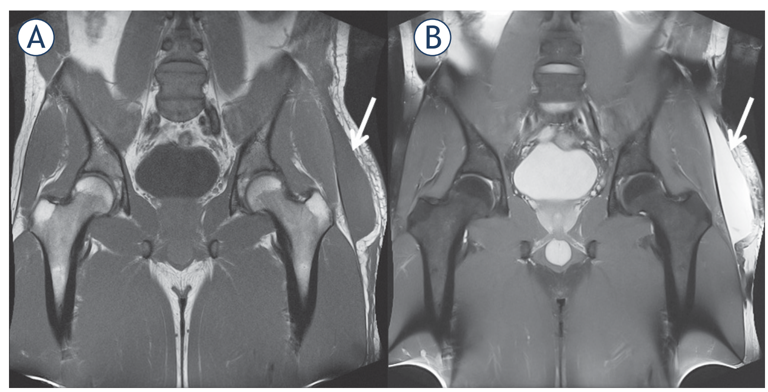

FIGURE 1. Morel-Lavallee lesion type 1. A 33-years-old professional skier 2 weeks after a fall. A large fusiform collection (arrows) between the subcutaneous fat and *fascia lata* demonstrating low signal intensity (SI) on T1 WI **(A)** and high SI on proton density fat-saturated image (PDFS) **(B)** in coronal plane indicating clear fluid i.e. seroma.

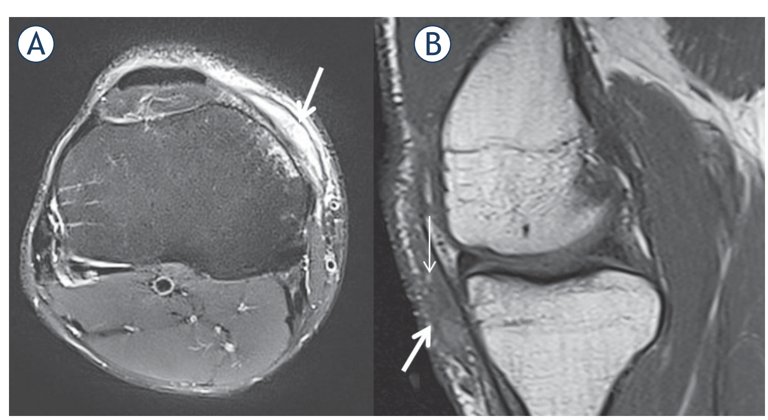

FIGURE 2. ML lesion type 3. A 34-year-old male after a distortion. On axial proton-density fat-suppression (PDFS) MRI **(A)** a fusiform fluid collection with hypointense debris is demonstrated between the deep subcutaneous fat and layers of medial patelofemoral ligament (arrows). On T1 weighted sagital image **(B)**, in moderately hypointense collection several fat globules are visible (thin arrow).

TABLE 1. MRI classification of Morel-Lavallee lesions according to Mellado-Bencardino[12]

Lesion type	T1W	T2W	Morphology	Other
Type 1 - Seroma	Homogenously hypointense seroma	Hyperintense collection	Laminar	No evidence of outer capsule formation
Type 2 – Subacute hematoma	Homogenously hyperintense	Homogenously hyperintense	Oval	Presence of methaemoglobin Thin capsule formation
Type 3 – Chronic organizing hematoma	Hypointense	Heterogeneous hypointense/ isointense	Oval	Thick capsule formation Capsular and internal enhacement on postcontrast sequences
Type 4-Closed laceration	Hypointense	Hyperintense	Linear	No capsule formation
Type 5-Small, rounded pseudonodular appearance	Variable	Variable	Round	Variable capsule formation
Type 6-Superimposed infection	Variable	Variable	Variable sinus tract	Thick enhancing capsule

Patients and methods

The study design was a single-center retrospective review, performed accordingly to the Declaration of Helsinki and approved by the local ethics committee. The search identified fourteen patients; ten male and four female. Their age ranged between 11–67 years with the mean age 34.8 years. The examinations were performed with various MRI scanners. MRI protocol consisted of T1 sequence in at least one plane and proton density fat-suppressed sequences (PDFS) in several planes. In addition, T2 sequence without fat suppression was utilized several times. Intravenous (I.V.) contrast was not administered in any case.

The mechanism of injury as well the time frame between injury and MRI were recorded, when provided. Additionally, the imaging reports and MRI images were reviewed. Also, the possible additional imaging modalities were identified. The following characteristics of the MR-images were evaluated by the radiology resident (first author) and musculoskeletal (MSK) radiologist with 14 years of experience (second author) in consensus: location, shape, signal intensity (SI), presence of a (pseudo) capsule, septations or nodules within the collection, mass effect and fluid-fluid levels.

Results

Mechanism of injury and time frame between the injury and MRI

In five patients out of fourteen (30.1%) the mechanism was distortion, in 3/14 patients (21.4%) fall, 2/14 (14.3%) were athletes without acute injury, 1/14 (7.1%) patient kneeled and one (7.1%) was injured in a motor vehicle accident. In 2/14 patients (14.3%), the mechanism of injury was unknown.

For 11/14 patients (78.6%) the time frame between the injury and MRI was 4 days to 4 months, with mean time of 17 days. For 3/14 patients (21.4%) the time frame was unknown.

Additional ultrasound

Only one patient (7.1%) had an ultrasound before the MRI. One patient (7.1%) had a follow-up ultrasound.

MRI characteristics

Location and shape

The collections were located around the knee in 9/14 patients (64.3%) and in the peritrochanteric region in 5/14 (35.7%) patients.

The majority (12/14, 85.7%) of collections was fusiform and only 2/14 (14.3%) had oval shape.

MRI signal intensity and lesion classification

Most collections (9/14, 64.3%) were T1 hypointense and PDFS hyperintense (Figure 1). 4/14 (28.5%) collections had intermediate T1 and high PDFS SI (Figure 2). 1/14 (7.1%) collection had intermediate T1 and PDFS SI. (Pseudo)capsule was noted in 3/14 cases (21.4%). Septations or nodules were found in 4/14 (28.5%) cases. No cases with mass effect or fluid-fluid levels were observed. Additionally, in 5/14 (35.7%) cases fat globules were found. Also, in 10/14 (71.4%) cases the oedema of subcutaneous fat was noted without lacerations.

The collections were classified according to the Mellado-Bencardino classification as seroma – type 1 in 9/14 (64.3%), subacute hematoma – type 2 in 1/14 (7.1%) and chronic organizing hematoma – type 3 in 4/14 (28.5%).

Discussion

To our knowledge, the presented study is one of larger cohorts in the published literature, in particular with the focus on the MRI. ML lesions most commonly occur around the greater trochanter, although they can be found around the knee, trunk, peri-scapular etc.[2-3,5-7,10,11,15] Sometimes the collections may extend through thin sinus tract far from the original location (Figure 3). The location of the ML lesion around the knee was more frequent in our cohort than previously reported. Frequently, small fluid collections in the deep subcutaneous tissues around the knee joint are interpreted as simple seroma or hematoma whereas they could be also described as ML lesion. Alternatively, in the clinical practice, prepatellar fluid collections are commonly interpreted as a bursitis, which may represent the differential diagnosis. Prepatellar ML lesions often extend medially or laterally and proximally to the mid-thigh whereas a prepatellar bursitis does not extend beyond the mid-coronal plane and the boundaries of normal and slightly swollen bursa.[16,17] The exact definition of location might represent a challenge in the definition and classification of the ML lesions in the future. However, the distinction may not be clinically relevant as treatment is often the same. A chronic hemorrhagic prepatellar bursitis may mimic a type 3 ML lesion.[14,18] The shapes of the lesions were in line with the previous reports.[5] Septations and nodules, as well as fat globules, were less frequent in the presented group than in a published literature[5], probably owing to a small patient group. The presence of intralesional fat globules (Figure 4) is not pathognomonic, although they may be found in some subacute hematomas.[19] However, their finding may contribute to the characterization of the collection as the ML lesion.[20,21] On the other hand, they are not among criteria of Mellado-Bencardino classification.

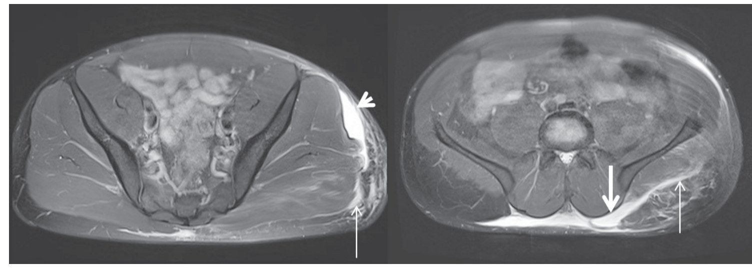

FIGURE 3. Extension of the Morel-Lavallée (ML) lesion. Same patient as in the Figure 1. On axial proton-density fat-suppression (PDFS) images, a thin communication (thin arrows) between *gluteus maximus* muscle and the deep gluteal fat connects the primary lesion (thick short arrow) and another collection posteriorly (thick arrow). Note also the mild oedema signal of the *gluteus maximus* muscle and gluteal fat indicating contusions.

Most collections in the study group were classified as the Type 1 lesions. This could possibly be explained with the relative short time frame between the injury and the MRI. We could not find the time frame data in previous published reports. The results of less frequent type 2 and type 3 lesions are in line with other reports.[5]

We did not encounter type 3–6 lesions according to Mellado-Bencardino classification, possibly owing to their rarity, variable presentations on MRI, short time-frame between the injury and MRI, and a small patient group. Similar results were found in other small series.[5]

In the presented cohort, routine PDFS sequences were utilized as fluid-sensitive fat-suppressed sequences. The Mellado-Bencardino classification is based on T1/T2 MRI protocol, as it was most probably derived from MRI of soft tissue tumours as well as from other MSK protocols in mid-2000s, when it was introduced. The PDFS sequence was

FIGURE 4. Fat globule and concomitant injury. In this 14-year-old boy with unknown time and mechanism of injury, a small fusiform fluid collection is visible at the right side between deep subcutaneous fat and *fascia lata* with low T1 **(A)** and high proton-density fat-suppression (PDFS) **(B)** SI (thin arrows) on coronal images. Note also a large fat globule in the lesion (short thick arrows). In addition, on the left side **(C)**, an small avulsion of the *sartorious tendon* off the anterior superior iliac spine is visible (long thick arrow).

mostly not utilized routinely in the MSK MRI at the time, however owing to its robustness it has been a MSK workhorse since 2010, when the routine role of non-fat-suppressed T2 sequence was reduced. Therefore, to be strict, the classification in the presented series could be characterized as »Mellado-Bencardino related«. Furthermore, as in routine MSK MRI trauma settings, no contrast had been administered in the presented series. However, owing to other typical findings, follow-up examination with contrast was not indicated in any case. Modified MRI protocols, as well as not encountering types 3–6 lesions, might both imply the possible opportunity for an update and simplification of the Mellado-Bencardino classification to the three stages in the future. This should be verified in studies with larger patient cohorts and clinical correlation.

The specific location between the subcutaneous tissue and the fascia, the imaging signs and knowledge of the classification system may all be helpful in the differential diagnosis with other fluid-filled collections in the soft tissues.[5] In addition to bursitis, described above, other differential possibilities include soft tissue masses and other posttraumatic collections. Among soft tissue masses, sarcomas represent the most dangerous possibility which can mimic type 1 or 3 ML lesion. In short, sarcomas, as vascularized tumours, mostly demonstrate contrast enhancement, whereas collections do not. However, in most cases, particularly in trauma setting, I.V. contrast is not administered, as it was not in the presented cohort, as mentioned. Therefore, caution is warranted and low threshold to follow-up MRI with contrast or US Doppler examination (the role of US contrast in these settings is yet to be evaluated) should be set, particular in growing masses.

Other possible differential diagnoses include fat necrosis, where MRI signal depends on timing after trauma. It may appear spiculated or more laminar[22] and may sometimes mimic a type 4 ML lesion.[11] Another possibility is pseudolipoma, which can develop after blunt trauma as well as iatrogenic after surgery and hematoma.[11] On MRI, it usually presents as subcutaneous lipomatous mass without capsule or contrast enhancement.[23]

Owing to their superficial location, most of ML lesions can be detected with ultrasound (US). Interestingly, only one patient in the presented cohort had had US examination performed before the MRI. This could be explained with the lack of data of possible US examinations performed outside our institution. Mostly, similar as on MRI, the US appearance depends on their age, often with heterogenous echogenicity. The latter depends on the degradation stage of the blood products; acute and subacute (up to a month) lesions will appear heterogeneous with irregular margins and lobular shape. Over the time, the blood products will liquefy and become more hypoechoic. Chronic lesions (more than 18 months) are more often homogenous with smooth margins.[7,20,21,24] MRI, however, enables more detailed analysis of deeper tissues and demonstration of possible concomitant muscle, nerve and bone injuries (Figures 4, 5). In our opinion, it is therefore preferred imaging modality at least before possible invasive therapeutic procedures or clinical suspicion of possible extension in different compartments, larger collections, superinfections or unclear differential diagnosis.[5] Nevertheless, US could be an excellent method for the follow-up of the lesion, particularly in conservatively managed cases, as well as in suspected complications after invasive treatment.

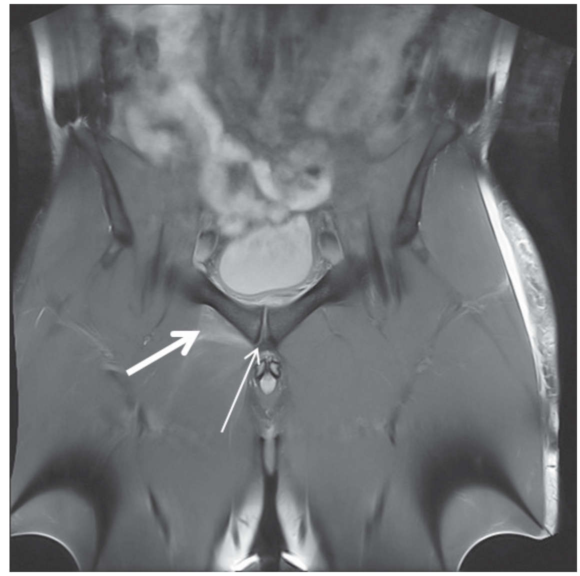

FIGURE 5. Concomitant injuries. Same patient as in Figure 1 and 3. In proton-density fat-suppression (PDFS) coronal image, a mild hyperintensity of adductor muscles is visible (thick arrow) indicating mild distension without fibre disruption. In addition, note secondary cleft sign (thin arrow) at the lower right edge of the pubic symphysis indicating possible injury of the rectus/adductor aponeurosis. In such case, a dedicated MRI examination might be warranted.

Computed tomography (CT) has minor role in the evaluation of the ML lesions. They may, however, incidentally show-up in the examinations, performed for the evaluation of possible bone injuries. On CT, they may demonstrate with fluid-fluid levels and lower densities than simple hematomas owing to mixing of low-density lymphatic fluid.[4] Therefore, they may be easily overlooked, especially in the bone window.

Treatment of the ML lesion depends on the stadium. It varies from compression banding, aspiration or incision and evacuation, with or without injection of sclerosing agents.[14,25]

The lack of US data in the presented cohort represents a limitation of the presented study. Another limitation could be the lack of the data of further clinical and imaging management because most patients were outpatients who were lost to follow-up. However, both were not primary purposes of the study.

Conclusions

Morel-Lavallée lesion results from the traumatic separation of the skin and subcutaneous fat from the underlying fascia where a fusiform fluid collection is demonstrated on imaging. On MRI, six types of ML lesion can be differentiated, with the seroma, the subacute hematoma and the chronic organizing hematoma being the most frequent presentations. Knowledge of the most common locations, imaging signs and classification system may be helpful in the differential diagnosis. The results of the presented study, as well as the modified MRI protocols in the last decade, might suggest the opportunity for the possible update and simplification of the Mellado-Bencardino classification.

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