Observational Study

Medicine®

OPEN

Laparoscopic drainage as a minimally invasive treatment for a psoas abscess

A single-center case series and literature review

Chang Hwa Hong, MD[a], Yong Cheol Hong, MD[a], Sang Ho Bae, MD[b], Myoung Won Son, MD[b], Sung Hun Won, MD[c], Aeli Ryu, MD[d], Chang Hyun Kim, MD[a], Hee Jun Chang, MD[a], Woo Jong Kim, MD[a,*]

Abstract

A psoas abscess is a rare but potentially devastating condition that is associated with risks of neurological deficits, septic shock, and even death. The current first-line treatment is percutaneous catheter drainage (PCD) under imaging guidance, combined with broad-spectrum antibiotics. Surgical drainage should be considered if PCD fails or is impossible.

Although many studies on PCD and open surgical drainage have appeared, the outcomes of laparoscopic drainage have rarely been reported. Thus, we laparoscopically drained the psoas abscesses of 6 patients; drainage was complete and we encountered no recurrence or complication. All patients were evaluated by plain radiography, contrast-enhanced computed tomography, and laboratory tests; all were followed-up for 1 year. Laparoscopic drainage is a good treatment option when PCD fails, affording all the advantages of open surgery (complete drainage, resection of infected tissue, and contermporaneous treatment of concomitant lesions). Also, laparoscopic drainage is minimally invasive, requires a smaller incision, and allows rapid recovery.

Abbreviations: BMI = body mass index, CRP = C-reactive protein, CT = computed-tomography, ESBL = extended-spectrum beta-lactamases, ESR = erythrocyte sedimentation rate, PCD = percutaneous catheter drainage, PLF = posterolateral fusion, PLIF = posterior lumbar interbody fusion, WBC = white blood cell.

Keywords: laparoscopic drainage, minimally invasive treatment, psoas abscess

1. Introduction

A psoas abscess is rare (the incidence is 0.4/100,000[1]) but may be devastating, placing patients at risk of neurological deficits, septic shock, and even death.[2] The common symptoms include fever, persistent back pain, and limitation of hip motion.[3–5] However, as the symptomatology varies and the clinical features are non-specific, diagnosis and effective management are frequently delayed.[6] A psoas abscess can be caused by lymphatic or hematological infective spread from a distant lesion but also by direct spread from a nearby infection.[7]

The current first-line treatment is broad-spectrum antibiotics combined with percutaneous catheter drainage (PCD) under imaging guidance, depending on the size of the abscess.[8–13] Surgical drainage should be considered in cases with a concomitant intra-abdominal disease that requires open surgical intervention, or if PCD is technically difficult because of abscess inaccessibility, a multi-loculated abscess cavity, diffuse phlegmonous muscle involvement, or very thick pus.[8–10,14–16] However, open surgical drainage is invasive, may trigger adhesions in surrounding tissue, and delays recovery. In contrast, laparoscopic drainage is minimally invasive, allows rapid recovery, and does not require the use of radiation.[17–19] Although many reports on computed-tomography (CT)-guided PCD and open surgical drainage have appeared, the outcomes and clinical characteristics of patients undergoing laparoscopic drainage have received little attention.[17,20] We laparoscopically drained 6 psoas abscesses; no patient required an additional procedure or secondary surgery. We hypothesized that laparoscopic drainage might afford good clinical outcomes. We here present the clinical outcomes and efficacy of such drainage.

2. Materials and methods

This was a retrospective, case-controlled observational study. This study was approved by the institutional review board of Soonchunhyang University Hospital (IRB no. 2019–04–040). The requirement for informed patient consent was waived

Editor: Leyi Wang.

CHH and YCH contributed equally to this study and should be considered co-first authors.

No benefit in any form has or will be received from a commercial party related directly or indirectly to the subject of this article.

All data are included in the article.

This study was approved by the institutional review board of Soonchunhyang University Hospital (IRB no. 2019-04-040).

The authors have no conflicts of interests to disclose.

All data generated or analyzed during this study are included in this published article [and its supplementary information files]

[a] Department of Orthopaedic Surgery, [b] Department of Surgery, Soonchunhyang University Hospital Cheonan, Dongnam-gu, Cheonan, [c] Department of Orthopaedic Surgery, Soonchunhyang University Hospital Seoul, Yongsan-gu, Seoul, [d] Department of Obstetrics and Gynecology, Soonchunhyang University Hospital Cheonan, Suncheonhyang 6-gil, Dongam-gu, Cheonan, Korea.

[*] Correspondence: Woo Jong Kim, Department of Orthopaedic Surgery, Soonchunhyang University Hospital Cheonan, 31, Suncheonhyang 6-gil, Dongam-gu, Cheonan 31151, Korea (e-mail: kwj9383@hanmail.net).

How to cite this article: Hong CH, Hong YC, Bae SH, Son MW, Won SH, Ryu A, Kim CH, Chang HJ, Kim WJ. Laparoscopic drainage as a minimally invasive treatment for a psoas abscess: a single-center case series and literature review. Medicine 2020;99:14(e19640).

Received: 25 November 2019 / Received in final form: 11 February 2020 / Accepted: 25 February 2020

http://dx.doi.org/10.1097/MD.0000000000019640

because of the retrospective nature of the study. We retrospectively evaluated 6 patients who underwent laparoscopic drainage of psoas abscesses in our institute between January 2015 and December 2017. Each case was individually reviewed and the diagnosis confirmed by the attending surgeon and an infectious diseases physician. All patients were evaluated by plain radiography and contrast-enhanced CT both pre- and postoperatively. At baseline, we recorded sex, age, any comorbidity, and any previous treatment. We noted all symptoms or signs (fever, flank pain, hip flexion contracture, localized swelling, redness, and a sense of heating); the white blood cell (WBC) count; the erythrocyte sedimentation rate (ESR); the C-reactive protein (CRP) level; wound culture results; and the causative organisms.

2.1. Surgical techniques

Under general anesthesia, each patient was prepared in the supine position and a 12-mm-diameter subumbilical trocar was inserted into the abdominal cavity and insufflated with carbon dioxide to a pressure of 12 mm Hg. Under direct visualization, 2 additional, 5-mm-diameter working trocars were inserted into the left and right lower quadrants, respectively, forming a triangle. After carefully stripping the peritoneum from the abdominal wall, avoiding injury to the bladder or iliac vessels, the psoas muscle became visible and a small incision was made in a thin portion of the abscess wall via laparoscopic electrocautery (Fig. 1). After collection of some of the abscess for microbial culture, massive irrigation and debridement of granulation tissue followed. A 5-mm-diameter, closed suction drain was inserted into the abscess cavity. The drain remained in place for about 1 week and was removed when pus drainage ceased.

2.2. After surgery

Postoperative CT was routinely performed on postoperative day 3 to explore the status of any residual abscess and the drain position. Intravenous antibiotic therapy was empirically initiated prior to surgery, and continued, using tailored antibiotics, after the causative strain had been identified microbiologically. After

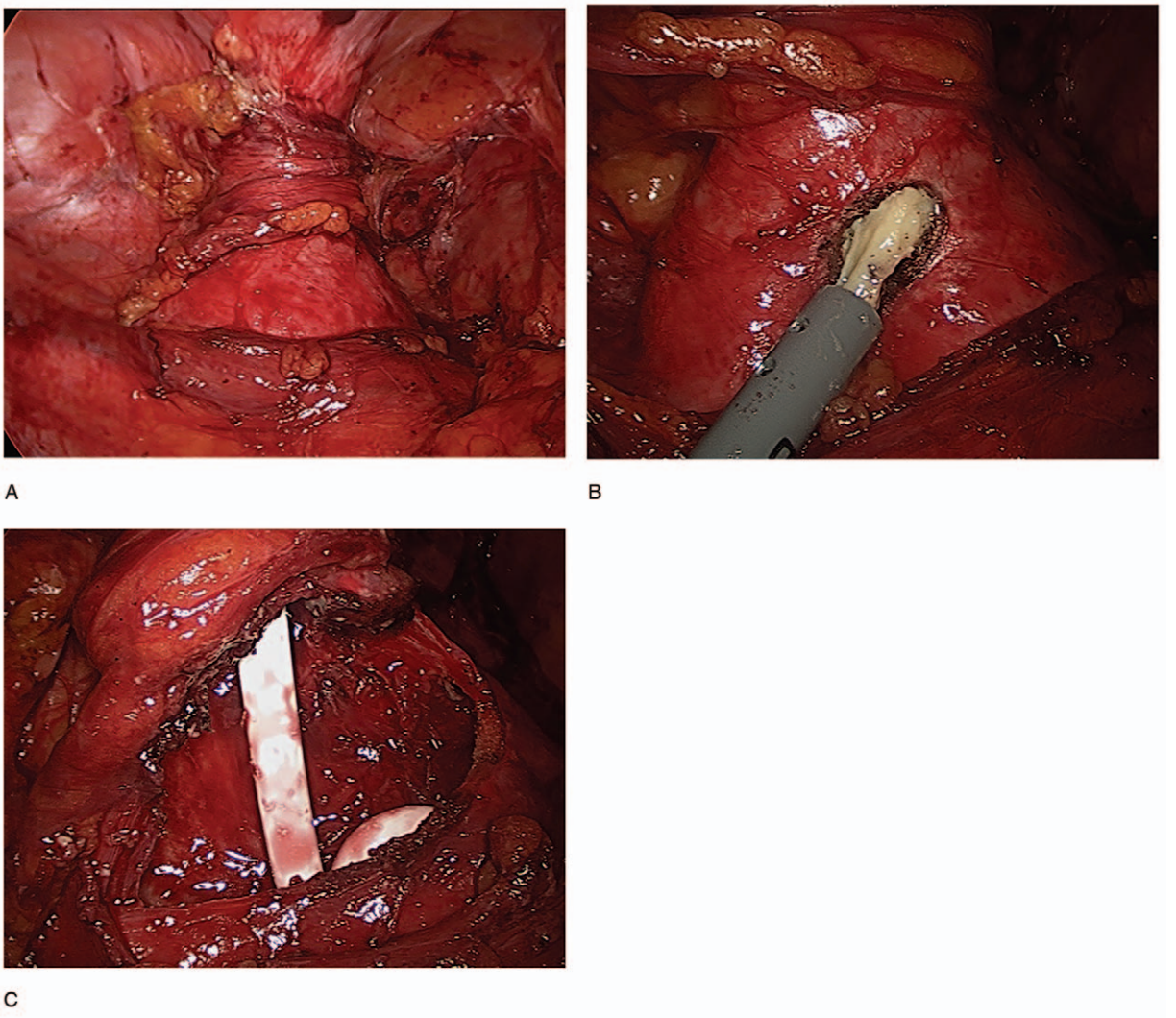

Figure 1. Laparoscopic finding shows (A) a psoas abscess with granulation tissue, (B) incision on psoas abscess for laparoscopic drainage and (C) drain placement into abscess cavity.

Table 1

Summary of patient characteristics and demographics.

Patient No. Sex/Age	1 F/85	2 F/79	3 M/42	4 F/74	5 F/55	6 F/87
Chief complaint	Lower back pain and fever for 2 weeks	Lower back pain and intermittent fever for 6 days	Lower back pain and radiating pain for 3 months	Lower back pain and fever for 2 weeks	Right flank pain and hip flexion contracture	Bilateral flank pain
Past medical history	HTN, untreated DM	Chronic pulmonary embolism, HTN	Chronic tuberculous prostatitis	Angina, HTN, DM	HTN, dyslipidemia	HTN
Previous Spine surgery	none	Kyphoplasty for compression Fx. L1 & L5	none	none	Posterior lumbar interbody fusion L4–5	Posterolateral fusion L2–5 for burst Fx. L3
Previous treatment	Empirical intravenous ciprofloxacin	none	PCD and anti-tuberculous medication	PCD and antibiotic therapy	PCD and antibiotic therapy	none
leukocyte	19,080/μl	11,410/μl	7,690/μl	9,290/μl	10,250/μl	8,990/μl
ESR	104 mm/h	106 mm/h	16 mm/h	61 mm/h	115 mm/h	86 mm/h
CRP	84.8 mg/L	246.50 mg/L	3.79 mg/L	86.01 mg/L	94.68 mg/L	22.12 mg/L
Diagnosis	Primary psoas abscess with multilocular abscess pocket on left side of L3–5	Subsequent unilocular psoas abscess after kyphoplasty on right side of L4–5	Tuberculous spondylodiscitis L4–5 with right psoas abscess	Bilateral multilocular psoas abscess with gas inclusions on L3–5 area	Right side unilocular psoas abscess with discitis & vertebral osteomyelitis L4–5	Bilateral multilevel, multilocular psoas abscess
Microbiological culture result	No growth	Staphylococcus epidermidis	Mycobacterial tuberculosis	ESBL	MRSA	No growth
Tailored antibiotics	Same as before surgery	Intravenous piperacillin-tazobactam	Antituberculous medication (Isoniazid, Rifampin, Ethamputol)	Intravenous vancomycin and meropenem	Intravenous vancomycin	Intravenous cefazolin
Follow-up duration	1 year	1 year	1 year	1 year	1 year	1 year
Abscess recurrence	No recurrence	No recurrence	No recurrence	No recurrence	No recurrence	No recurrence

Laboratory normal range: leukocyte count (4000–10,800/μl), ESR (0–30 mm/h), CRP (0.0–5.0 mg/L).
CRP = C-reactive protein, ESBL = extended-spectrum beta-lactamases, ESR = erythrocyte sedimentation rate, F = female, M = male, MRSA = methicillin-resistant staphylococcus aureus, PCD = percutaneous catheter drainage.

the symptoms had been alleviated and the levels of inflammatory hematological markers became normalized, patients were discharged on ongoing oral antibiotics. Outpatient follow-up was performed at 1, 3, 6, and 12 months after discharge. CT scans, plain radiographs, and blood tests were performed to assess recovery/recurrence status.

3. Results

Patient baseline characteristics and demographics are summarized in Table 1. We treated 3 males and 3 females of mean age 70 years (range 42–87 years). The average preoperative laboratory findings (the WBC, the ESR, and the CRP level) were 9620/μl, 81.33 mm/hour and 89.65 mg/L, respectively. WBC and CRP levels increased in all but 1 patient, who developed a secondary tuberculous psoas abscess. All patients initially complained of back or flank pain, and all but 2 complained of high fever (over 38°C). Three of the 6 patients had undergone prior spinal surgery [kyphoplasty, posterior lumbar interbody fusion (PLIF), and posterolateral fusion (PLF)] but the other 3 had not. Primary CT-guided percutaneous drainage was attempted in 3 cases but failed. In the other 3 cases, we preferred primary laparoscopic drainage because the psoas abscesses were bilateral or multi-loculated, and the patients were not in good condition. Causative strains were identified in only 4 cases; in the other 2 cases, the empirical antibiotics were continued on the advice of an infectious diseases physician. We found no evidence of abscess recurrence at the 1-year follow-up.

3.1. Case 1

The patient was an 85-year-old female with fever and lower back pain of 2 weeks duration. The local clinic found no specific fever focus but empirical ntravenous ciprofloxacin had been prescribed for 1 week. When the symptoms did not improve, the patient was referred to our hospital. She was clearly ill and complained of progressive back pain. Her temperature was within the normal range but the laboratory found elevations in the levels of inflammatory markers: WBC 19,080/μl, ESR 104 mm/hour, and CRP level 84.8 mg/L. Contrast-enhanced CT revealed a homogenous, minimally attenuating multilocular abscess exhibiting peripheral rim enhancement in the left psoas muscle in the L3–5 area (Fig. 2A). We performed laparoscopic drainage. The postoperative CT scan obtained 3 days later showed that drainage was adequate and that the drain was well-positioned (Fig. 2B). No causative organism was identified; we continued the empirical antibiotics. The patient was discharged after 1 month when her symptoms resolved and the inflammatory marker levels normalized.

3.2. Case 2

A 79-year-old female who had undergone kyphoplasty to successfully treat a compression fracture of L1/L5, and had been discharged when well, presented to our clinic once more. She complained of intermittent high fever and focal tenderness on palpation of the lower back. Lumbar spine mobility was markedly decreased by the severe pain. She was re-admitted 6 days after initial discharge. Her temperature was 38.2°C. The laboratory findings were: WBC 19,080/μl, ESR 104 mm/hour, and CRP level 84.8 mg/L. The plain radiograph revealed no specific interval change compared to the radiograph taken after

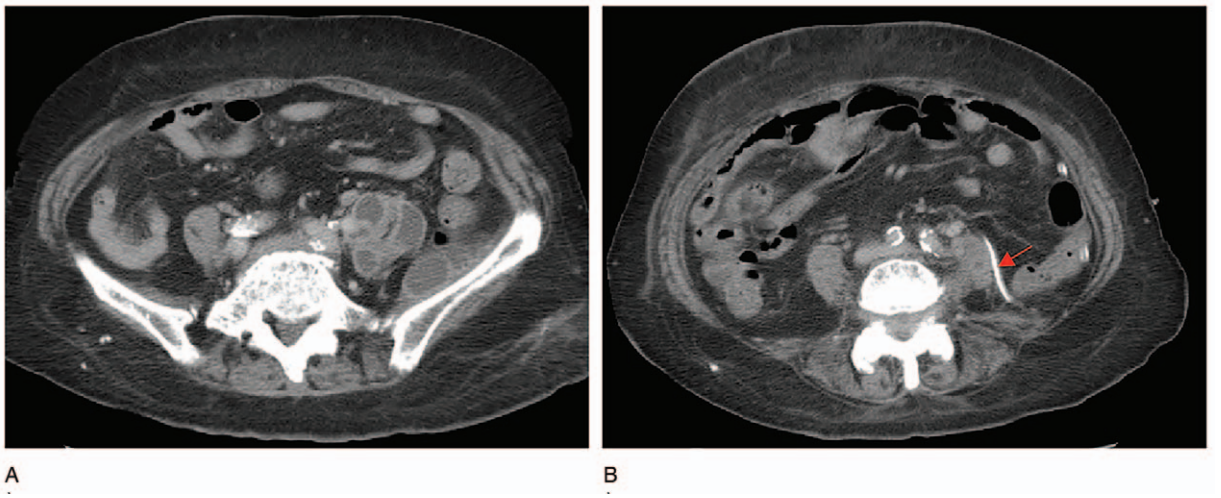

Figure 2. Contrast-enhanced CT scan demonstrating multilocular abscess with peripheral rim enhance in left psoas muscle of L3-5 area (A) and follow-up CT scan performed at the 3rd postoperative day showing drainage of abscess and a well-positioned drain (arrow) (B).

kyphoplasty. CT revealed a ca. 2-cm-diameter, mildly attenuating homogenous abscess on the right of the L4–5 area. In the past, she had developed a chronic pulmonary embolism and had been prescribed warfarin which, however, was stopped before for surgery. An IVC filter had been inserted on the day before surgery to prevent any massive postoperative embolism. On hospital day 7, we laparoscopically drained the psoas abscess using the same technique. The sample obtained during surgery grew *Staphylococcus epidermidis*; we commenced intravenous piperacillin/tazobactam. On postoperative day 1, her temperature became normal. On postoperative day 2, lumbar spine mobility greatly improved; only mild tenderness was evident in the lumbar region. Antibiotics were continuously administered and, on day 14 postoperatively, the elevated parameters indicating infection fell to normal for the first time. After 1 month of hospitalization, she was discharged on continuing antibiotic therapy for 1 week.

3.3. Case 3

A 42-year-old male complained of constant lower back pain radiating to the right lower extremity 3 months in duration, and also hypoesthesia of the anterior aspect of the right lower leg, but with normal motor function. Two months prior, he had attended a urology clinic because of dysuria and difficulty in urination. His serum prostate-specific antigen level was abnormally high; we performed a prostate biopsy and confirmed chronic tuberculous prostatitis. The laboratory found that the inflammatory marker levels were within normal limits: WBC 7690/μl, ESR 16 mm/hour, and CRP level 3.79 mg/L; his temperature was also in the normal range. A plain chest radiograph showed evidence of pulmonary tuberculosis and the sputum was also positive. CT revealed a right-side psoas abscess ca. 9.5 cm in diameter; the abscess was unilocular, of low-density, but evidenced peripheral enhancement. On admission, he underwent CT-guided percutaneous drainage via a catheter inserted into the abscess cavity (first-line treatment); pus culture yielded *Mycobacterium tuberculosis*. Anti-tuberculosis medical therapy was initiated after the catheter was placed. After 1 week of drainage, follow-up CT showed that the abscess had greatly decreased in size. The catheter was removed and the patient discharged on continuing anti-tuberculosis medication. One month later, he complained of relapsed lower back and radiating pain. CT confirmed a recurrent right psoas abscess; we considered that surgical drainage was required to ensure that drainage was adequate and to wash out the abscess cavity. We laparoscopically drained the psoas abscess. The patient was discharged after 2 weeks on a further 6 months of anti-tuberculosis medical therapy. A CT scan taken after 1 year showed no evidence of abscess recurrence.

3.4. Case 4

A 74-year-old female complained of progressive lower back pain and fever 2 weeks in duration that commenced after she fell off a chair. She was first admitted to a local clinic and diagnosed with a bilateral psoas abscess confirmed by CT. Her medical history included unstable angina, hypertension, and insulin-dependent diabetes mellitus. Despite 9 days of empirical intravenous vancomycin/meropenem, and percutaneous drainage of the abscess, her symptoms did not improve and follow-up CT revealed aggravated abscess formation. Finally, she was transferred to our clinic for surgical drainage of the abscess. She presented with severe tenderness in the lumbar region and a temperature of 37.8°C. She complained of excessive flexion contracture of the hip, but no neurological deficit was evident. The laboratory findings were: WBC 9290/μl, ESR 61 mm/hour, and CRP level 86.01 mg/L. CT detected a bilateral, multiloculated psoas abscess containing gas in the L3–5 region (Fig. 3). We laparoscopically drained the abscess on the day after admission; we encountered extensive gas and necrotic debris. We performed massive debridement/irrigation and obtained a culture specimen. Extended-spectrum beta-lactamases (ESBL) were identified microbiologically and she was continued on the pre-surgery antibiotics for 3 weeks. She was discharged without symptoms at 1 month after initial hospitalization.

3.5. Case 5

A 55-year-old male who had undergone posterior decompression and posterior lumbar interbody L4–5 fusion 1 year prior because of spinal stenosis was hit by a car. Two weeks after the accident,

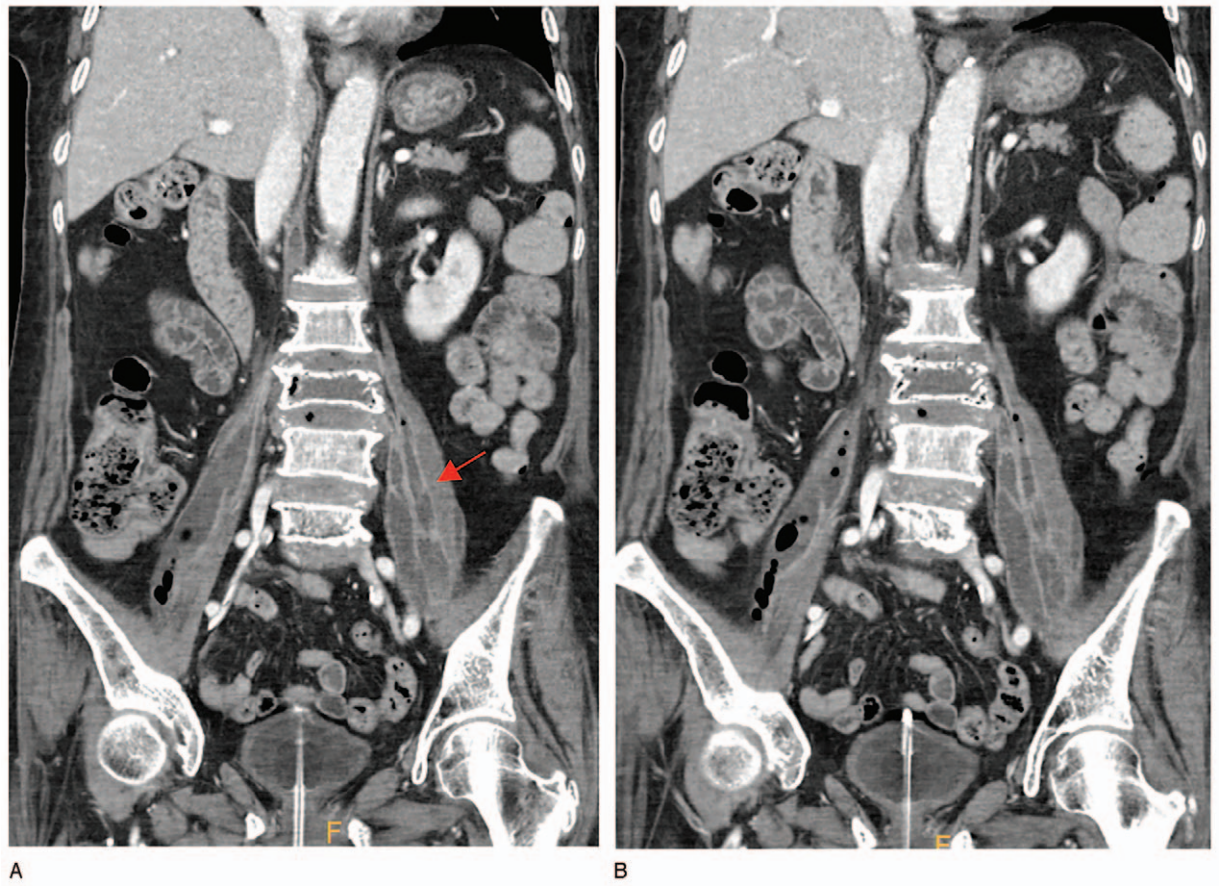

Figure 3. Coronal view of CT scan demonstrating extensive multi-loculated abscess of bilateral psoas muscle with gas inclusions (arrow).

he presented with right flank pain and flexion contracture of the right hip. CT revealed a unilocular right-side psoas abscess at the L4–5 level. On a plain radiograph, the internal (metal) dorsal device at the L4–5 level appeared to be stable; no metal loosening nor pull-out was evident. Magnetic resonance imaging (MRI) was performed to explore a possible periprosthetic infection; L4–5 vertebral osteomyelitis was detected (Fig. 4). His body temperature was normal but the laboratory inflammation data were elevated: WBC 10,250/μl, ESR 115 mm/hour, and CRP level 94.68 mg/L. As it was difficult to access the deep abscess pocket, CT-guided PCD was first attempted, but failed. Surgical drainage was planned; laparoscopic drainage was performed on hospital day 3. The sample grew methicillin-resistant *Staphylococcus aureus*. Intravenous vancomycin was initiated and continued for 2 months, at which time the patient was symptom-free and was discharged without any neurological deficit. At the 1-year follow-up, neither CT nor MRI yielded any evidence of an abscess or osteomyelitis.

3.6. Case 6

An 87-year-old male underwent posterolateral L2–5 fusion to treat an L3 burst fracture. About 1 year later, he complained of continual fever and lower back pain, and flexion contractures of both hips. The plain radiograph and CT scan revealed a bilateral multi-locular psoas abscess associated with loosening of the internal (metal) dorsal fixator. He complained of severe back pain but we found no neurological deficit. His temperature was 38.1°C. Gadolinium-enhanced MRI revealed L2–5 infective spondylitis and osteomyelitis. The laboratory data were: WBC 8990/μl, ESR 86 mm/hour, and CRP level 22.12 mg/L. We performed primary laparoscopic drainage on the day of admission, given the fact that the abscess was bilateral and multi-loculated, and the rapid progression of clinical symptoms. No pathogen was identified microbiologically. Cefazoline was initiated and continued as empirical antibiotic therapy. After 2 months of hospitalization, he was discharged free of symptoms with the levels of all inflammatory markers within normal ranges. CT performed at the 6-month follow-up yielded no evidence of abscess recurrence.

4. Discussion

Psoas abscesses are rather rare but can be life-threatening. Such abscesses are classified as primary or secondary by reference to their etiology. A primary abscess is caused by the lymphatic or hematological spread of a microorganism from a distant site, whereas a secondary abscess occurs after direct spread from a nearby site of inflammation or infection. Primary abscesses account for 30% of all cases,[21] being common in intravenous drug abusers and the immunocompromised, particularly patients infected with human immunodeficiency virus (HIV).[22,23] Secondary psoas abscesses constitute most cases and are most commonly caused by intra-abdominal inflammatory conditions

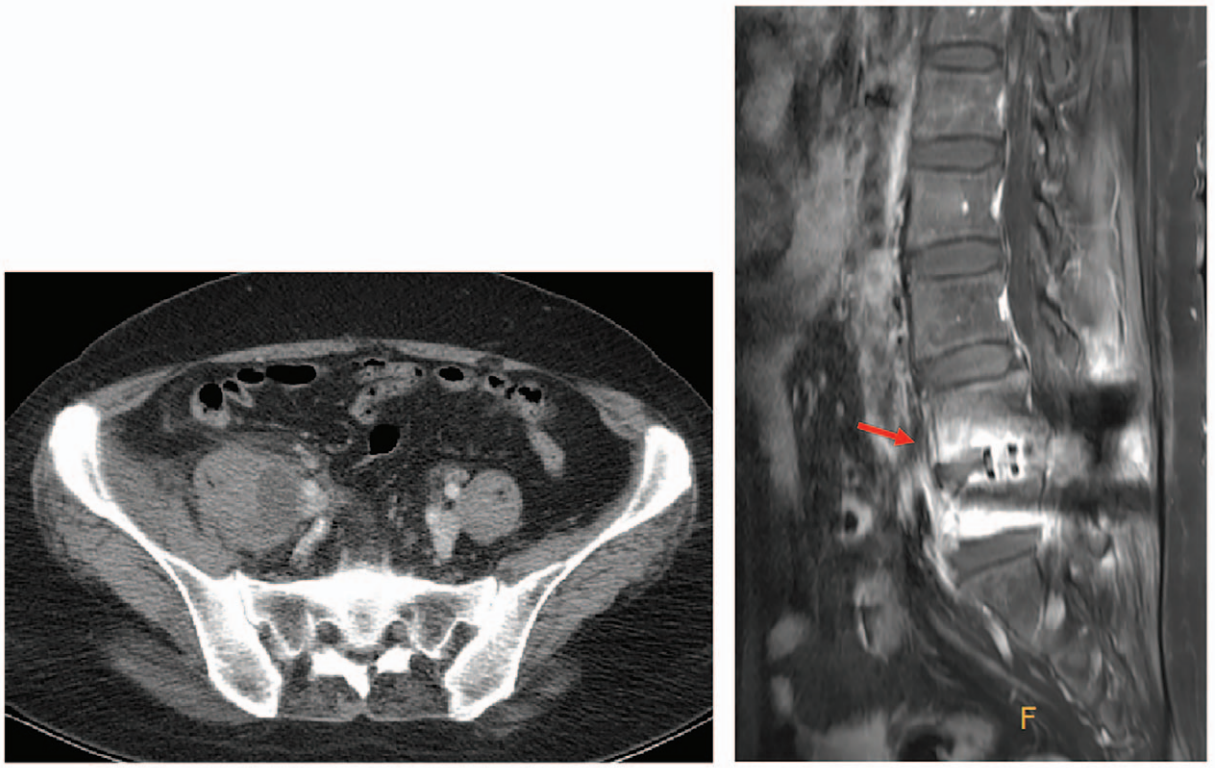

Figure 4. CT scan (left) at the level of L4-5 shows right psoas abscess and gadolinium enhanced MRI (right) demonstrates vertebral osteomyelitis of L4-5 (arrow).

such as Crohn disease, appendicitis, and diverticulitis[24]; spinal pathologies; and urinary tract infections.[21,22] The most common causative organism of both types of abscess is *S. aureus*.[25,26]

The prognosis is good if appropriate treatment commences early.[27] However, diagnosis is often delayed because the clinical manifestations are nonspecific, increasing mortality.[21,28] Most of our patients complained of flank pain or flexion contracture of the hip, creating a risk of misdiagnosed infection or septic arthritis of the hip joint.[29,30] A psoas abscess can also paralyze and distend the intestines; if flank pain and abdominal discomfort co-present, the abscess may be misdiagnosed as an intestinal problem and appropriate treatment delayed.[31] As shown in our cases, prior spinal surgery (spinal fusion or kyphoplasty) may cause psoas abscesses attributable to surgical site infections. Therefore, even if the clinical symptoms are nonspecific, the possibility of a psoas abscess should be considered when a patient has undergone a spinal operation. In particular, a psoas abscess developing after spinal fusion can be misinterpreted as a degenerative change in a segment adjacent to the fused segment.[32] An elevated leukocyte count, an increase in the ESR, and an elevated CRP level are typical laboratory findings of psoas abscess patients compared to those with degenerative spinal diseases. In general, the extent of CRP elevation reflects the extent of inflammation.[11,26]

We used contrast-enhanced CT to evaluate all abscesses pre- and post-operatively. CT is the recognized gold standard for diagnosis; the detection rate exceeds 90%.[26–28] Plain radiography and ultrasound may also be useful but are less sensitive than CT. Typical features on plain radiographs include an abnormal psoas shadow, gas, and abscess calcification, but not all features are always present.[27,33] Although ultrasound is advocated by some authors because of its advantages (no use of radiation, low cost, and real-time monitoring), sensitivity may be compromised by intestinal gas and small lesions are easy to miss.[8] MRI readily identifies osteomyelitis and the extent of abscesses, but metal implants and gas may cause artifacts.[34,35]

In the time since Mueller et al first used PCD to treat a psoas abscess in 1984, CT-guided PCD and broad-spectrum antibiotics have served as front-line treatments.[8–13,15] Although this is relatively simple and cost-effective, there are certain limitations. First, catheter obstruction/dislocation can compromise drainage.[8] As the iliopsoas is a major flexor muscle of the hip joint, the catheter may readily exit from the abscess cavity if the patient changes position or moves. Second, if the pus is sticky or purulent, it is difficult to maintain catheter patency. The psoas abscess pus of tuberculous spondylitis is particularly viscous; catheter obstruction is a real possibility.[18,19] Third, if the abscess is multi-loculated or chambered, PCD may not afford adequate drainage.[36,37] Finally, in patients with secondary abscesses, the primary lesions must also be treated (in addition to draining the abscess) because recurrence has been reported in about 50% of cases undergoing drainage alone.[11,21]

Standard surgical drainage features an extraperitoneal approach via an incision in the iliac fossa.[27] Unlike PCD, this allows complete drainage, full debridement of infected tissue, and treatment of the intra-abdominal, primary infection focus.[13,17] In terms of drainage time, all abscesses are rapidly and contermporaneously removed by surgical drainage whereas PCD is associated with an average catheter dwell duration of 2 weeks to 2 months.[8,9,38] As is true of open surgical drainage,

laparoscopic drainage allows complete drainage via the extraperitoneal approach, is less invasive than open surgery, and a bilateral abscess can be treated via a single incision whereas the open method requires 2 incisions. This reduces postoperative wound complications, shortens hospitalization, and facilitates rapid recovery. Rapid drainage is essential for patients with sepsis or septic shock attributable to an extensive psoas abscess. In such a situation, the slow PCD rate may be fatal, and open drainage may be dangerous because it is invasive. Laparoscopic drainage is more effective in severe cases, being associated with a shorter operative time and less invasiveness than open surgical drainage. Here, cases 1, 2, and 6 were elderly patients with severe psoas abscesses, and were at risk of septic shock, but recovery was rapid after laparoscopic drainage and no perioperative complication was encountered. However, there is a limitation that this method should be performed by a surgeon who can handle laparoscopic drainage. In general, orthopedic or neurosurgery doctors who experience and treat a lot of this disease should work closely with a general surgeon who knows how to treat a laparoscope whether the patient will be subject to PCD or open surgery or minimal invasive laparoscopic drainage.

5. Limitations

Our study had certain limitations. First, the all cases contained relatively few patients. Second, the follow-up period was 1 year only. A large number of patients and longer follow-ups are needed.

6. Conclusions

Laparoscopic drainage of a psoas abscess may be a good option when PCD is impossible or fails. Such drainage affords all the advantages of open surgical drainage (complete drainage, resection of infected tissue, contemporaneous treatment of the intra-abdominal primary lesion, and no need for radiation). Also, laparoscopic drainage is less invasive, requires a smaller incision, and allows more rapid recovery than the open method.

Acknowledgments

The authors thank the Soonchunhyang University Research Fund (2019-0016) for support.

Author contributions

Conceptualization: Chang Hwa Hong, Yong Cheol Hong, Woo Jong Kim.
Investigation: Myoung Won Son, Chang Hyun Kim, Hee Jun Chang.
Methodology: Sang Ho Bae, Myoung Won Son.
Project administration: Woo Jong Kim.
Resources: Myoung Won Son.
Software: Sung Hun Won, Hee Jun Chang, Woo Jong Kim.
Supervision: Sang Ho Bae, Sung Hun Won, Aeli Ryu, Woo Jong Kim.
Visualization: Sung Hun Won, Aeli Ryu, Woo Jong Kim.
Writing – original draft: Yong Cheol Hong.
Writing – review & editing: Woo Jong Kim.
Woo Jong Kim orcid: 0000-0002-4579-1008.

References

[1] Bartolo D, Ebbs S, Cooper M. Psoas abscess in Bristol: a 10-year review. Int J Colorectal Dis 1987;2>:72–6.
[2] Ouellette L, Hamati M, Flannigan M, et al. Epidemiology of and risk factors for iliopsoas abscess in a large community-based study. Am J Emerg Med 2019;37>:158–9.
[3] Chern C-H, Hu S-C, Kao W-F, et al. Psoas abscess: making an early diagnosis in the ED. Am J Emerg Med 1997;15>:83–8.
[4] Tabrizian P, Nguyen SQ, Greenstein A, et al. Management and treatment of iliopsoas abscess. Arch Sur 2009;144>:946–9.
[5] Askin A, Bayram KB, Demirdal US, et al. An easily overlooked presentation of malignant psoas abscess: hip pain. Case Rep Orthop 2015;2015:410872.
[6] Goldberg B, Hedges JR, Stewart DW. Psoas abscess. Am J Emerg Med 1984;1>:533–7.
[7] Shields D, Robinson P, Crowley T. Iliopsoas abscess–a review and update on the literature. Int J Surg 2012;10>:466–9.
[8] Cantasdemir M, Kara B, Cebi D, et al. Computed tomography-guided percutaneous catheter drainage of primary and secondary iliopsoas abscesses. Clin Radiol 2003;58>:811–5.
[9] Dinç H, Ahmetoglu A, Baykal Sl, et al. Image-guided percutaneous drainage of tuberculous iliopsoas and spondylodiskitic abscesses: midterm results. Radiology 2002;225>:353–8.
[10] Gupta S, Suri S, Gulati M, et al. Ilio-psoas abscesses: percutaneous drainage under image guidance. Clin Radiol 1997;52>:704–7.
[11] Ricci MA, Meyer KK. Psoas abscess complicating Crohn's disease. Am J Gastroenterol 1985;80(12.):
[12] Yacoub WN, Sohn HJ, Chan S, et al. Psoas abscess rarely requires surgical intervention. Am J Surg 2008;196>:223–7.
[13] Lobo D, Dunn W, Iftikhar S, et al. Psoas abscesses complicating colonic disease: imaging and therapy. Ann R Coll Surg Engl 1998;80:405.
[14] McAuliffe W, Clarke G. The diagnosis and treatment of psoas abscess: a 12 year review. Aust N Z J Surg 1994;64>:413–7.
[15] Mueller P, Ferrucci JJr, Wittenberg J, et al. Iliopsoas abscess: treatment by CT-guided percutaneous catheter drainage. Am J Roentgenol 1984;142>:359–62.
[16] Williams M. Non-tuberculous psoas abscess. Clin Radiol 1986;37>: 253–6.
[17] Atkin G, Qurashi K, Isla A. Laparoscopic drainage of bilateral tuberculous psoas abscesses. Surg Laparosc Endosc Percutan Tech 2005;15>:380–2.
[18] Joob B, Wiwanitkit V. Retroperitoneoscopic drainage of bilateral psoas abscesses. Asian J Endosc Surg 2014;7:345.
[19] Buyukbebeci O, Seckiner I, Karsli B, et al. Retroperitoneoscopic drainage of complicated psoas abscesses in patients with tuberculous lumbar spondylitis. Eur Spine J 2012;21>:470–3.
[20] Neola B, D'Ambra M, Capasso S, et al. Laparoscopic drainage of a recurrent psoas abscess. Ann Ital Chir 2014;85(ePub):
[21] Ricci MA, Rose FB, Meyer KK. Pyogenic psoas abscess: worldwide variations in etiology. World J Surg 1986;10>:834–42.
[22] Walsh TR, Reilly JR, Hanley E, et al. Changing etiology of iliopsoas abscess. Am J Surg 1992;163>:413–6.
[23] Van den Berge M, de Marie S, Kuipers T, et al. Psoas abscess: report of a series and review of the literature. Netherlands J Med 2005;63>:413–6.
[24] Agrawal SN, Dwivedi AJ, Khan M. Case report: primary psoas abscess. Dig Dis Sci 2002;47>:2103–5.
[25] López VN, Ramos JM, Meseguer V, et al. Microbiology and outcome of iliopsoas abscess in 124 patients. Medicine 2009;88:120–30.
[26] Santaella RO, Fishman EK, Lipsett PA. Primary vs secondary iliopsoas abscess: presentation, microbiology, and treatment. Arch Surg 1995; 130:1309–13.
[27] DeSandre AR, Cottone F J, Evers M L. Iliopsoas abscess: etiology, diagnosis, and treatment. Am Surg 1995;61:1087–91.
[28] Gruenwald I, Abrahamson J, Cohen O. Psoas abscess: case report and review of the literature. J Urol 1992;147:1624–6.
[29] Toren A, Ganel A, Lotan D, et al. Delayed diagnosis of a primary psoas abscess mimicking septic arthritis of the hip. J Pediatr Surg 1989;24:227–8.
[30] Perry J, Barrack RL, Burke SW, et al. Psoas abscess mimicking a septic hip. Diagnosis by computed tomography. J Bone Joint Surg 1985;67:1281–3.
[31] Stern WE, Balch RE. Surgical aspects of nonspecific inflammatory and suppurative disease of the vertebral column. Am J Surg 1966; 112:314–25.

[32] Thomas E, Leroux J-L, Segnarbieux F, et al. Multiple psoas abscesses after posterior spinal fusion. Spine (Phila¦Pa 1976) 1995;20:373–4.
[33] Hresko MT, Hall JE. Latent psoas abscess after anterior spinal fusion. Spine (Phila¦Pa 1976) 1992;17:590–3.
[34] Taiwo B. Psoas abscess: a primer for the internist. South Med J 2001;94:2–5.
[35] Lee J, Glazer HS. Psoas muscle disorders: MR imaging. Radiology 1986;160:683–7.
[36] Gerzof SG, Johnson WC, Robbins AH, et al. Expanded criteria for percutaneous abscess drainage. Arch Surg 1985;120: 227–32.
[37] Pruett TL, Simmons RL. Status of percutaneous catheter drainage of abscesses. Surg Clin North Am 1988;68:89–105.
[38] Staatz G, Adam GB, Keulers P, et al. Spondylodiskitic abscesses: CT-guided percutaneous catheter drainage. Radiology 1998;208: 363–7.