Morel-Lavallee lesion in children
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Abstract
Morel-Lavallee lesion (MLL) is a closed degloving injury resulting from blunt shearing or tangential forces. In this condition, hemolymph is collected in the closed space between the separated subcutaneous tissue and the underlying fascia. The clinical manifestation of MLL varies from soft fluctuant swelling to skin necrosis or wound sepsis. Due to its inconsistent clinical manifestations and delayed onset, it is rarely described. We present a case of a 28-month-old child who developed delayed MLL arising from pelvic fracture after a motor vehicle accident. In addition, we provide a review of MLL and describe rare cases of it in children.

Keywords: Morel-Lavallee lesion, Closed degloving injury, Children

Introduction
Morel-Lavallee lesion (MLL) is a closed, soft-tissue degloving injury that is accompanied by disruption of perforating vessels and lymphatics. It occurs as a result of blunt shearing or tangential forces that separate the mobile subcutaneous tissue from the immobile underlying fascia. In this disorder, hemolymphatic collection is formed in the closed space between the two detached layers [1,2]. The diagnosis of MLL is routinely made based on clinical and radiological examination [3,4]. In 1/3 of cases, there is a possibility that clinicians might fail to diagnose MLL due to its inconsistent clinical manifestations and because it often involves initial skin bruising due to underlying soft tissue injury [2,5-7].

We present a case of delayed MLL arising from pelvic fracture caused by a motor vehicle accident. Based on the available literature, this case involves the youngest individual yet reported to suffer from delayed MLL. In addition, we provide a review of MLL and describe rare cases of the disorder in children.

Presentation
A 28-month-old child was presented to the department of emergency medicine of our medical institution following a traffic accident. The patient had no history of neonatal injury or developmental abnormality and had stable vital signs and no neurologic symptoms. On physical examination, the patient had mild swelling and tenderness in the right inguinal region but no tenderness or rebound tenderness in the abdomen. Moreover, the patient had a perineal laceration and slight bleeding. The range of motion (ROM) of both hip and knee joints was within the normal range. Initial laboratory examination showed a hemoglobin level of 11.7 and a hematocrit of 35.1. Initial radiographs revealed the presence of a fracture of the left anterior superior iliac spine as well as fractures of the right superior and inferior pubic rami. Computed tomography (CT) scans showed that the patient had a hematoma in the paravesical, prevesical retroperitoneum and subcutaneous emphysema in the left pelvic region (Figure 1). The patient received conservative management, including absolute bed rest and pain control, at the department of orthopedic surgery of our medical institution. On day 3, the patient’s hemoglobin and hematocrit levels had decreased to 6.8 and 20.2, respectively. In addition, the patient showed an increase in the amount of retroperitoneal hematoma on follow-up CT scans. Although this finding might have been due to preexisting pelvic fractures, the patient showed no other internal organ damage and continually received conservative management after transfusion with 2 pints of packed red blood cells (RBCs). On day 4, the patient exhibited darkish skin color changes and necrosis in the left gluteal region (Figure 2). At this point, the patient was referred to us for further evaluation and treatment. The patient was suspected of having MLL, for which we followed conservative management with silvadene occlusive dressing until a demarcation of necrotic
skin was achieved. On day 9, although the patient showed a decrease in the amount of retroperitoneal hematoma on follow-up CT scans, hematoma or fluid collection was identified in the space between the subcutaneous area and the fascia. Based on these findings, we established a diagnosis of MLL in our patient (Figure 3). On day 10, the patient displayed a necrotic skin demarcation indicating the boundary between the necrotic and viable areas. The patient underwent partial escharectomy, which resulted in natural drainage of the subcutaneous fluid. The fluid was serous and did not show any signs of infection. On day 13, the patient underwent debridement of a thick eschar 12 × 10 cm in size (Figure 4) under general anesthesia accompanied by the application of a vacuum-assisted closure (VAC) device for the purpose of promoting the growth of healthy granulation tissue. These maneuvers were repeated three times until day 23. Thus, the patient achieved resolution of the pocket under the wound margin as well as formation of healthy granulation tissue. On day 24, the
patient underwent a split-thickness skin graft (STSG), through which successful coverage of the skin defect was achieved. At 6-month follow-up, the patient displayed complete cure of the wound without recurrence of fluid collection (Figure 5). In addition, the patient also achieved radiologic union of the pelvic bone and was able to resume daily activities.

Discussion

MLL was first reported in 1863 by the French physician Maurice Morel-Lavallee, who described it as a post-traumatic collection of fluid due to soft tissue injury [8]. MLL was initially used to refer to injuries involving the trochanteric region and proximal thigh. In recent years, however, the term has been used to describe lesions with similar pathophysiology in various anatomical locations, including the hip and thigh [5,6,9]. MLL commonly occurs as a result of peri-pelvic fracture due to high-impact trauma. However, it may also result from a low-velocity crush injury that occurs during sports activities such as football or wrestling [6,9,10]. The clinical features of MLL vary depending on the amount of blood and lymphatic fluid collected at the site of injury and on the time elapsed since the injury. Moreover, MLL may also concurrently present with symptoms such as soft tissue swelling, contour deformity, palpable bulge, skin hyper mobility and decreased cutaneous sensation [6,7]. Furthermore, the presence of a soft fluctuant area due to fluid collection is a hallmark of its physical findings [3,4].

The symptoms of MLL are frequently manifested within a few hours or days following the onset of trauma. In up to 1/3 of total cases, however, symptoms may occur several months or years following the onset of injury. This strongly suggests that obtaining a meticulous history of the patient is essential for making an accurate diagnosis of MLL [2,5-7].

A diagnosis of MLL can be established based on imaging studies of the suspected sites and by physical examination. On radiological examination, it is characterized by the presence of a non-specific, non-calcified soft tissue mass [11,12]. On ultrasonography, it is characterized by hyperechoic (blood-predominant) or anechoic (lymph-predominant) fluid collection depending on the age of the lesion and its predominant content. Acute and subacute lesions less than 1 month old show a heterogeneous appearance with irregular margins and lobular shape. In addition, both chronic lesions and lesions older than 18 months show a homogenous appearance with smooth margins and flat or fusiform shape [12,13]. On CT and magnetic resonance imaging (MRI) scans, MLL lesions are well visualized as well-defined encapsulated fluid collections with fluid-fluid levels. On MRI scans, however, the lesions are better visualized with soft-tissue contrast enhancement. Therefore, MRI is a better choice of imaging modality than CT in making a diagnosis of MLL [12,14]. Based on T1- and T2-weighted MRI scans, MLL can be classified into six types. In addition, the age of the blood within the lesion is a key factor in making an accurate diagnosis of MLL [14-16].

Although various strategies for the treatment of MLL have been reported, including the application of compression bandages, percutaneous aspiration and drainage, open debridement and sclerodhesis, there are no established treatment modalities for patients with MLL [4,9,12,16-33]. Conservative management such as compression bandage application, NSAID medication, physiotherapy and absolute bed rest are considered the first-line treatment regimen in patients with acute, small lesions without underlying fractures. Of these, the compression bandage can be used to supplement other treatment options [4,9,12,16,20,22,28]. Percutaneous drainage can be used to manage larger acute lesions that cannot be resolved with a single application of compression bandages. It may also be attempted along with sclerotherapy as a first-line therapy in patients with chronic lesions [17,24,26,31]. Talc sclerotherapy was introduced by Luria et al. [23] in 2007. Since then, various methods of sclerodhesis, including some that involve the use of alcohol and doxycycline, have been reported. Sclerotherapy is performed by injection of sclerosant into the dead space; the sclerosant is allowed to remain for a few minutes, followed by percutaneous drainage. Sclerotherapy can be used as a first-line therapy in patients with acute lesions that are refractory to compression bandages and in patients with chronic lesions [18,23,25]. In patients with chronic lesions, percutaneous drainage may result in recurrent postoperative hematoma or secondary infection.
[30]. It is therefore mandatory to combine percutaneous drainage with sclerotherapy. In patients with acute lesions with underlying open fractures and in those with chronic lesions with evidence of infection or tissue necrosis due to a local mass effect, open debridement can be attempted as a first-line therapy. Open debridement may also be considered as the final therapy in patients who are refractory to percutaneous drainage with sclerotherapy [19,21,27,29,30,32,33]. Surgical intervention is also indicated in patients with longstanding MLL with pseudocapsule because they are unresponsive to percutaneous drainage and therefore vulnerable to recurrence [11,27,32,33]. The use of synthetic glue and the quilting suture technique after removal of the fibrous capsule have also been reported to prevent fluid collection in the dead space [1,33-36].

Based on a review of the literature, MLL occurs predominantly in patients in their 30s-40s. To our knowledge, only rare cases of MLL occur in children (Table 1). Letts [37] reviewed 16 pediatric cases of degloving injuries and analyzed the causes and sites of injury. This author classified degloving injuries into those involving anatomical degloving (gloving injuries with skin surface disruption) and those involving physiological degloving (degloving injuries with disruption of the underlying skin vasculature without skin surface disruption). Six of the studied patients suffered from physiologic degloving injuries due to train or motor vehicle accidents involving the leg, buttock and back; the mean age of these six patients was 11 years (range, 6–14 years). All six patients, most of whom received defatted skin grafts, had a concurrent anatomical degloving injury. Harma et al. [22] reported five pediatric cases of MLL, of which two were due to automobile crashes. These authors treated a 6-year-old patient with conservative management and a 14-year-old patient with debridement and local flap coverage. In addition, Mukherjee et al. [12] reported a case of MLL in a 14-year-old boy who presented with a soft tissue mass on the right greater trochanter. For this patient, no data were available concerning a possible past history of shearing injury. The patient had no abrasions or bruises on initial physical examination, and MLL was therefore not considered in the initial diagnosis. For this reason, the patient initially received conservative management only for the pelvic fracture. Moreover, this patient displayed no fluid collection other than the retroperitoneal hematoma detected on CT scans on admission and on day 3. This patient therefore posed a diagnostic challenge. On day 4, the patient presented with skin color change with swelling and fluctuation. This led to the speculation that not only did fluid collection occur as a result of persistent bleeding from the pelvic fracture in the dead space caused by detachment after the onset of initial shearing injury but also that the resulting mass effect led to the occurrence of skin necrosis.

Pediatric cases of MLL are characterized by the relatively high vulnerability of young patients to trauma. It is also noteworthy that the diagnosis of MLL is often delayed in very young patients, for whom history taking regarding shearing injury and the duration of symptoms is often difficult [12,17,22,38]. It is therefore mandatory to carefully examine the patient for external wounds, bruises, swelling, fluctuation, hypermobility of skin and other clues, such as a tire mark, that may be evidence of shearing injury by exposing the patient from head to toe [37]. Even in patients who initially present immediately after the onset of injury with no symptoms,
Table 1 A summary of reported cases of MLL in children

| Patient | Age/sex | Etiology | Site | Duration from injury to development of symptom | Symptoms and sign | Associated fracture | Associated condition | Treatment | Complication | Reference |
|---------|---------|----------|------|-----------------------------------------------|------------------|---------------------|---------------------|-----------|--------------|----------|
| 1       | 6/M     | Crush under automible | Lateral lumbar | Unknown | Pelvic fracture | Bladder neck rupture | Conservative treatments | (−) | Harma et al. [22] |
| 2       | 14/M    | Crush under automible | Lumbo-sacral | Unknown | Pelvic, femur fracture | Perianal soft tissue injury | Debridement and local flap | Sacral decubitus ulcer | Harma et al. [22] |
| 3       | 14/M    | Unknown | R greater trochanter | Unknown | Swelling, discomfort, soft tissue mass | (−) | (−) | Elastic compression bandage | (−) | Mukherjee et al. [12] |
| 4       | 13/M    | Motorvehicle collision | R hip | Immediate | L ulnar fracture, R knee subluxation | L knee laceration, L hand degloving injury | Debridement and dead space closure | Carlson et al. [19] |
| 5       | 13/M    | Motorvehicle collision | Presacral | Immediate | R iliac wing, bilateral anterior ramus, femur, R tibia, fibular fracture | L pulmonary contusion | Debridement and dead space closure | Carlson et al. [19] |
| 6       | 12/M    | ATV accident | L thigh | 2 wks | Swelling, blister | | | Aspiration and sclerodesis with Sotradecol foam injection and doxycycline | (−) | Choudhary et al. [38] |
| 7       | 11/M    | Football | L knee | 2 wks | Pain, bruise, open blister, nonfluctuant mass | | | Compressive dressing and physical therapy | (−) | Anakweze et al. [17] |
| 8       | 14/M    | Blunt trauma | Lumbar area | 2 hrs | Voluminous swelling, bruising | | | Open drainage | (−) | Efrimescu et al. [21] |

Abbreviations: R right, L left, wks weeks, hrs hours.
it is necessary to perform a follow-up physical examination and imaging studies. This is essential for the identification of delayed lesion development. When children and adults are subjected to blunt trauma of the same width, children are vulnerable to higher shock per unit area. It can therefore be inferred not only that children are more vulnerable to developing multiple organ damage due to MLL but also that they are at increased risk of developing fractures or deep organ injuries due to the incomplete development of their musculoskeletal systems. Moreover, children have a relative lack of the shock-absorbing function due to the incomplete development of subcutaneous fat [39]. It can therefore be inferred that pediatric cases of MLL might lead to severe degloving injuries. Furthermore, due to their lower volume of blood, children are vulnerable to hypovolemic shock due to bleeding as well as to skin necrosis due to an abrupt mass effect arising from the collection of internal bleeding in the dead space. Such children should be promptly treated immediately after being diagnosed with MLL.

Conclusions
MLL is a collection of hemolymph resulting from a closed degloving injury. Its diagnosis and treatment are often delayed because it involves internal degloving without surface penetration. Diagnosis of MLL can be made based on clinical and radiological examination. A number of treatment modalities, ranging from conservative management to open debridement, can be attempted for patients with MLL. However, there are no established case-specific treatment regimens for patients with MLL. Although rare, pediatric cases of MLL deserve special attention. This is true not only because MLL in children may pose a diagnostic challenge due to possible difficulties in determining whether there is a past history of shearing injury but also because MLL in children is associated with an increased frequency of fatal complications compared to MLL in adults. Clinicians should therefore include MLL in the differential diagnosis of patients with trauma, even in the absence of a past history of shearing injury. Moreover, clinicians should also perform both physical examinations and imaging studies in establishing a diagnosis of MLL in children.

Consent
Written informed consent was obtained from the patient for publication of this case report and the accompanying images.

Competing interests
The authors declare that they have no competing interests.

Authors’ contributions
All of the authors were involved in the preparation of this manuscript. EYR wrote the manuscript and reviewed the literature. DHK assisted in the surgery and contributed to the literature search. HK participated in the clinical and surgical management of the patient. S-NI participated in the conception and design of the study and operated on the patient. All of the authors read and approved the final manuscript.

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Received: 8 November 2013 Accepted: 26 December 2013
Published: 30 December 2013

References
1. Kalaci A, Karazincir S, Yanat AN: Long-standing morel-lavalle lesion of the thigh simulating a neoplasm. Clin Imaging 2007, 31:287–291.
2. Bonilla-Yoon I, Marish S, Patel DB, White EA, Levine BD, Chow K, Gottesgern CJ, Matsuk GR Jr: The morel-lavalle lesion: pathophysiology, clinical presentation, imaging features, and treatment options. Emerg Radiol 2013, 20:1046–1051.
3. Shen C, Peng JP, Chen XD: Efficacy of treatment in peri-pelvic morel-lavalle lesion: a systematic review of the literature. Arch Orthop Trauma Surg 2013, 133:635–640.
4. van Gennip S, van Bokhoven SC, van den Eede E: Pain at the knee: the morel-lavalle lesion, a case series. Clin J Sport Med 2012, 22:153–156.
5. Hak DJ, Olson SA, Matta JM: Diagnosis and management of closed internal degloving injuries associated with pelvic and acetabular fractures: the morel-lavalle lesion. J Trauma 1997, 42:1046–1051.
6. Tejwani SG, Cohen SB, Bradley JP: Management of morel-lavalle lesion of the knee: twenty-seven cases in the national football league. Am J Sports Med 2007, 35:1162–1167.
7. DA Hudson KJ, Krije JE: Closed degloving injuries: results following conservative surgery. Plast Reconstr Surg 1992, 89:853–855.
8. Morel-Lavallée M: Décollements traumatiques de la peau et des couches sousjacentes. Arch Gen Med 1863, 1:20–38.
9. Parra JA, Fernandez MA, Encinas B, Rico M: Morel-lavalle effusions in the thigh. Skeletal Radiol 1997, 26:239–241.
10. Matava MJ, Ellis E, Shah NR, Pogue D, Williams T: Morel-lavalle lesion in a professional american football player. Am J Orthop (Belle Mead NJ) 2010, 39:144–147.
11. Mellado JM, Bencardino JT: Morel-lavalle lesion: review with emphasis on MR imaging. Magn Reson Imaging Clin N Am 2005, 13:775–782.
12. Mukherjee K, Pierrin SM, Hughes PM: Morel-lavalle lesion in an adolescent with ultrasound and MRI correlation. Skeletal Radiol 2007, 36(Suppl 1):S43–S45.
13. Neal C, Jacobson JA, Brandon C, Kalume-Brigido M, Morag Y, Grish G: Sonography of morel-lavalle lesions. J Ultrasound Med 2008, 27:1077–1081.
14. Mellado JM, Perez del Palomar L, Diaz L, Ramos A, Sauri A: Long-standing morel-lavalle lesions of the trochanteric region and proximal thigh: MRI features in five patients. AJR Am J Roentgenol 2004, 182:1289–1294.
15. Bontero CG, Maxwell N, Kavanagh E: MRI findings of prepatellar morel-lavalle effusions. Skeletal Radiol 2008, 37:451–455.
16. Moriarty JM, Bontero CG, Kavanagh EC: A rare cause of calf swelling: the morel-lavalle lesion. Jr J Med Sci 2011, 180:265–268.
17. Anakwenze OA, Trivedi V, Goodman AM, Ganley TJ: Concealed degloving injury (the morel-lavalle lesion) in childhood sports: a case report. J Bone Joint Surg Am 2011, 93:148.
18. Bansal A, Bhatia N, Singh A, Singh AK: Doxycycline sclerodesis as a treatment option for persistent morel-lavalle lesions. Injury 2013, 44:66–69.
19. Carlson DA, Simmons J, Sando W, Weber T, Clements B: Morel-lavalle lesions treated with debridement and meticulous dead space closure: surgical technique. J Orthop Trauma 2007, 21:140–144.
20. Ciaschini M, Sundaram M: Radiologic case study. Prepatellar morel-lavallee lesion. Orthopedics 2008, 31(626):719–721.
21. Efrimescu CI, McAndrew J, Bitzidis A: Acute lumbar morel-lavallee haematoma in a 14-year-old boy. Emerg Med J 2012, 29:433.
22. Harma A, Inan M, K E: The morel-lavallee lesion: a conservative approach to closed degloving injuries. Acts Orthop Traumatol Turc 2004, 38:270–273.
23. Luria S, Appilbaum Y, Weil Y, Liebergall M, Peyser A: Talc sclerodhesis of persistent morel-lavallee lesions (posttraumatic pseudocysts): case report of 4 patients. J Orthop Trauma 2006, 20:435–438.
24. Moran DE, Napier NA, Kavanagh EC: Lumbar morel-lavallee effusion. Spine J 2012, 12:1165–1166.
25. Penaud A, Quignon R, Danin A, Bahe L, Zakine G: Alcohol sclerodhesis: an innovative treatment for chronic morel-lavallee lesions. J Plast Reconstr Aesthet Surg 2011, 64:e262–e264.
26. Sawkar AA, Swischuk LE, Jadhav SP: Morel-lavallee seroma: a review of two cases in the lumbar region in the adolescent. Emerg Radiol 2011, 18:495–498.
27. Scaramella AM, Davanco RA: Pseudocyst formation after abdominal liposuction-extravasations of morel-lavallee on MR images. Br J Plast Surg 2005, 58:849–851.
28. Steiner CL, Trentz O, Labler L: Management of morel-lavallee lesion associated with pelvic and/or acetabular fractures. European J Trauma Emerg Surg 2008, 34:554–560.
29. Suzuki T, Morgan SJ, Smith WR, Stahel PF, Galliani SA, Hak DJ: Postoperative surgical site infection following acetabular fracture fixation. Injury 2010, 41:396–399.
30. Tran W, Foran J, Wang M, Schwartz A: Postsurgical bleeding following treatment of a chronic morel-lavallee lesion. Orthopedics 2008, 31:814.
31. Tseng S, Torretta P 3rd: Percutaneous management of morel-lavallee lesions. J Bone Joint Surg Am 2006, 88:92–98.
32. Yilmaz A, Yener O: Giant post-traumatic cyst after motorcycle injury: a case report with review of the pathogenesis. Prague Med Rep 2013, 114:123–127.
33. Zecha PJ, Missotten FE: Pseudocyst formation after abdominoplasty–extravasations of morel-lavallee. Br J Plast Surg 1999, 52:500–502.
34. Coulibaly NF, Sankale AA, Sy Mh, Kinkpa CV, Kasse AN, Diouf SA, Seye SL: Morel-lavallee lesion in orthopaedic surgery (nineteen cases). Ann Chir Plast Esthet 2011, 56:27–32.
35. Demrel M, Dereboy F, Ozturk A, Turhan E, Yazar T: Morel-lavallee lesion. Results of surgical drainage with the use of synthetic glue. Saudi Med J 2007, 28:65–67.
36. Vanhegan IS, Dala-Ali B, Verhelst L, Mallucci P, Haddad FS: The morel-lavallee lesion as a rare differential diagnosis for recalcitrant bursitis of the knee: case report and literature review. Case Rep Orthop 2012, 2012:93193.
37. Letts RW: Degloving injuries in children. J Pediatr Orthop 1986, 6:193–197.
38. Choudhary AK, Methratta S: Morel-lavallee lesion of the thigh: characteristic findings on US. Pediatr Radiol 2010, 40(Suppl 1):S49.
39. Lee KJ: Initial stabilization in severely injured child. J Korean Med Assoc 2008, 51:219–220.

doi:10.1186/1749-7922-8-60
Cite this article as: Rha et al.: Morel-lavallee lesion in children. World Journal of Emergency Surgery 2013 8:60.