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ORIGINAL ARTICLE

Imaging Findings of the Morel-Lavellée Lesion

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Abstract

Introduction: This study aims to evaluate the magnetic resonance imaging (MRI) findings of the Morel-Lavellée lesion (MLL), which described as degloving injury of the subcutaneous fatty tissue.

Methods: MRI features of fifteen patients in whom the diagnosis of MLL was established by clinically or surgery retrospectively analyzed.

Results: All the lesions were located in the lower extremities, and 86.6% (n=13) were located at the knee level or above. All lesions had an anatomic relationship with deep fascia. The majority of the lesions were in either fusiform or crescentic form. 60% (n=9) of the lesions showed a well-defined smooth contour. Pseudocapsules were observed in nine patients (60%). 46.6% (n=7) of the lesions had a homogeneous signal property. The intralesional hemorrhagic signal was observed in 26.6% (n=4) of the lesions and intra-lesional fat signal in 46.6% (n=7). One patient had fluid-fluid leveling. In two cases, muscle injury were accompanied by the MLL. In all cases, no associated bone lesion was noted.

Discussion and Conclusion: MLL should be considered if a well-circumscribed, crescentic or fusiform subcutaneous mass lesion in association with the deep fascia is present, especially in the presence of a history of previous trauma.

Keywords: Lower extremities; morel-Lavellée lesion; MRI.

Morel-Lavellée lesion (MLL) commonly develops as a consequence of a shearing trauma of subcutaneous fatty tissue resulting in the separation of the superficial and deep fascia, namely the degloving injury. The lesion usually occurs by the formation of fluid collection, including blood, lymph, and necrotic fat, which eventually be lined by a fibrous pseudocapsule preventing the absorption of the contained fluid remaining for a long time after injury (Fig. 1)[1,2].

The sites of occurrence most commonly included the trochanteric and proximal thigh region, but they might be seen in the other sites of the body[1,2]. Magnetic resonance imaging (MRI) is the best modality of choice in the detection and diagnosis of these lesions. However, the diagnosis may be challenging since imaging properties vary depending on the age and the content of the lesion[3,4]. To our knowledge, in the literature, most MML cases have been reported as a single case report. Moreover, most of the prospective or ret-

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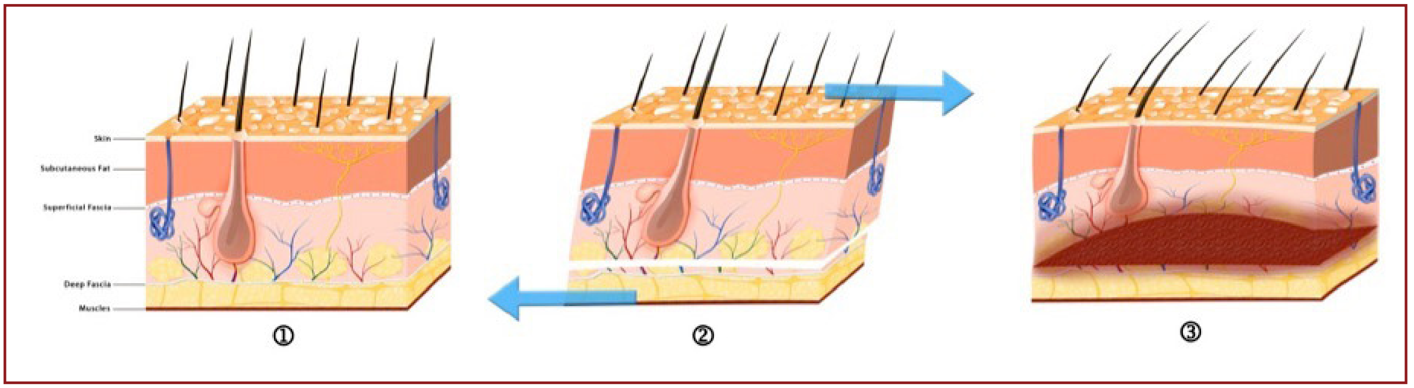

Figure 1. The illustration demonstrates Morel-Lavallee degloving injury mechanism. 1) Normal anatomical structures of skin are shown. 2) In severe trauma, tangential and shearing force vector causing separation of the fatty tissue from the underlying deep fascia. 3) This results in a potential gap between these structures and due to disruption of the vascular and lymphatic plexus, the cavity fills with haematoma, lymph, necrotic fat and debris.

rospective studies concerning MLL have focused on the clinical aspect of this entity rather than the radiological features.

In this paper, we aimed to discuss the radiological, in particular magnetic resonance imaging (MRI), features of fifteen patients with MLLs to describe the spectrum of the appearance of the lesions, with an emphasis on the value of MRI features in diagnosis.

Materials and Methods

Patients

This retrospective study was conducted with the approval of the Institutional Review Board of our institution. Fifteen patients diagnosed with MLL following trauma in our hospital between November-2014 and December-2017 were included in the study. There were eight male (53.3%) and seven female (46.7%) patients, aged from 20 to 70 years with a mean of 43.8 years. There was no history of anticoagulant use or bleeding diathesis in patients. The main symptoms were pain (n=9, 60%) and soft tissue swelling (n=7, 46.7%). Pain in the lesion area was present in all patients with acute trauma, whereas there was no pain in three of 6 chronic patients. The duration of symptoms varied from a week (7 days) to six months with a mean of two months. Physical examination revealed a localized swelling at the lesion site in the extremities (n=5, 33.3%), palpated mass lesion at lesion area (n=7, 46.7%), reduction of the range of motion of effected extremities (n=4, 26.7%), and pain at superficial palpation (n=9, 60%). The clinical data of the fifteen patients are summarized in Table 1.

Table 1. Clinical features of fifteen patients with morel-Lavalle lesion

Case	Age (Year)	Gender	History	Duration (Week)	Location	Treatment
1	65	Female	Trauma	1	Knee	Aspiration
2	70	Female	Trauma	3	Knee	Surgery
3	24	Female	Trauma	12	Trochanter	Surgery
4	52	Male	Trauma	1	Trochanter	Conservative-Follow up
5	20	Female	Trauma	1	Gluteal	Aspiration
6	34	Female	Trauma	2	Cruris	Conservative-Follow up
7	45	Male	Trauma	5	Tigh	Aspiration/ cortisone injection
8	41	Male	Trauma	4	Trochanter	Conservative-Follow up
9	40	Male	Trauma	1	Gluteal	Conservative-Follow up
10	46	Female	Trauma	20	Trochanter	Surgery
11	45	Male	Trauma	4	Knee	Surgery
12	33	Male	Trauma	1	Tigh	Conservative-Follow up
13	61	Female	Trauma	3	Knee	Surgery
14	38	Male	Trauma	1	Cruris	Conservative-Follow up
15	40	Male	Trauma	10	Trochanter	Surgery

Imaging

X-ray plain film of the affected area was initially obtained. To further evaluate the lesion details, all patients underwent MRI, and two patients had additional computed tomography (CT) scanning. MRI examinations were performed within a mean interval of two months (ranging from 1 week to 5 months) after the trauma. MR images were obtained with a 3 Tesla MR Unit (Signa, GE Healthcare, Milwaukee, WI, USA), using a dedicated superficial coil at the affected area of the extremities. Appropriate parameters were used according to our standard MRI protocols for the imaging of the affected area. The sequences included at least two orthogonal planes fast spin-echo (FSE) T1- and T2-weighted images, and STIR or fat saturated FSE PD or T2-weighted images of the lesion area. The parameters of these sequences were repetition time (TR)/echo time (TE) ranging 510–580/15–20 ms for T1-weighted imaging, TR/TE ranging 3.200–3.600/98–120 ms for T2-weighted imaging and for STIR sequences TR/TE were ranging 3800-4,100/24-29, inversion time ranging 110-130 msec. Other parameters were settled as; the field of view (ranging 120 mm to 420 mm), matrix (ranging 256×256 to 384×512), signals acquisition (3 to 6), and a slice thickness/gap (3/0.3 to 5/0.5 mm). In two patients' contrast-enhanced T1-wegithed imaging was obtained after intravenous injection of gadolinium (Magnevist, Schering, Berlin, Germany) with a dosage of 0.1 mmol/kg of body weight.

Image Interpretation

Two experienced radiologists evaluated each case, and the final assessment was reached in a consensus. The lesions' location, size, morphology, contour characteristics (smooth well defined or lobulated), signal intensity, and signal characteristics (homogeneous or heterogeneous) were noted. The presence of pseudocapsule, intra-lesional fatty tissue, septation, debris, and fluid-fluid leveling were also assessed. The relationship of the lesions with the deep fascia was noted.

Results

The MR imaging findings of all the fifteen patients are summarized in Table 2.

Location

Lesions were located in the gluteal region (2 cases; 13.3%), trochanteric (5 cases; 33.3%), thigh (2 case; 13.3%), prepatellar (4 cases; 26.6%) and distal cruris region (2 case; 13.3%). All the lesions were located in the same area that previously exposed to the direct trauma and 86.6% (n=13) were located at the knee level or above. All of the lesions showed a close anatomic relationship with deep fascia.

Morphology and Signal Properties of Lesions

The largest dimensions of the lesions varied from 18 mm to 110 mm, with an average of 64 mm. Two (13.3%) of the lesions were ovoid/round-shaped, seven (46.7%) were fusiform and six (40%) had crescentic form. The lesions, which had a fusiform or crescentic shape, had a longitudinal axis parallel to that of the deep fascia. The lesions were well defined from surrounding the tissues in all the patients. In nine cases (60%), lesions had a uni-compart-

Table 2. MRI features of fifteen patients with Morell-Lavalle lesions

Case	Size (mm)	Contour	Shape	T1-WI	T2-WI	Homogenity	Capsule	Septation	Fat sign
1	34x12x40	Smooth	Cresentic	Hyper	Hyper	Heterogeneous	+	-	+
2	90x25x70	Lobulated	Cresentic	Hypo	Hyper	Heterogeneous	-	+	-
3	75x60x65	Smooth	Ovoid	Hyper	Hyper	Homogeneous	+	-	+
4	68x30x40	Lobulated	Fusiform	Hypo	Hypo	Heterogeneous	-	-	-
5	84x30x51	Lobulated	Fusiform	Hypo	Hyper	Heterogeneous	-	-	-
6	18x10x16	Smooth	Cresentic	Hypo	Hyper	Homogeneous	+	-	-
7	53x10x37	Smooth	Cresentic	Hypo	Hyper	Homogeneous	-	-	-
8	50x10x40	Smooth	Fusiform	Hypo	Hyper	Homogeneous	+	-	-
9	90x25x60	Lobulated	Fusiform	Hypo	Hyper	Heterogeneous	-	-	+
10	110x100x98	Smooth	Spheric	Hypo	Hyper	Homogeneous	+	-	-
11	50x60x20	Smooth	Cresentic	Hyper	Hyper	Heterogeneous	+	+	+
12	50x12x40	Lobulated	Fusiform	Hypo	Hyper	Homogeneous	-	-	-
13	60x20x50	Lobulated	Cresentic	Hyper	Hyper	Heterogeneous	+	-	+
14	70x18x44	Smooth	Fusiform	Hypo	Hyper	Heterogeneous	+	-	+
15	70x55x18	Smooth	Fusiform	Hypo	Hyper	Homogeneous	+	-	+

mented appearance with a smooth contour, whereas in six cases (40%), lesions had lobulated contours and two of them showed multi-loculated appearance due to the intra-lesional septation. The lesions's signal intensity was heterogeneous (on both T1- and T2-weighted sequences) in eight cases (53.3 %) and homogeneous in seven cases (46.7%). All the cases with intrinsic signal homogeneity had fluid signal intensity (a hypointense signal on T1-weighted imaging and hyperintense signal on T2-weighted imaging). The intralesional hemorrhagic signal was observed in 26.6% (n=4) of the lesions. Pseudocapsules were observed in nine cases (60%) and in two of these cases, marked peripheral rim-like enhancement after the administration of contrast agents was observed. A nodular-like pattern of enhancement was not seen in any part of the lesions of these two cases. The intra-lesional fat signal was positive in the lesion of seven patients (46.7%) and one patient (6.7%) had intra-lesional fluid-fluid leveling. The detailed signal characteristics of the lesions are shown in Table 2.

The MRI examinations revealed peri-lesional soft tissue edema in seven patients (46.7%), and in two patients (13.3%), there was muscular edema consistent with muscle contusion/strain associated with Morel Lavallee lesion. However, none of the patients had accompanying traumatic bone lesion. Figures 2-6 demonstrate several MLL in our study cohort.

Treatment and Follow-up

Six patients (40%) underwent an operation and total removal or decompression was accomplished in all of them. Three patients (20%) underwent percutaneous aspiration, and in one of them, intralesional cortisone injection was additionally performed. Remaining six patients (40%) were followed conservatively. All patients had a follow-up from two months to four months. All nine patients who had surgical and percutaneous treatment showed no recurrence at two months after treatment. Among the six patients who had conservative treatment, the smaller residual lesion was found in two patients at two months after treatment, followed by four other patients without residual lesion. Fortunately, both two patients sustaining residual lesion were free of a lesion at four months follow-up.

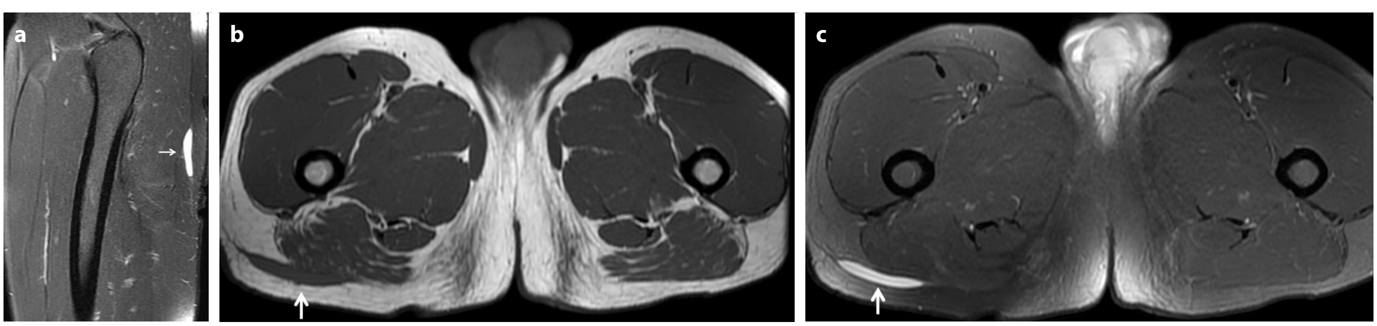

Figure 2. Case No 7: **(a)** Sagittal fat-suppressed FSE PD, **(b)** axial FSE T1, **(c)** axial fat-suppressed FSE PD images. A crescentic collection with homogeneous fluid signal adjacent to deep fascia located posteriorly to the proximal thigh on the right (arrows).

Figure 3. Case No 1: **(a)** Sagittal fat-suppressed FSE PD, **(b)** Sagittal FSE T1, **(c)** Axial fat-suppressed FSE PD, **(d)** Axial FSE T2 weighted images showing a fluid-fluid levelling collection with high T1 signal property, including internal debris, and surrounded by pseudocapsules in prepatellar area of the right knee (arrows).

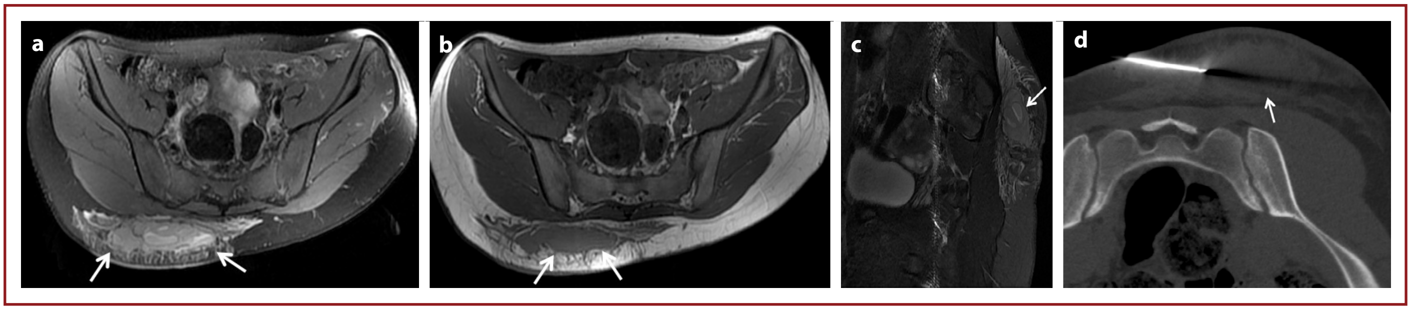

Figure 4. Case No 5: **(a)** Axial fat-suppressed FSE PD, **(b)** axial FSE T1, **(c)** sagittal fat-suppressed FSE T2 weighted images showing a heterogenous fusiform collection (slightly hyperintense compared to the muscle on T1 weighted image) with peripheral edema at the right gluteal region in association with deep fascia (white arrows). **(d)** Axial CT image showing thick spinal needle (black arrow) for the CT guided percutaneous aspiration procedure of the lesion (white arrow).

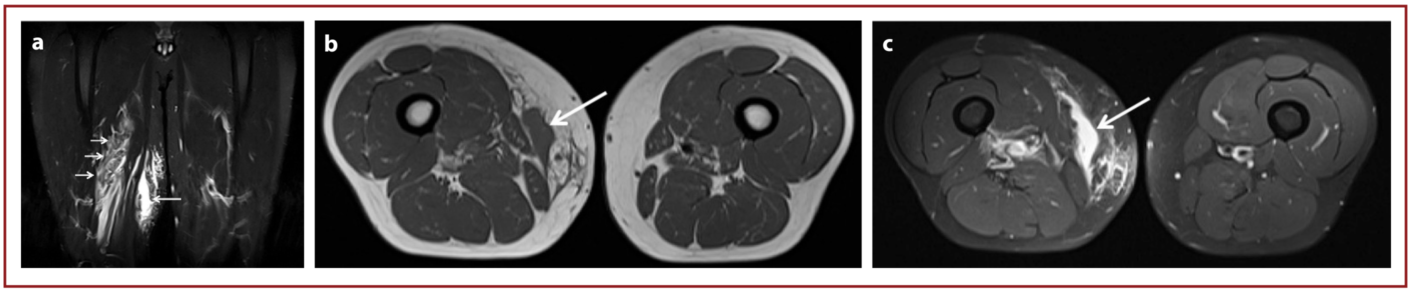

Figure 5. Case No 12: **(a)** Coronal fat-suppressed FSE PD, **(b)** axial FSE T1 and **(c)** axial fat-suppressed FSE PD weighted images showing a water-like signal collection and surrounding edema in the medial aspect of the right thigh adjacent to the deep fasia (long arrows) and associated adductor magnus muscle strain (short arrows in a and c).

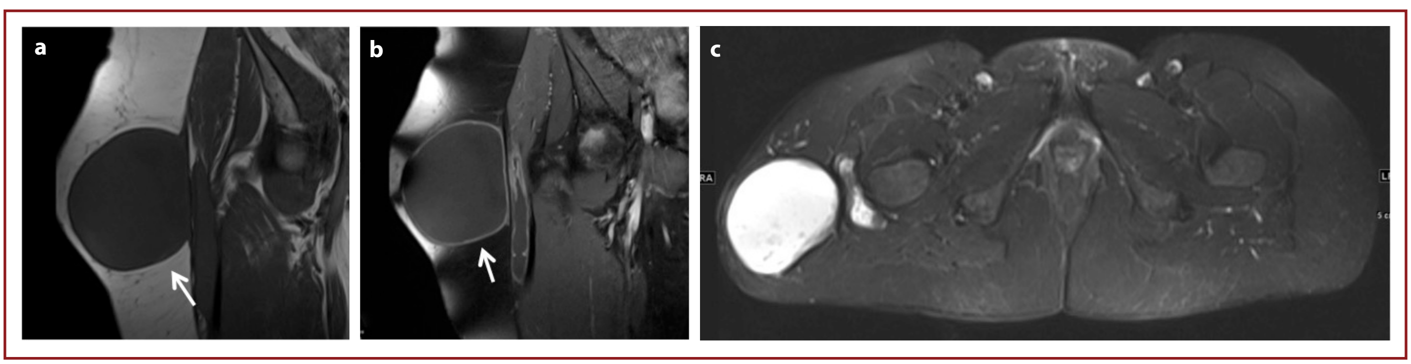

Figure 6. Case No 10: **(a)** Coronal FSE T1, **(b)** coronal contrast-enhanced fat-suppressed FSE T1weighted and **(c)** axial STIR images showing a chronic Morel-Lavellee lesion at the right trochanteric region. A spherical collection of seroma with homogenous internal fluid signal intensity surrounded by pseudocapsule (arrows).

Discussion

MLL was first described by Maurice Morel Lavallée in 1853. The primary mechanism is commonly a severe direct trauma with tangential impact resulting in shearing of hypodermis from underlying deep fascia, which is named as degloving injury. This potential space eventually filled with blood, lymph, and necrotic fat and surrounded by a fibrous pseudocapsule, in which granulation tissue may become organized (Fig. 1). Pseudocapsule prevents the absorption of the contained fluid remaining for a long time after injury[1,2]. Although MLL is most commonly seen in the trochanteric and proximal thigh region, it has been reported at multiple locations, including head, abdominal wall, pelvis, lumbosacral and gluteal region, thigh, knee, and calf[1,2]. In the current study, all of the lesions were located at the knee level or above, the mostly trochanteric region (33.3%).

The diagnosis is mainly depends on detection of the fluctuant area on psychical examination with a combination of imaging modalities. Imaging plays a major role in the

Table 3. Differential diagnosis of MLL

Differential Diagnosis	Findings
Fat necrosis	• Usually seen over tibia and gluteal region • On MRI: linear hyperintensities within
Coagulopathy related hematoma	• History and clotting parameters assessment
Soft tissue tumour (sarcoma)	• Lack of history of trauma • Progressive painful enlargement • Contrast enhancement
Tubercular cold abscess	• Develops slowly • Grows to huge sizes • No manifestation of inflammatory features

detection of MLL, delineating morphologic features and lesion characterization. Ultrasonography[5], CT[6] and MRI are the main radiological tools for the diagnosis.

MRI is the first-line diagnostic modality in demonstrating the internal properties of the lesion. However, MRI findings are not always specific, and one should be kept in mind that the presence of a pseudocapsule may delay the presentation, and image properties may vary depending on the age and the content of the lesion[3,4].

Acute stage (immediate or days after the trauma) MLL is a result of the pooling of blood and lymph fluid after the trauma into the gap between the subcutaneous fatty tissue and the adjacent deep fascia[4,8]. The acute presentation includes an ecchymotic soft fluctuant area of variable size, skin hypermobility, soft-tissue swelling, abrasions, local contusions and hypoesthesia near the traumatic site[7-10]. MRI signal characteristic is similar to the acute hematoma signal properties[4,11,12]. In seven of the cases (46,6%), we commenced an MRI examination within one week after the initial traumatic event, which might have lead MLL. Therefore, one might assume that MLL lesions in these cases could be classified as acute lesions. Among these seven patients, five patients had MLL lesions (71.4%) with T1W hypointense and T2W hyperintense signal characteristics. One patient had a lesion with T1W and TW2 hyperintensity and one patient had a lesion with T1W and TW2 hyperintensity. All but one of these MLL lesions (85.7%) had heterogeneous signal intensity. By the time and the growing of the lesions, substantially reabsorption of the blood and its replacement by a serosanguinous fluid happens. The lesion is covered with an elastic capsule[4]. As it was in our study, in nine cases, pseudo capsules were observed.

In the chronic stage (initial days or a week after the trauma), MLL may decrease in size, remain stable or enlarge slowly. If enlarges, due to being painful and firm, this may lead to a misdiagnosis of a soft tissue tumor. In this stage, increased intralesional water may lead lesions to show homogeneously hypointensity on T1WI and hyperintensity on T2WI. Also, they are partially encapsulated by a peripheral ring that is hypointense on all pulse sequences[4,10,13]. In the present work, among eight lesions in the chronic stage, five lesions (62,5%) had hypointensity on T1WI and hyperintensity on T2WI. However, MLL might show homogeneous hyperintensity on both T1- and T2-WI with a hypointense peripheral ring in the chronic stage, which is mainly closely related to the ratio of the methemoglobin in the lesion[14]. In our study, three of the eight lesions had the aforementioned signal characteristics. Also, chronic MLL may have a third MRI pattern, with variable T1WI signal properties and T2 heterogeneous hyperintensity accompanied with hypointense peripheral ring. According to lesion shape, signal and enhancement characteristics, Mellado et al.[14] described an MRI classification system for MLL (Table 4).

Table 4. MRI classification of MLL

Types	Shape	Intensity (Appearance)	Intensity and Signal Chracteristics	Capsule
I	laminar	Fluid	Decreased T1, increased T2 signal	Yes, but not enhance
II	oval	subacute haematoma	Increased T1 and T2 signal	Thick capsule with variable enhancement
III	oval	chronic organizing haematoma	Intermediate T1 and heterogeneous T2 signal	Thick capsule with internal/peripheral enhancement
IV	linear	closed laceration	hypointense T1 signal and hyperintense T2 signal	No capsule and variable enhancement
V	round	pseudonodular	variable T1 and T2 signal	thin or thick capsule with internal/peripheral enhancement
VI		infected	variable T1 and T2 signal	variable sinus tract formation thick capsule and internal/peripheral enhancement

Because MLL may become a focus for infection, pseudocyst formation, and cause adjacent tissue necrosis from local mass effect, an aggressive management should be considered in treatment[17]. On the other hand, due to a minor risk of the iatrogenic injury to the remaining subcutaneous vascular supply and overall cosmesis improvement, non-invasive methods, such as percutaneous aspirations and suction drainage, play a significant role in treatment[18,19]. Small lesions may need less invasive methods like aspiration with compression bandaging[20], while larger lesions often require open drainage and healing by secondary intention[3]. Talc, doxycycline, alcohol or cortisone injections after seroma aspiration are other options which can be used in refractory cases[21].

The major limitation of our study was none of the lesion was pathologically proven MLL. However, we believe that clinical data in addition to surgical findings were adequate for this kind of retrospective case control study.

In conclusion, in the present study, more than half of the MLLs were located proximal to the knee region and are often at the trochanteric area. In presence of a history of trauma and a subcutaneous cresentic or fusiform encapsulated lesion in association with deep fascia, MLL should be considered. We suggest that MRI is the most best imaging modality to characterize MLL, especially for chronic stage that could be misdiagnosed as cystic neoplasm. Early diagnosis is significant in choosing appropriate treatment and preventing late complications, such as chronic pain or infection.

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