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Unveiling rare complications after Anterior Lumbar Interbody Fusion (ALIF): A comprehensive analysis of fluid collections and surgical risks

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Abstract

Objective: To investigate the diagnosis and management of retroperitoneal fluid collections following anterior lumbar interbody fusion (ALIF), focusing on their presentation, diagnostic timelines, and therapeutic approaches through a systematic review of existing literature.

Methods: A comprehensive review was conducted to synthesize data on the incidence, diagnosis, and management of retroperitoneal fluid collections post-ALIF. Key parameters assessed included types of collections, average time to diagnosis, imaging modalities used, and treatment strategies. Statistical analysis was applied to determine significant differences in presentation and management outcomes.

Results: The analysis of 23 studies revealed that the most commonly observed retroperitoneal fluid collections following ALIF were lymphoceles, hematomas, and urinomas. Lymphoceles exhibited a statistically larger mean volume (1.3 L) than urinomas (0.6 L), with an overall mean collection volume of 770 ml across all cases. Regarding diagnostic timelines, lymphoceles had an average time to diagnosis of 10 days, whereas urinomas were identified sooner, with an average of 3.5 days. Notably, some cases of infected lymphocele were documented as late as five years postoperatively, and chyloperitoneum as late as 206 days post-surgery. Computed tomography (CT) emerged as the most frequently utilized diagnostic modality, employed in 16 of the 23 studies, underscoring its role as the primary method for detecting these collections.

Conclusion: Retroperitoneal collections following ALIF present a significant diagnostic and management challenge, requiring timely identification and intervention. CT imaging is the primary diagnostic tool, with varying management strategies based on collection type and severity. This review underscores the importance of early diagnosis and a multidisciplinary approach to optimizing patient outcomes.

Keywords: Spinal Fusion; Postoperative complications; Hematoma; Lymphatic diseases; Retroperitoneal space; Incidence.

Abbreviation list

ALIF - Anterior Lumbar Interbody Fusion

MRI - Magnetic Resonance Imaging

CT - Computed Tomography

CSF - Cerebrospinal Fluid

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Introduction

Anterior lumbar interbody fusion (ALIF) is a surgical technique that involves anterior spinal arthrodesis, allowing for the indirect decompression of neural structures and the placement of a prosthetic device (cage) in the disc space. This approach facilitates the restoration of disc height and realignment of sagittal balance, promoting spinal fusion. Over recent decades, ALIF has gained significant popularity in neurosurgery due to its minimally invasive nature and its ability to achieve indirect decompression without direct manipulation of the spinal cord and nerves [1,2].

The primary indication for ALIF is degenerative lumbar spine disease, often characterized by loss of disc height, with or without lumbar spondylolisthesis. Surgical intervention is generally considered when conservative treatment options fail. Access to the spine in ALIF is typically achieved through an anterior abdominal approach, often necessitating the involvement of a specialized surgeon. In our experience in Brazil, collaboration with a vascular surgeon is frequently required to ensure safe access. Despite its advantages, this approach is not without risks, and complications such as venous thrombosis, arterial injury, and postoperative infections remain concerns [3-6].

Low back and abdominal pain, as well as complaints such as abdominal swelling, are common postoperative occurrences following anterior lumbar interbody fusion (ALIF). In some cases, these symptoms may represent clinical manifestations of complications, such as lymphatic or urinary system injuries, or they may indicate the presence of hematomas or infections at the surgical site. Given that collections at the surgical site are relatively common, we found it valuable to study each type in detail, aiming to distinguish between simpler collections that might be managed conservatively and more severe lesions that, in certain circumstances, require surgical intervention.

Our study aims to examine the incidence of postoperative fluid collections following ALIF surgeries, including hematomas, lymphoceles, and chyloretroperitoneum, and to provide a detailed review of their occurrence and management.

Objective

To investigate the incidence and underlying causes of rare fluid collections following Anterior Lumbar Interbody Fusion (ALIF), including hematomas, lymphatic leaks, and ureteral injuries leading to retroperitoneal fluid accumulation. This study aims to identify the prevalence, clinical significance, and potential risk factors associated with these complications, providing insights for improved diagnosis, prevention, and management.

Methods

A systematic literature search was performed using the databases PubMed (MEDLINE), Embase, and Google Scholar to identify relevant studies investigating rare fluid collections following Anterior Lumbar Interbody Fusion (ALIF). The search strategy incorporated Boolean operators and was designed with the following key terms: *"*ALIF (Anterior Lumbar Interbody Fusion)" AND ("collection" OR "complication")**. This search was conducted without any limitations regarding the publication date or language, ensuring a broad scope of potential studies.

Two independent reviewers searched in August 2024. Each reviewer screened titles and abstracts for relevance and eligibility, applying predefined inclusion and exclusion criteria. Full texts of potentially eligible studies were then retrieved for detailed assessment. In the case of any disagreements or uncertainties between the reviewers regarding study inclusion, a consensus was reached through discussion. When necessary, further consultation with a third reviewer was considered to resolve conflicts, although this step was not needed.

Data extraction focused on identifying studies reporting the incidence of rare fluid collections after ALIF, including hematomas, lymphatic leaks, and ureteral injury leading to retroperitoneal fluid accumulation. Information extracted included patient demographics, study design, clinical outcomes, complications, and the nature of fluid collections.

For the quantitative synthesis, a meta-analysis was conducted using Jamovi® statistical software to calculate pooled proportions of these complications. A random-effects model was applied due to anticipated heterogeneity among the included studies. The results of the meta-analysis were visually represented in forest plots, demonstrating the incidence of fluid collections and their associated 95% confidence intervals. Additionally, heterogeneity across studies was assessed using the I^2 statistic, and sensitivity analyses were performed where appropriate.

This comprehensive approach ensured a thorough evaluation of the current evidence on the incidence and risk factors for rare fluid collections following ALIF, contributing valuable insights into the safety and complications of this surgical approach.

Results

2,103 records were identified from three databases (PubMed, Embase, and Google Scholar). After removing 114 duplicates, 1,989 records were screened, with 1,587 excluded. Full-text retrieval was attempted for 402 studies, but 46 were unavailable. Of the 356 assessed for eligibility, 333 were excluded due to irrelevance or incomplete data. Ultimately, 23 studies were included in the systematic review.

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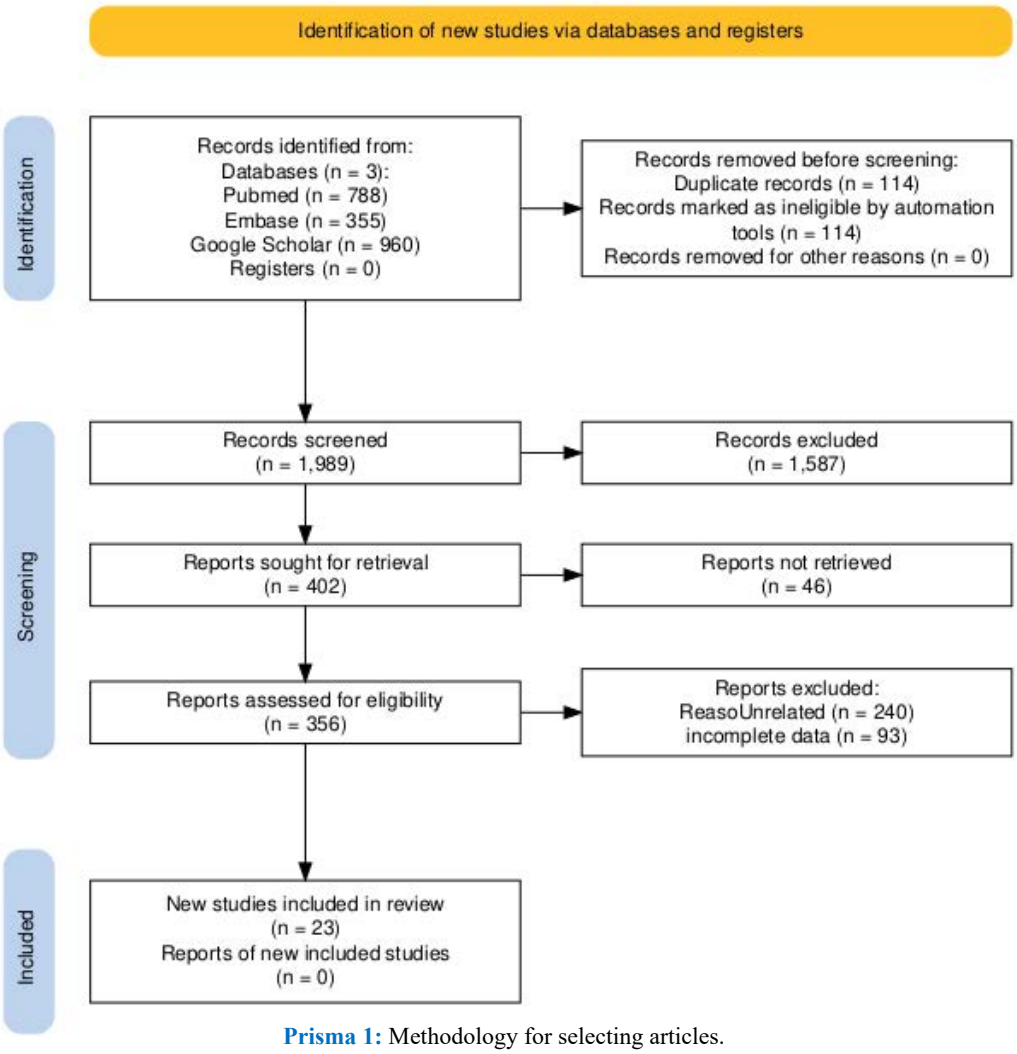

Prisma 1: Methodology for selecting articles.

Nine studies focused on lymphoceles, eight on hematomas, four on urinomas, one on infected lymphoceles, and one on chyloperitoneum. The average patient age across the studies was 51.9 years. Regarding the presence of an access surgeon during surgery, three studies confirmed the involvement of this specialist, while four studies reported the absence of an access surgeon. The remaining studies did not address this information.

Regarding symptoms, the most common symptoms associated with collections were abdominal pain, followed by abdominal pain accompanied by abdominal distension, and abdominal distension alone.

Table 1: Incidence of clinical presentation in different collections.

	Clinical Presentation					
	Abdominal distension	**Abdominal pain**	**Abdominal pain and distension**	**Asymptomatic**	**Leg swelling**	**Previous aspirations of collection**
Lymphocele	1	3	3	1	1	0
Hematoma	0	1	0	7	0	0
Urinoma	0	3	1	0	0	0
Chyloperitoneum	1	0	0	0	0	0
Infected Lymphocele	0	0	0	0	0	1

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Table 2: Incidence of pain regarding different collections.

		Distension		
		Yes	No	Total
Type	Lymphocele	4	3	7
	Hematoma	0	1	1
	Urinoma	1	3	4
	Chyloperitoneum	1	0	1
	Infected Lymphocele	0	1	1
Total		6	8	14

Table 3: Incidence of distention regarding different collections.

		Distension		
		Yes	No	Total
Type	Lymphocele	4	3	7
	Hematoma	0	1	1
	Urinoma	1	3	4
	Chyloperitoneum	1	0	1
	Infected Lymphocele	0	1	1
Total		6	8	14

In 16 of the 23 studies included in the synthesis of results, the collection was diagnosed through computed tomography, making it the most commonly used method for its identification.

Table 4: Different treatments used in the collections.

		Treatment					
			Image guided aspiration	Laparoscopic treatment	Open Surgery	Nephrostomy and Double J	Total
Type	Lymphocele	0	5	2	1	0	9
	Hematoma	4	0	0	4	0	8
	Urinoma	0	1	0	0	3	4
	Chyloperitoneum	0	1	0	0	0	1
	Infected Lymphocele	0	0	2	1	0	1
Total		4	7		6	3	23

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The average volume of collections was 770 ml, with lymphoceles showing a statistically larger volume compared to other collections – 1.3 L versus 0.6 L for urinomas. Few studies reported hematoma volume, despite it being one of the most frequently cited collections in the literature.

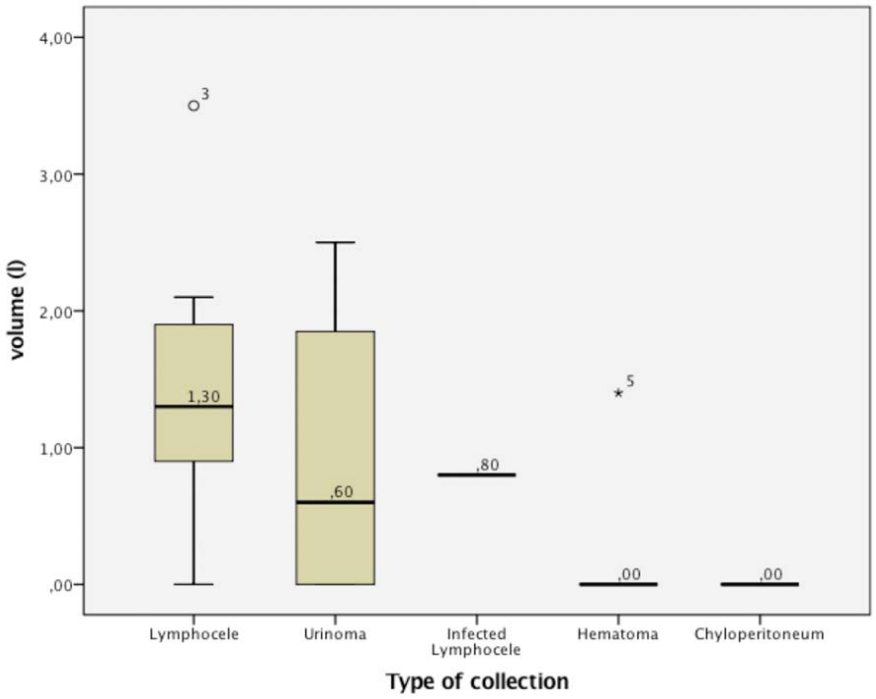

Figure 1: Volume of the collections and its relation to different collections.

Regarding the time to lesion diagnosis, we observed an overall average time of 10 days for lymphoceles and 3.5 days for urinomas. Notably, cases of infected lymphocele have been reported as presenting up to five years postoperatively, and chyloperitoneum has been diagnosed as late as 206 days following ALIF surgery.

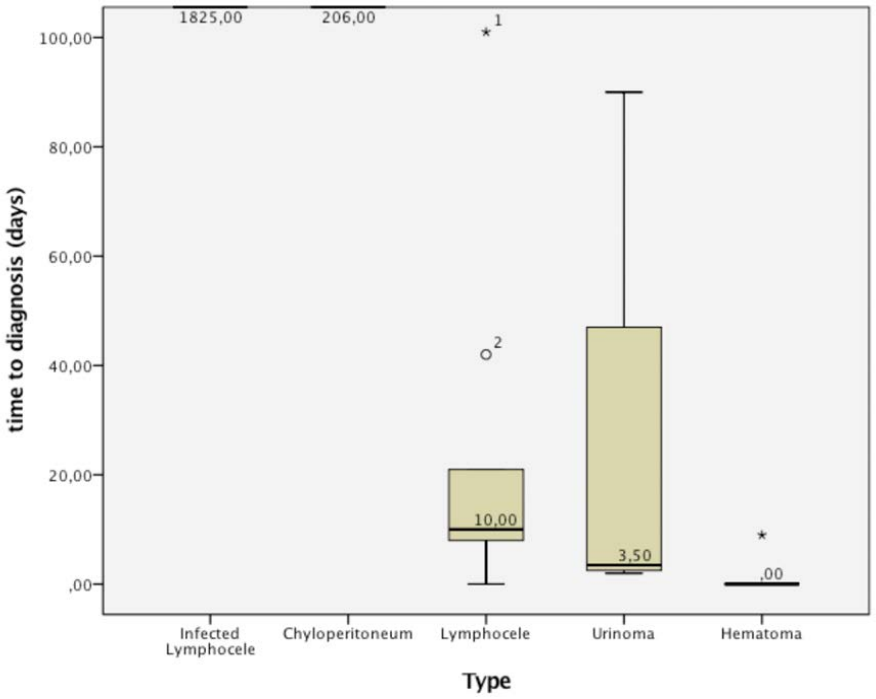

Figure 2: Time to diagnosis.

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Discussion

Postoperative fluid collections are relatively common yet clinically significant complications following anterior lumbar interbody fusion (ALIF). These collections can stem from a variety of causes, including vascular injuries leading to hematomas, lymphatic disruptions causing lymphoceles, or ureteral injuries resulting in urinomas. In some cases, they may also represent severe complications, such as retroperitoneal abscesses or rare occurrences like chyloretroperitoneum and cerebrospinal fluid (CSF) leaks.

The symptoms of these collections, such as abdominal pain, swelling, or distension, often overlap, making differential diagnosis challenging. Accurate identification relies on clinical suspicion combined with imaging modalities and fluid analysis, as early recognition is critical for determining the appropriate management. While some collections, such as small hematomas or lymphoceles, may resolve with conservative treatment, others, like urinomas or abscesses, often require prompt surgical or interventional management to prevent severe outcomes [7].

This review aims to explore the characteristics, diagnostic approaches, and clinical implications of these fluid collections, emphasizing the importance of tailored strategies to address their diverse presentations and minimize morbidity following ALIF.

In the postoperative setting of anterior lumbar interbody fusion (ALIF), fluid collections such as hematomas, urinomas, and lymphoceles are frequently encountered complications, each associated with distinct timelines for diagnosis and clinical manifestations. Our findings indicate that hematomas tend to be diagnosed earlier, followed by urinomas, with lymphoceles identified at a comparatively delayed stage. These trends in diagnostic timing correspond with each collection type's pathophysiological development and clinical presentation, as corroborated by multiple studies in the literature.

Hematomas are one of the most commonly encountered fluid collections following anterior lumbar interbody fusion (ALIF), typically resulting from vascular injury during the surgical approach, particularly during retroperitoneal dissection. While most hematomas are small and can be managed conservatively, larger hematomas with significant volume can present more serious challenges. These may cause systemic symptoms such as hypotension, tachycardia, and a marked drop in hemoglobin levels, indicating internal bleeding. Localized symptoms, including pain, swelling, and bruising near the surgical site, are also common and can serve as early warning signs.

Imaging modalities such as computed tomography (CT) or magnetic resonance imaging (MRI) are instrumental in the early identification of hematomas, typically revealing hyperdense collections when the blood is fresh. Over time, hematomas may become hypodense as the blood products break down, further aiding in diagnosis. The acute nature of hematomas, combined with their potential for rapid progression and risk to hemodynamic stability, often necessitates early postoperative imaging for timely intervention.

In rare cases, high-volume bleeding can lead to severe complications, such as neurological deficits from spinal cord compression or vascular compromise affecting tissue circulation [8]. When such symptoms arise, reoperation or other urgent interventions may be required to address the hematoma and prevent further complications. Understanding the spectrum of hematoma presentations, from minor self-limiting cases to those requiring surgical intervention, is critical to optimizing outcomes and ensuring patient safety following ALIF.

Larger hematomas causing mass effect or significant blood loss often require prompt intervention to prevent further complications and ensure patient stability. In many cases, percutaneous drainage under imaging guidance can effectively manage subacute symptomatic hematomas. However, in more severe cases, particularly when there is ongoing bleeding, hemodynamic instability, or compression of critical structures, surgical revision may be necessary. Timely identification of these hematomas through appropriate imaging modalities and their targeted management are essential to mitigate the risks of compression-related complications, such as neurological deficits or vascular compromise, and to optimize postoperative recovery. Early and decisive intervention tailored to the severity of the hematoma plays a pivotal role in ensuring favorable outcomes following ALIF.

Urinomas, resulting from iatrogenic ureteral injury during ALIF, are typically identified within a relatively short postoperative timeframe, though often later than hematomas. Ureteral injuries can lead to the extravasation of urine into the retroperitoneal space, provoking flank pain, symptoms of renal impairment, or signs of obstructive uropathy, such as hydronephrosis. Although urinomas may initially present with less dramatic symptoms than hematomas, clinical suspicion is often raised based on localized pain and renal function abnormalities, prompting further investigation. Elevated creatinine levels in aspirated fluid are particularly useful for differentiating urinomas from other fluid collections, such as lymphoceles, thus guiding targeted management strategies [9-11].

Imaging modalities such as computed tomography (CT) or retrograde pyelography are pivotal in confirming the presence of urinomas and assessing the extent of ureteral damage. These imaging techniques enable timely intervention with percutaneous drainage or ureteral stenting to prevent

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progressive renal compromise. Additionally, retrograde pyelography provides a direct visualization of urine extravasation, facilitating accurate diagnosis and treatment planning [9,10].

The presence of postoperative collections in ALIF surgeries is not uncommon. Therefore, it is important to know when we need to surgically address this type of complication. Furthermore, it is essential that we understand how each type of collection presents clinically.

The management of urinomas following ALIF depends on the extent of ureteral damage. Small urinomas may resolve with percutaneous drainage and ureteral stenting to promote healing. However, more extensive injuries may require surgical repair to restore urinary continuity. In cases where ureteral damage is detected early, stenting or nephrostomy can help divert urine flow, preventing complications such as infection or progressive kidney damage [12,13-16].

Lymphoceles are a rare but potentially serious postoperative complication following anterior lumbar interbody fusion (ALIF), typically resulting from inadvertent damage to retroperitoneal lymphatic vessels during the surgical approach. This damage can lead to the accumulation of lymphatic fluid in the retroperitoneal space, creating a collection known as a lymphocele. Small lymphoceles may remain asymptomatic and are often incidentally discovered on postoperative imaging. However, larger collections can lead to abdominal distension, pain, and compression of adjacent structures, such as the ureters and iliac veins, resulting in secondary complications, including hydronephrosis and lower extremity edema [8].

Diagnosis of lymphoceles is generally achieved through imaging studies, including ultrasound, computed tomography (CT), or magnetic resonance imaging (MRI), which can reveal fluid collections in the retroperitoneal space and help differentiate lymphoceles from other postoperative collections, such as hematomas, urinomas, or abscesses. Fluid aspiration and analysis are essential for confirmation, as lymphoceles exhibit high levels of proteins and lymphocytes, with low creatinine values, distinguishing them from urinomas [10].

Several risk factors have been associated with the development of lymphoceles post-ALIF. Patients undergoing multilevel fusions, particularly at higher lumbar levels (L2–L4), are at greater risk due to the extensive exposure required, which increases the likelihood of lymphatic injury [7]. Additional risk factors include older age and higher body mass index (BMI), both of which have been identified as independent contributors to lymphocele formation. Pre-existing conditions that impair lymphatic drainage, such as previous surgeries, radiation therapy, or inflammatory processes, further elevate this risk [17].

Management of lymphoceles is guided by the size of the collection and the presence or absence of symptoms. Asymptomatic or small lymphoceles may be managed conservatively with observation and serial imaging. However, symptomatic lymphoceles, particularly those compressing surrounding structures, often require active intervention. Percutaneous drainage, guided by ultrasound or CT, is typically the first-line treatment. Although this minimally invasive approach can alleviate symptoms, it carries a relatively high recurrence rate. In cases where the lymphocele recurs or persists, more definitive surgical intervention may be necessary. Laparoscopic marsupialization or the creation of a peritoneal window, as described by Collins et al. provides a more durable solution by allowing continuous drainage of the lymphatic fluid into the peritoneal cavity, reducing the likelihood of recurrence [8].

For particularly complex cases where percutaneous drainage proves ineffective and the lymphocele causes significant anatomical disruption, early referral to surgical intervention may be beneficial. Laparoscopic approaches, which are generally well-tolerated, have shown excellent long-term outcomes and are supported by the literature as an effective management strategy for lymphoceles refractory to conservative measures [18].

Cerebrospinal fluid (CSF) leaks are rare complications following anterior lumbar interbody fusion (ALIF), but they can occur and require careful evaluation. Such leaks typically result from inadvertent dural tears during surgery. Although uncommon, they should be suspected if the patient experiences symptoms such as positional headaches-worsening in the upright position—tinnitus, nausea, or vomiting in the postoperative period. These clinical manifestations are indicative of low intracranial pressure caused by CSF leakage.

Diagnosing CSF leaks in anterior approaches poses unique challenges due to the anatomy of the retroperitoneal space. Unlike other types of fluid collections, CSF does not always form well-defined pockets in the retroperitoneal area, as the large and complex space allows the fluid to diffuse. This can make imaging findings less conspicuous. Nonetheless, advanced imaging modalities, such as magnetic resonance imaging (MRI) with fluid-sensitive sequences or CT myelography, are instrumental in confirming the diagnosis and locating the site of the leak.

Management of CSF leaks typically depends on the severity of symptoms and the extent of the leak. Conservative approaches, including bed rest, adequate hydration, and the use of an epidural blood patch, may suffice for minor leaks. However, in cases of persistent or symptomatic CSF leaks, surgical repair may be necessary to seal the dural defect and prevent complications such as infection or prolonged discomfort. Early identification and appropriate management

are critical to preventing further morbidity and ensuring optimal recovery.

The differential timing in the diagnosis of these fluid collections underscores the importance of tailored postoperative surveillance strategies in patients undergoing ALIF. Hematomas and urinomas, with their more immediate presentations, often necessitate early postoperative imaging and prompt intervention, potentially including percutaneous drainage or surgical exploration to prevent complications such as mass effect or infection. In contrast, the delayed presentation of lymphoceles emphasizes the need for extended monitoring and follow-up imaging, particularly in cases where subtle symptoms emerge, as delayed intervention may lead to severe compressive sequelae.

The literature strongly supports the approach of customized postoperative protocols based on collection type and clinical presentation, integrating imaging and clinical judgment to optimize outcomes [7-9]. By recognizing the distinct diagnostic timelines for each fluid collection, healthcare providers can facilitate timely intervention, minimizing the morbidity associated with these postoperative complications and improving patient recovery following ALIF.

Conclusion

Fluid collections following ALIF are uncommon but significant complications that require prompt diagnosis and tailored management. Hematomas typically present acutely due to vascular injury, while lymphoceles and urinomas often manifest later with compressive symptoms or renal impairment, necessitating targeted intervention. Rare complications, such as chyloretroperitoneum and CSF leaks, further highlight the diverse spectrum of postoperative fluid collections.

Effective management relies on early differentiation through clinical assessment, imaging, and fluid analysis. Factors like creatinine levels, protein content, and lymphocyte counts help distinguish between lymphoceles and urinomas, guiding appropriate treatment. While minor collections can often be managed conservatively, recurrent or symptomatic cases may require surgical intervention, such as laparoscopic marsupialization or ureteral stenting.

The potential for persistent collections, sometimes appearing years after surgery, underscores the need for vigilant follow-up. A multidisciplinary approach involving spine, urology, and vascular specialists is critical to optimizing outcomes by ensuring timely and comprehensive care. Early recognition, accurate differentiation, and collaborative management are essential to minimizing complications and improving recovery for ALIF patients.

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