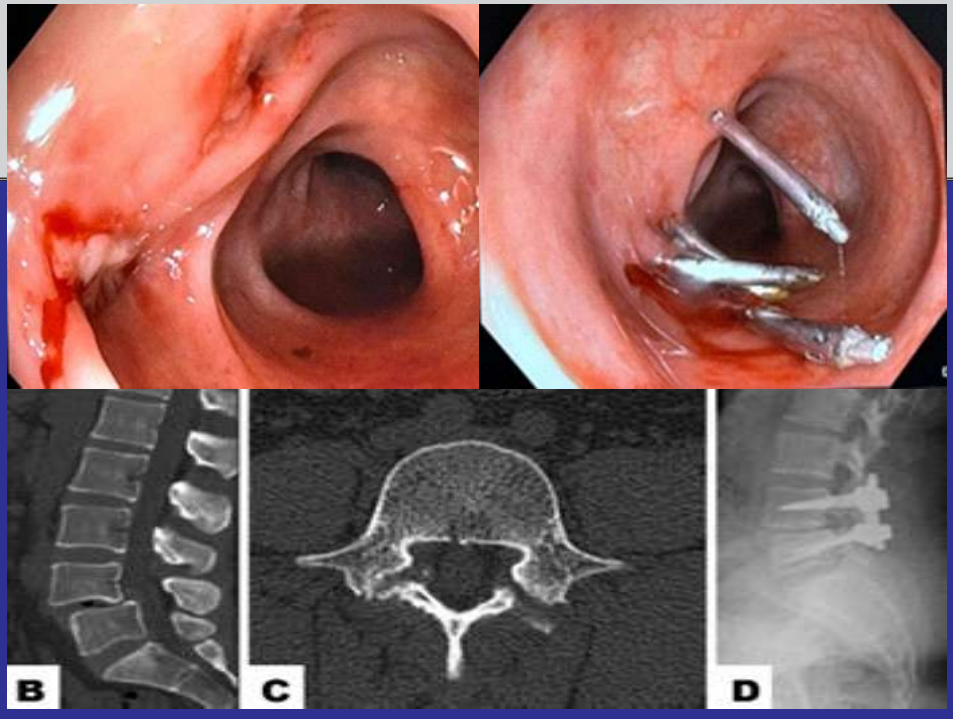
THE SRI LANKA JOURNAL OF SURGERY

July 2025 Volume 43 No. 2 ISSN 1391-491X



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The College of Surgeons of Sri Lanka

The Sri Lanka Journal of Surgery

Journal of The College of Surgeons of Sri Lanka.

July 2025 Volume 43, No.2 - Quarterly. ISSN 1391-491X e - journal ISSN 2279 2201

Mission: "To reach the highest standard of scientific surgical practice by dissemination of high quality scientific information and to foster and promote the growth of scientific surgery in Sri Lanka and in the region"

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Published by
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THE COLLEGE OF SURGEONS OF SRI LANKA
QUARTERLY ISSN 1391-49X

The Sri Lanka Journal of Surgery

July 2025 Volume 43, No. 2

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The Sri Lanka Journal of Surgery

July 2025 Volume 43, No. 2

PERSPECTIVE

Is an endoscope necessary to undertake thyroidectomy?

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Keywords: Thyroidectomy endoscope, Robot

Introduction

Endoscopy is derived from Greek and means "viewing the inner spaces of the human body" ("endo" and "skopein") [1]. Minimizing tissue damage and enhancing the cosmetic outcome have been pivotal concerns in modern surgery. Any procedure with minimum pain and scarring is readily acceptable patients.

Laparoscopic techniques were for known about 100 years [1], but the advantages of laparoscopic surgery were taken note of, following the performance of the first laparoscopic appendectomy by Kurt Semm a Gynaecologist in 1980 [2]. This technique made a significant difference to outcomes especially in surgical procedures for organs deep in body cavities. Addition of a robot to this procedure made it appear more modern and technologically advanced.

Laparoscopic cholecystectomy was the operation that popularized laparoscopic surgery among the general surgical community. In the next few decades there was exponential growth in use of laparoscopic and robotic techniques in many forms of surgery and open surgical techniques were superseded by endoscopic techniques. The inevitable introduction of endoscopic techniques to extirpation of the thyroid gland took place including the performance of robotic thyroidectomy.

The technique of thyroidectomy

The technique of open thyroidectomy has been converted to fine art due to the efforts of pioneers in thyroid surgery including the 'father of thyroid surgery Theodore Kocher. The safety and efficacy of open thyroidectomy prompted William Halstead of John Hopkins Medical school to state in 1920 to claim *"The extirpation of the thyroid gland…typifies, perhaps better than any operation, the supreme triumph of the surgeon's art…. A feat which today can be accomplished by any competent operator without danger of mishap and which was conceived more than one thousand years ago…. There are operations today more delicate and perhaps more difficult…. But is there any operative problem propounded so long ago and attacked by so many…which has yielded results as bountiful and so adequate?"* [3].

The current rate of complications in open thyroidectomy is around 1-2% which has made it a very safe surgical procedure in the modern era [4].

The thyroid is a surface structure approached readily by a fine skin crease incision which will produce an almost invisible scar in majority of patients. With the explosion of endoscopic surgery in the last 3 decades it was inevitable that surgeons started performing Endoscopic/Robotic thyroidectomies (E/RoT). The primary purpose of minimizing tissue damage and being minimally invasive is totally negated by the introduction of endoscope to thyroidectomy as gaining access to the thyroid necessitate moving far away from the glad and approaching it with a long telescope causing maximum tissue damage. The purported advantages of better magnification and avoiding a scar in front of the neck while being true, tends to downplay the tissue damage it causes. Several studies have shown that there is no particular advantage in terms of complications duration of surgery and cost effectiveness when E/RT is compared with open thyroidectomy in fact, a higher pain score and new compactions like chest wall paresthesia have been recorded [5], [6], [7].

While adopting newer techniques and updating training methods is essential for progress caution must be exercised when introducing new techniques, especially those involving expensive equipment like endoscopes Robots etc. to surgical practice. Surgeons like to 'play with new toys'

Unless it can be irrefutably shown that the newer techniques benefit the patients significantly advocating the use of such techniques must be done with a lot of caution. In addition, all surgeons undertaking E/Ro thyroidectomy must be well versed in open thyroidectomy to deal with the need to covert.

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https://orcid.org/0000-0003-4479-1716
Received: 30-06-2025 Accepted: 01-07-2025
DOI: https://doi.org/10.4038/sljs.v43i2.9260

If centre focus only on E/Ro thyroidectomy that raises questions about training young surgeons on the open technique.

It can be stated that E/Ro thyroidectomy is here to stay. But the role of E/RoT needs to be better defined, cost effectiveness established especially in a developing economy and sufficient expertise gained before it is, used due to the difficult learning curve. The role of E/RoT in dealing with thyroid malignancy effectively needs to be established with properly designed studies.

It appears that the E/RoT have a very limited role in thyroidectomy. This technique needs to be practiced in specialized centres with a policy of careful patient selection. Even in countries like the USA robotic thyroidectomy is losing favour [8]. In contrast in some countries like Korea RT is a popular option offered to patients [9],[10]. Lack of an endoscope does not preclude the performance of a safe, cosmetically acceptable and cost effective, thyroidectomy. Each country must adopt a policy that suits its needs and more than anything, the methods that offers the best to the patient and is affordable to the health care system.

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REVIEW

Kidneys role in liver transplantation

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Keywords: Liver Transplantation, Chronic Kidney Disease, Acute Kidney Injury

Abstract

Renal dysfunction in the form of acute kidney injury and chronic kidney disease is abundant in patients with chronic liver cell disease with a negative impact on post liver transplant patient survival. Chronic kidney disease post liver transplantation is another frequently encountered complication associated with adverse allograft and patient survival. Hence, early and precise measurement of renal function is pivotal in pre and post liver transplantation. Nonetheless, the existing methods of renal function evaluation have pros and cons, hence yet to establish complete authority. This review aims at exploring the precise methodology of evaluating renal function in liver disease, the impact and preventive strategies for pre LT AKI, CKD and post LT CKD..

Introduction

Renal dysfunction is commonly observed in patients with liver disease. Wong et al. reported a 46.8% prevalence of chronic kidney disease (CKD) with a significant impact on survival among hospitalized cirrhosis patients in 2019 [1]. Acute kidney injury (AKI) has also displayed a projected prevalence of 20-50% among cirrhosis patients associated with poor prognosis, further to being an important predictor of short term mortality [2]. The liver transplantation remains the gold standard therapy for chronic liver cell disease(CLCD) including hepatocellular carcinoma [3]. Yet, the presence either form of renal dysfunction prior to LT, is associated with reduced patient survival post transplantation [4,5]. Furthermore, CKD has emerged as a major long term complication of post LT despite improvement of mortality over the years [6 ,7].

The liver allocation Model for End-Stage Liver Disease (MELD) score, introduced in 2002 is presently used for assessment of severity of liver disease as well as prioritization of advanced liver disease patients for LT. The inclusion of serum creatinine in MELD score, reflects thefundamental prognostic role of renal function in cirrhosis [8,9]. Hence, early and precise measurement of renal function is pivotal in cirrhosis. Yet, the available methods for the evaluation of renal function ranging from formulas that estimate the glomerular filtration rate(GFR) , to non-invasive markers has not proven their comprehensive authority [10]. Hence, this review article looks at the optimal ways of evaluating renal function in liver disease, and the impact and preventive strategies for pre LT AKI, CKD and post LT CKD.

Evaluation of renal function in liver disease

For the assessment of renal function, serum creatinine (Scr) level based estimated GFR(eGFR) calculations are commonly used in clinical practice. Nonetheless, Scr levels CLCD patients may be variable due to numerous reasons including liver disease causing reduced generation of creatine, decreased skeletal muscle mass resulting in lessened creatine-to-creatinine conversion, augmented tubular secretion of creatinine, and lower estimation of Scr level by hyperbilirubinemia [11,12]. Hence, glomerular filtration rate(GFR) in CLCD is classically overestimated by the Scr based equation, hence a normal Scr level won't exclude kidney dysfunction. Further, Scr is furthermore regarded a late marker of kidney dysfunction, necessitating a reduction of 50% of GFR before a rise in Scr is detected . Regardless of limitations and till better substitutes are developed, the latest Scr based MDRD equation (MDRD-6) is commended by experts to utilize in cirrhotic patients [11].

Accuracy of GFR quantification could improve through measurement of 24 h creatinine clearance, yet limited by been expensive, errors in sample collection (Eg: incomplete bladder emptying) and the effect of tubular secretion of creatinine [14].

Cystatin C is a protein generated by all nucleated cells which is entirely removed by glomerular filtration. It's not affected by muscle mass , sex, hepatic function, hyper-bilirubinemia and tubular secretion. Hence, cystatin C-based eGFR may be

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Received: 05-09-2024 Accepted:05-12-2024
DOI:https://doi.org/10.4038/sljs.v43i2.9189

a superior alternate to the Scr-based equation in CLCD [15,16]. However, the level of cystatin C is affected by steroid use, thyroid disease, hypoalbuminemia, raised C-reactive protein and leukocytosis limiting it's use in estimating GFR in cirrhosis [17]. However, cystatin C based eGFR measurement is yet to be agreed for routine utilization in cirrhotic patients .

The utilization of conventional urinary markers like albuminuria is restricted in patients with cirrhosis, due to hypoalbuminemia and relatively increased capillary permeability [11]. The novel urinary biomarkers of renal tubular injury, including interleukin-18, urinary neutrophil gelatinase-associated lipocalin (uNGAL), liver-type fatty acid-binding protein and kidney injury molecule-1, has been studied to identify early renal dysfunction. uNGALis the most extensively evaluated biomarker, which is an inflammatory biomarker generated by damaged renal tubular cells [17]. The usefulness of uNGAL and other urinary and serum biomarkers in predicting AKI following LT remains to be clearly established. Additionally, ideal threshold values and potential confounding variables need to be validated before these biomarkers can be routinely implemented in clinical practice for LT [10].

Inulin renal clearance is the gold standard of GFR quantification. Yet, requirement of standardized environment with continuous intravenous injection of the inulin, and high cost, practically limit the assay in clinical practice, hence mainly utilised for research. The utility of renal and plasma clearance of radioactive isotopes, including [51] Cr-ethylenediamine tetraacetic acid (EDTA), is gaining popularity in practice, as tests are safe, less complex and sufficiently accurate to measure GFR [18].

Pre-transplant kidney dysfunction

Pre transplant AKI

AKI is common in patients with cirrhosis with an estimated prevalence of 20 to 50% among hospitalized patients depicting a substantial impact on survival [2]. Moreover CLCD is a recognized risk factor for AKI, further as a predisposing factor for CKD development [19] . Portal hypertension resulting in accumulation of blood in the splanchnic circulation causes lower effective circulating blood volume risking CLCD patients towards AKI [20].

The aetiology of AKI in cirrhosis could be pre-renal, resulting from volume depletion due to gastrointestinal bleeding, diuretics use, sepsis, aggressive paracentesis, use of vasodilators and hepatorenal syndrome (HRS). Intrinsic renal causes such as nephrotoxics, infections, prolonged pre-renal AKI can result in acute tubular necrosis. Post renal obstruction leading to AKI is very rare [2].

HRS is a significant etiological entity seen in advanced decompensated CLCD, due to circulatory dysfunction induced by portal hypertension [21]. The combined use of albumin and terlipressin can reinstate renal function in 40% to 73% of patients with HRS [22]. Moreover, Piano et al reported that response to terlipressin and albumin was associated with a reduved need of renal replacement therapy after LT and lessened the risk of CKD at 1 year post LT [23]. However, LT is the definitive treatment for HRS. Since hepatorenal syndrome (HRS) is a functional condition without microscopic evidence of structural damage to the glomeruli or tubules, renal function is anticipated to recover following LT alone [24]. However, individuals with underlying tubular or glomerular injury or those experiencing prolonged HRS may not regain renal function through liver LT alone and might require simultaneous liver-kidney (SLK) transplantation or a kidney transplant following LT [25].

Perioperative AKI

Perioperative AKI increases the risk of acute rejection, infection, and mortality [26]. Risk factors for perioperative AKI include sepsis, nephrotoxic drugs, hemodynamic instability and ischemia-reperfusion injury [27]. In a study carried out by Guitard et al. showed that AKI was significantly associated with higher time for Aspartate transaminase peak, decreased post-operative diuresis (< 100 ml/h), post-operative use of vasopressive drugs, increased duration on mechanical ventilation, extended duration in the intensive care unit and overall length of hospital stay [28] . In addition, utilization of more marginal grafts leading to higher ischaemic reperfusion injury could have contributed to higher prevalence of perioperative AKI [29].

Pre transplant CKD

The rising incidence of CKD in cirrhotic patients likely reflects increasing metabolic risk factors—diabetes, hypertension, obesity—and the growing impact of nonalcoholic fatty liver disease (NAFLD) as a key driver of cirrhosis [17]. NAFLD depicts an independent and significant association with a higher incidence and prevalence of CKD [30,31]. Numerous factors like the pro-inflammatory environment, insulin resistance, oxidative stress, and the activated renin-angiotensin system, may contribute to faster CKD onset and progression in NAFLD patients, alongside prevalent diabetes and hypertension.. Moreover, NAFLD accounted for a substantial rise in SLK transplantation, from 8.2% in 2002 to 22% in 2011 [32].

Immune complex glomerulonephritis is seen in certain distinct etiologies of cirrhosis like hepatitis B virus (HBV) or hepatitis C virus (HCV). Further, immunoglobulin A

nephropathy is increasingly seen in alcoholic cirrhosis [21]. Further, there is evidence indicating that the risk of de novo CKD remains elevated. among AKI survivors [33].

Presence of CKD in a CLCD patient can have a significant bearing on clinical manifestations. Anorexia, anaemia, ascites, bleeding, and encephalopathy may stem from hepatic, renal, or combined dysfunction, complicating diagnosis and management. Further, CKD in cirrhosis is linked to worse outcomes and more frequent complications such as higher rates of superimposed AKI, need for dialysis, 30 day mortality rate, refractory ascites, bacterial infections and LT requirement (25% vs 10%) matched with those without CKD [1], [33]. Pre-transplant CKD increases waitlist mortality and worsens post-LT survival. Cullaro et al. reported a one-year post-LT mortality of 12% with CKD vs. 9% without [34]. Presence of CKD in a CLCD patient can have a significant bearing on clinical manifestations. Anorexia, anaemia, ascites, bleeding, and encephalopathy may stem from hepatic, renal, or combined dysfunction, complicating diagnosis and management.

Simultaneous liver kidney transplant

Margreiter et al. introduced SLK transplantation as a treatment strategy for coexistent cirrhosis and kidney dysfunction, which has been performed increasingly since the introduction of MELD scoring system [35]. Five-year survival for SLK recipients ranges from 64% to 76% [20]. At present, there is no global consensus regarding SLK eligibility and organ allocation. The reversibility of kidney dysfunction associated with CLCD is the determinant between LT alone or a SLK transplantation. In 2017, United Network for Organ Sharing (UNOS) implemented a comprehensive SLK policy outlining medical eligibility criteria (Table 1) [36].

Post-transplant CKD

Post LT kidney dysfunction is a frequently encountered complication associated with a significant negative impact on allograft and patient survival [37]. Pre-transplant AKI or CKD is a key risk factor for post-LT CKD [10]. CKD develops in most patients surviving beyond 6 months. The incidence of post LT CKD is higher compared to heart or lung transplanted patients [38]. The prevalence of LT-CKD differ in literature mainly due to differences in definition of CKD [10]. However, Van wagner et al. recently showed a CKD prevalence of 41.5% and a mortality of 6% upon 6 months survival in post LT cohort of 602 patients [39].

Table 1: Medical eligibility criteria for combined SLK.

Candidate's Transplant Nephrologist Confirms a Diagnosis of	Transplant Program Must Document at least 1 of the following
CKD with a measured or calculated GFR ≤60 mL/min for >3 months	Candidate is on regular hemodialysis
	Candidate's most recent GFR is ≤ 30 mL/min at the time of registration for kidney transplant
Sustained AKI	Candidate is on dialysis at least 6 weeks
	Candidate's GFR is ≤ 25 mL/min for at least 6 weeks (as documented in weekly measurements)
	Candidate has any combination of above 2 criteria for 6 weeks
Metabolic disease	Hyperoxaluria
	aHUS from mutations in factor H or I
	Familial nonneuropathic systemic amyloidosis
	Methylmalonic aciduria

Legend: CKD = chronic kidney disease, AKI = acute kidney injury. GFR = glomerular filtration rate, aHUS = atypical hemolytic uremic syndrome.

The main aetiopathological diagnoses of early post LT CKD(<1 year) are calcineurin inhibitors (CNI) toxicity, diabetic nephropathy, and thrombotic microangiopathy [37]. Early CNI nephrotoxicity is a dose-dependent and mainly functional hence; early dose reduction may reverse kidney injury [38]. Vasoconstriction of afferent and efferent arterioles reduces glomerular filtration, causing kidney dysfunction [40].

Iglesias et al. demonstrated that the recovery of pre transplant kidney function is mainly influenced by absence of graft dysfunction followed by anti thymocyte globulin induction and reduction of CNI use [41]. Further, Lin et al demonstrated that the Serum creatinine at the 4th week Post-LT is a strong predictor of CKD over 5 years, highlighting the need for early, aggressive kidney management [42].

CNI toxicity is the leading cause of late onset of CKD (> 1 year post LT) as well. Renal histology would demonstrate obliterative arteriopathy, glomerular ischemic collapse, of precedent renal disease, focal segmental glomerulosclerosis, non-recovered HRS , and acute tubular necrosis of amphotericin were identified as other important causes of late post LT CKD [44]. Diabetes mellitus and hypertension were also causative agents of CKD [21].

Ways to overcome post LT kidney dysfunction

Patients with post-transplant CKD depict a higher risk of hospitalization, infectious complications, and graft dysfunction hence, preventive strategies to preserve kidney function after LT are vital. It is advisable to measure GFR and proteinuria annually to diagnose and prognosticate CKD. Life style modification is of utmost importance. Meticulous control of blood pressure, diabetes mellitus, low salt and low protein intake along with prevention of weight gain to reduce metabolic syndrome are recommended [10].

As CNI-induced nephrotoxicity is the main contributory factor for both early and late post LT CKD, the greatest strategy is to minimize CNI use without affecting graft longevity. One successful strategy was to use induction with monoclonal or polyclonal antibodies(Basiliximab and daclizumab) with late introduction of CNI. Few clinical trials have displayed better renal outcome when used in LT recipients with preoperative renal dysfunction [21], [45]. Early usage of mycophenolate mofetil (MMF) with no or reduced doses of CNI has shown post LT favorable kidney outcomes without allograft rejection [46,47]. The mammalian target of rapamycin inhibitor, everolimus has also revealed a protective renal strategy with reduced dose of CNI [48]. Because of the adverse outcomes associated with Betalecept and Sirolimus in CNI minimizing trials , the use it is not recommended in post LT. Despite the evidence that early MMF and mTor-I usage minimizes renal dysfunction, but proves less effective if started after 1 year post-LT, making it unsuitable for routine practice [49]. To minimize the use of CNI, new drugs are currently being tested, such as CFZ533, an IgG1 anti-CD40 antibody, yet the utiliy in LT is not understood [10].

Conclusion

Pre LT AKI, CKD and post LT CKD have a significant negative impact on post liver transplant outcomes. Hence, meticulous measures should be taken to prevent and manage peri-transplant kidney dysfunction. Probe in to more accurate and readily accessible methods for evaluation of kidney dysfunction in patients with liver disease is a future need.

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SCIENTIFIC ARTICLE

Endoscopic ultrasound guided drainage of necrotic pancreatic fluid collections: a monocentric experience

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Keywords: EUS guided pancreatic necrosectomy, Pancreatic necrosis

Abstract

An episode of acute pancreatitis can lead to complications of acute necrotic collection (ANC) or walled-off necrosis (WON) in 20% of patients. Many of these patients with pancreatic necrosis are symptomatic with infected necrosis, gastrointestinal obstruction, persistent pain or inflammation and require an intervention. Present guidelines on management of complication in acute pancreatitis advise against early invasive interventions for pancreatic necrosis. A four week time line is give, which usually coincides with the time an "acute necrotic collection" develops in to a WON and is suitable for safe interventions.

We present eleven patients who underwent endoscopic drainage of WON of the pancreas using endoscopic ultrasound (EUS), of which eight patients were successfully (72%) managed and three succumbed to their illness due to complications. Three patients needed additional surgical drainage of endoscopically inaccessible para colic collections.

EUS guided drainage is an effective and successful, minimally invasive method to drain WON in the appropriate patient.

Introduction

An episode of acute pancreatitis can lead to complications of acute necrotic collection (ANC) or walled-off necrosis (WON) in 20% of patients [1]. An ANC by definitions has "no definable wall encapsulating the collection," whilst a WON is an "encapsulated collection" with a "mature wall". A four week time line is give, which usually coincides with the time an "acute necrotic collection" develops in to a mature WON [1].

Many patients with pancreatic necrosis are symptomatic with infected necrosis, gastrointestinal obstruction, persistent pain or inflammation and require an intervention [2]. Consensus guidelines on management of complications in acute pancreatitis advice postponing invasive interventions for pancreatic necrosis until the stage of WON has been reached, that is usually at least 4 weeks after disease onset [1].

At present management of pancreatic necrotic collections involves a multi-disciplinary staged step-up approach depending on the location of collection and the available expertise. Endoscopic trans luminal drainage, percutaneous drainage and surgical drainage have all been used successfully depending on the need of the individual patient.

Endoscopic step-up approach has been shown to be associated with reduced risk of external fistulae occurrence, shorter hospital stays, new onset multiorgan failure and physiological stress, better quality of life and ultimately lower costs to the health care system, with no significant difference in mortality when compared with surgical approach in three randomized trials [3].

The endoscopic approach involves creating a cysto gastrostomy/enterostomy and thereafter transluminal necrosectomy depending on the response to the initial drainage. While this has been accepted and practiced routinely in other parts of the world, there are no published data available in Sri Lanka. Here we present a mono centric experience of eleven cases of endoscopic necrosectomy performed at the tertiary care hospital in Sri Lanka.

Methods

Study sample

Gastroenterology and endoscopy unit in the university surgical unit, National Hospital Colombo is a main tertiary care referral center for managing patients with complicated pancreatic pathology, especially for endoscopic management. It maintains a unit database as an inception cohort, from which all patients who had undergone endoscopic drainage and necrostomy for management of necrotic collections following acute pancreatitis for the past 5 years were identified. The presence of WON had been confirmed in all patients using CECT prior to the procedure.

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Received: 05-01-2025 Accepted:14-07-2025
DOI: https://doi.org/10.4038/sljs.v43i2.9218

All interventions were performed by a single endoscopist (NF) in line with international guidelines. The Primary outcome of interest reported as clinical success was the resolution of WON on post intervention cross sectional imaging and ultimate clinical improvement of the patient.

Technical aspects of the procedure

Endoscopic ultrasound guided drainage and necrosectomy of WON is usually performed under deep sedation using midazolam or propofol with fentanyl. A linear-array endoscopic ultrasound (EUS) is performed to visualize the pancreatic fluid collection and to decide the optimal route for puncture which is usually via the posterior wall of the stomach or duodenum. There may be an endoscopically visualized bulging of the collection into the stomach or duodenum. Under EUS guidance, a 19G Needle is used to puncture the collection. The correct position of the needle can be confirmed by aspiration of the fluid content via the needle. A 0.035 guidewire used for ERCP is there after advanced through the needle under fluoroscopic guidance into the fluid collection. This is used as a railroad for passing of accessories in the next steps. A cystotome which is a electrocautery device with an 8.5Fr diameter sheath is used to create a puncture tract to enable the passage of the stent. Balloon dilatation of the puncture tract can be performed up to 15 mm to further dilate the tracts, which we did not use in any of our patients. A 2-3cm long 14-16mm diameter bi flanged self-expandable metal stent is there after inserted along the guide wire to create the cystogastrostomy/enterostomy. Necrotic fluid can be seen draining through the stent once the procedure is complete. To avoid blocking of the cystogastrotomy stent a nasocystic catheter may be positioned in the space of the walled-off necrosis which can be used for continuous irrigation of the collection with at least 1 liter of normal saline over 24 hours. Many centers do not routinely place nasocystic drains, but rather repeat the endoscopic interventions to irrigate the collection with saline and remove debris.

The effectiveness of EUS drainage on the clinical condition of the patient is monitored over the next 48-72 hours. A follow up endoscopic procedure is planned if there is no clinical improvement: improvement of the SIRS (Systemic inflammatory response syndrome) parameters, disappearance or reduction of fever, decrease in serum C-reactive protein and white blood cell count.

If necrosectomy is decided a forward-viewing endoscope (standard gastroscope) is advanced into the collection via the stent and the necrosectomy is performed. The pancreatic and peripancreatic necrotic tissue can be removed using either a basket, a polypectomy snare or grasping forceps. During the subsequent days, an endoscopic necrosectomy may be repeated as needed, depending on the amount of necrosis left in the collection and the clinical condition of the patient.

Whenever there are pancreatic fluid collections not accessible by EUS, a percutaneous or surgical approach may be additionally needed as done in three of our patients with collection in the right para colic region.

Results

Eleven patients underwent endoscopic interventions for necrotic collections following acute pancreatitis. Intractable abdominal pain was the indication for the intervention in more than 50% of the patients, while other indications included gastric outflow obstruction, suspected infection and obstructive jaundice. All patients underwent endoscopic drainage after 4 weeks of the initial presentation. Following initial drainage, the majority required at least one additional session of necrosectomy. Of the 11 patients, 3 patients required a combined laparoscopic drainage to drain endoscopically inaccessible sites in the para colic gutters. Clinical success was achieved in eight patients, with three patients succumbing to their illness due to ongoing sepsis/multi organ failure and disseminated intra vascular coagulation. The results are outlined in Table 1.

Discussion

Despite acute pancreatitis being a common cause of hospital admissions in Sri Lanka, local published data is limited to a handful of articles and unpublished abstracts [3]. Local data on necrotic collections following acute pancreatitis is therefore unknown and management strategies utilized in such Sri Lankan patients are not covered in scientific discourse. Patients with acute pancreatitis are managed by a diverse range of clinicians including general surgeons, gastrointestinal surgeons, gastroenterologists and general physicians. While all resort to available international guidelines in their management, the notion of centralized specialized care for patients with pancreatic conditions is not yet established [3]. In the multidisciplinary staged step-up approach in management of necrotic collections, place of endoscopic interventions is well established internationally. In this paper we discuss outcomes of endoscopic approach in the local setting, which has not yet been described in Sri Lanka.

Table 1

		Frequency (n=11)	Percentage
Gender	Male	8	72.7
	Female	3	27.2
Indication	Abdominal Pain	6	54.4
	Gastric outflow obstruction	1	9.0
	Suspected Infection	3	27.7
	Obstructive jaundice	1	9.0
Necrosectomy	01	6	54.4
	02	3	27.7
	03	2	18.1
	>3	0	00
Size of the PFC (cm)	40 -60	5	45.4
	61-80	5	45.4
	> 80	1	9.0
Combined Laparoscopy		3	27.7
Mortality		3	27.7
Clinical success		8	72.7

As previously mentioned, necrotic collections following acute pancreatitis can be either an acute necrotic collection (ANC) or walled off necrosis (WON). Most patients will require interventions for adverse events such as infections, inability to eat, persistent pain, persistent systemic unwellness or GI obstruction (gastric, intestinal, biliary) and current international guidelines recommend invasive interventions to be postponed until the stage of WON has been reached, which typically occurs in four weeks. On Contrast enhanced CT (CECT), the presence of necrosis is defined as "non-enhanced pancreatic parenchyma". A CECT should always be performed before an intervention is planned to anatomy of the collection can be seen abd best intervention planned. Although MR scans can better characterize necrotic collections, CECT is the standard mode of investigation in most centers, which can identify parenchymal necrosis, extent of necrosis and local complications of necrosis. Endoscopic Ultrasound (EUS) is equal or better at characterizing non-liquid necrosis and debris within pancreatic and peri-pancreatic collections [4]. Accurate identification of necrosis from a pseudocyst is important and is usually defined when there is more than 25% of debris within a pancreatic fluid cavity [2].

In our sample persistent pain was the most common indication for endoscopic drainage and/or necrosectomy. Pain can occur due to the mass effect of collections which will be relieved by drainage [2]. Following the procedure a significant reduction of pain levels was observed in all six patients.

Suspected infection was another common indication for intervention in our sample, which was identified by clinical deterioration, elevated inflammatory markers and imaging findings. Those patients underwent endoscopic drainage and necrosectomy along with systemic antibiotics. Infection of the collection typically occurs 3-4 weeks following presentation, however, can occur earlier [2]. In our sample infection was suspected 3-4 weeks after initial presentation in 03 patients. Due to high false negative rates, the place for percutaneous aspiration to identify infections is debatable and should not be practiced anymore. In addition, a positive culture does not necessarily require intervention as the decision to intervene is driven by other factors such clinical status of the patients [2]. Although current practice suggests delaying endoscopic interventions till WON is formed, some studies advocate earlier interventions especially when infections is suspected in a ANC. Occasionally infected ANC will require early radiological or endoscopic interventions, which will postpone or avoid surgical debridement all together [4]. Overall, delayed intervention is superior, especially in terms of adverse events. Delayed intervention allows pancreatic necrotic tissue to better demarcate between necrotic tissue from vital tissue, so vital pancreatic tissue will be preserved during necrosectomy enabling better long-term endocrine and exocrine outcomes for the patients [5]. All our patients underwent intervention after 4 weeks since presentation in lines with current recommendations. All patients with suspected infected necrosis needed an additional 2-3 necrosectomy after the initial drainage. Unfortunately, two of the three patients with suspected infected necrosis succumbed to the illness, questioning our approach to the patient. We feel we could have been more aggressive in the frequency of necrosectomy or stepped up to a surgical approach when endoscopic drainage wasn't improving the patient's overall status. The development of

coagulopathy was a major limiting factor even for surgery, in our approach to these complicated and complex cases.

Other patients underwent endoscopic drainage and necrosectomy due to gastric outlet obstruction and obstructive jaundice, which are well recognized indications for intervention. The patients who were asymptomatic despite having necrotic collections on imaging did not undergo any interventions and were not included in this study. These patients' pancreatic fluid collections spontaneously resolved over time regardless of size and extension in keeping with published evidence [2].

The recent advances in minimally invasive endoscopic, percutaneous and surgical techniques have revolutionized the management of necrotic collections. The scientific consensus regarding the role of open surgery in acute necrotizing pancreatitis has shifted significantly in the past decades. Initially, early surgical intervention for pancreatic necrotic collections [4],[2]. Open surgical management is associated with higher rates of complications and death [6]. Regardless of the advances endoscopic techniques and higher rates of complications in open surgical management, there's still a place for surgical management in certain indications for a minority of patients. Ischemic bowel, refractory abdominal compartment syndrome, perforation of a viscera and failure of step-up approaches are recognized indications for surgical management [2]. In three of our patients we had to seek the help of the surgeons to drain endoscopically inaccessible para colic collections which was not draining via the cystogastrostomy and causing an ongoing inflammatory response or infection.

All our patients underwent EUS guided drainage as opposed to conventional endoscopic drainage. When a collection is large enough it may create a endoscopically visible bulge which then can be punctured trans-luminally and drained using a standard endoscope. There is a potential risk of damaging intervening endoscopically invisible vessels causing life threatening bleeds. However, EUS guided drainage is now considered the standard, and it has advantages of being able to identify small collections and drain independent of the presence of a bulge. In addition, it can avoid puncture of vessels using color doppler [2].

The place for endoscopic approach in management of acute necrotizing pancreatitis is well established in the world. However, there are a few challenges to establishing the endoscopic approach in Sri Lanka. Limited availability of expertise and resources with regards to utilizing EUS is a major challenge. The lack of published local data regarding the incidence of necrotic collections in acute pancreatitis, the varying management strategies utilized in patients in other major centers in the country are limiting factors to any future attempts of establishing specialized multidisciplinary centers for pancreatic conditions.

While acknowledging the limitations of our study, namely the limited sample size and retrospective study design, we share our experience in utilizing EUS guided drainage for necrotic collections in a firmly established scientific background for the procedure. Our research aims to lay the background necessary to set international standards in Sri Lanka by sharing our successful experience of using EUS guided drainage for necrotic collections following acute pancreatitis in a tertiary care center in Sri Lanka. We hope this work can serve as a steppingstone towards achieving our objectives for the country.

Conclusion

EUS-guided interventions for PFCs have become an important component of the treatment of acute severe necrotizing pancreatitis and at present should be the first line approach in centers with endoscopists experienced in EUS guided interventions. Recent guidelines also advocate endoscopic guided PFC drainage as a safe and effective way in managing these complications of pancreatitis. With the advancement of techniques and availability of novel accessories there is substantial promise for the improved and simplified treatment of these collections.

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SCIENTIFIC ARTICLE

Intraoperative colonoscopy for anastomosis assessment in left sided colorectal surgery; does it prevent anastomotic leak?

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Keywords: Colorectal surgery, Left-sided colorectal anastomosis, Intraoperative colonoscopy, Anastomotic leak

Abstract

Background: Anastomotic leak is the most dreaded complication following colorectal surgery. Objective methods of assessing the anastomosis integrity are needed to minimise these catastrophes. Intraoperative colonoscopy allows immediate assessment of anastomosis integrity and possible bleeding from stapler line.

Purpose: The aim of our study is to evaluate the impact of intraoperative colonoscopy in preventing anastomotic leak following left-sided colorectal stapled anastomosis.

Method: A retrospective study was performed in a colorectal center in Malaysia. All patients who underwent laparoscopic and open left-sided colorectal surgery from 2019 till 2020 were included in this study. Demographic details, surgical procedure details and surgical outcome of participants were collected from their medical records. The incidence of anastomotic leak in patients who underwent intraoperative colonoscopy after anastomosis and those who did not were compared using Pearson's Chi Square test.

Results: A total number of 131 patients were enrolled in this study. 62 (47.3 %) patients underwent intraoperative colonoscopy evaluation and 69 (52.7%) patients without it. In the intraoperative colonoscopy group, 4 (6.5%) anastomotic leak were detected intraoperatively and repaired. Out of it 1 patient had postoperative leak. One patient had a leak during post operative period despite the intraoperative colonoscopy was normal. In patients without intraoperative colonoscopy, 9 (15.7%) anastomotic leak were detected during the tpostoperative period. The Pearson Chi-Square test value for the association between performing on table scope and surgery outcome was 4.092 (p=0.043) which is statistically significant.

Conclusion: The rate of anastomosis leak is lower among patients who had intraoperative colonoscopy. The detection of threatened anastomosis through intraoperative colonoscopy allows immediate surgical repair and prevention of potential anastomosis leak postoperatively. Therefore, intraoperative colonoscopy has a positive impact in terms of detection and prevention of postoperative anastomotic leak in left-sided surgical resections with stapled anastomosis.

Introduction

Surgical management of colorectal cancers has evolved over the years. Advancement in medical technologies and better understanding of the disease process has made tremendous impact in patient care. Improved surgical skills, technologies and the introduction of neoadjuvant therapy has given favourable results and improved patients' quality of life.

However anastomotic leak following a colorectal resection leads to a devastating outcome for patients. The reported rate of anastomotic leak in colorectal surgery varies from 1.8% to 19.2% with the highest risk in low rectal anastomoses [1]. Anastomotic leak considerably increases the short- and long-term morbidity and mortality rate[2]. It causes poor favorable outcomes in oncological point of view and increases financial burden both to the patient and hospital administration [2].

Factors influencing anastomotic leak can be categorized into patient-related and modifiable factors. Age, male sex, neoadjuvant chemoradiotherapy, tumor location, tobacco use and malnutrition are the known patient-related factors associated with anastomotic leak [3],[4]. Poor technical construction of the stapled anastomosis, anastomosis formed under tension and insufficient perfusion at the anastomotic site are among the modifiable factors that causes anastomosis leak in post operative period [1].

The reduction of rates of anastomosis leak, by improving its prevention, diagnosis and management continues to be a challenge. Surgeons have been routinely using many different intra-operative techniques to assess the integrity and bowel viability following surgery [5]. Usually, surgeons often look

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Received: 30-07-2024 Accepted:04-07-2025
DOI:https://doi.org/10.4038/sljs.v43i2.9167

for the bowel cut edge bleeding, pulsating marginal artery, and serosal mucosal color to determine the perfusion of the bowel before anastomosis. However, these subjective evaluations rarely guarantee a well perfused bowel edge. Karliczek et al. showed that the risk of anastomotic leak is underestimated and the accuracy of surgeons' prediction of anastomotic leak risk is low. The authors indicated a need for a reliable predictive test that could be used intraoperatively [3].

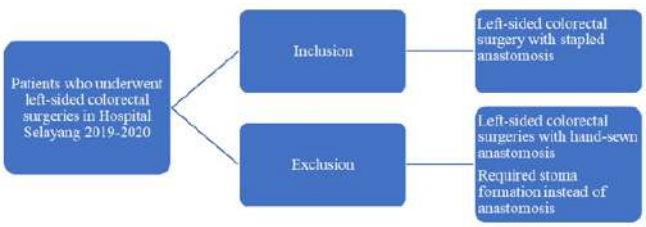
Many different tests are proposed to evaluate the integrity of the anastomosis intraoperatively. However, the ideal intraoperative test to prevent anastomotic leak is yet to be established. We have employed the usage of intraoperative colonoscopy since 2019 at our Centre. In our study we aimed to determine the utility of intraoperative colonoscopy in preventing and reducing anastomotic leak rate following colorectal surgery.

Methodology

This study was performed in a tertiary center hospital in the Klang Valley. It is a retrospective study where all patients who underwent left-sided colon/rectum resection either open or laparoscopic in year 2019 to 2020 were included. Indications for surgery were either colorectal carcinoma or diverticular disease. Both elective and emergency procedures were included. The study endpoint was incidence of anastomotic leak post-surgery.

Type of surgery performed was categorized according to tumor location. Left hemicolectomy was done for descending colon tumors and sigmoidectomy for sigmoid tumors. Anterior resection was performed for rectosigmoid tumors and rectal tumors above the peritoneal reflection, and low anterior resection for tumors below the peritoneal reflection. Anastomosis was constructed using double stapler technique in all cases. Patients with hand-sewn coloanal anastomosis were excluded from the study (Figure 1).

Figure 1: Inclusion and exclusion criteria of the study



Routine visual assessment of the proximal end of the mucosa was performed in all cases to determine the appropriate point of transection. The cut edge of the mucosal surface of the proximal colon was inspected for bleeding to determine the vascularity. Once the anastomosis is created with circular stapler, the donuts left in the device were inspected for completeness. It is mandatory in our institution to carry out an air leak test in all cases. For the air leak test, patients were tilted back to reverse trendelberg and the pelvis filled with water. The proximal end of the bowel was occluded with a grasper and 200mL of air was insufflated with a syringe over a rectal tube into the colorectal segment. The water in the pelvis was observed for bubbles from a possible anastomotic leak.

Intraoperative evaluation of anastomosis with colonoscopy was started in our center in late 2019. However, it was not routinely performed and was based on the operating surgeon's preference. After construction of the anastomosis, pelvic cavity was submerged with water. A colonoscopy will be introduced through the anus and advanced until the anastomosis was visualized. Firstly, the anastomosis will be visualized to confirm the integrity. Following that an air leak test will be performed by insufflating air through the scope while the operating surgeon occludes the proximal end of the bowel. All patients were placed in the Lloyd–Davies's position in Allen stirrups before the operation. The endoscopic surgeon stood between the legs of the patient at the end of the operating table, and the monitor was placed adjacent to the patient's left leg so that both the operating surgeon and the endoscopic surgeon could inspect the monitor in the same axis. A laparoscopic soft bowel clamp was carefully applied to occlude the lumen of the proximal bowel. Air insufflation was performed at the level of the anastomosis for an air leak test. Any bleeding or defects were noted and treated as appropriate. Salvage procedures were performed depending on the nature of the abnormality detected.

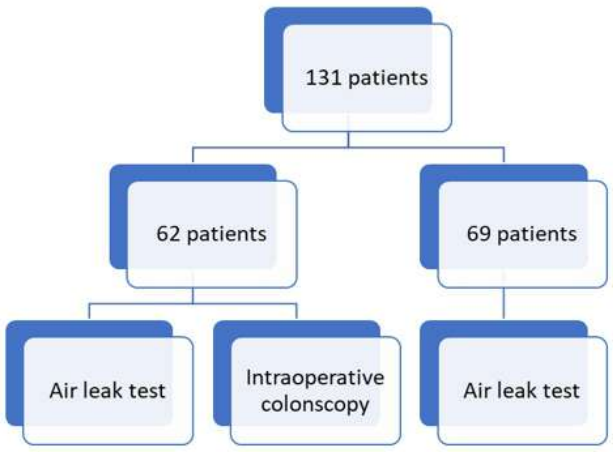
Results

A total of 131 patients were included in this study. Table 1 shows the sociodemographic details of study participants. The median age of those who underwent surgery was 61 [16-81] years. There was an equal distribution of male and female participants. The majority of surgery was done electively (91.6%) mostly involving malignant tumors (87.8%). Of the 131 patients, 40 (30.5%) underwent open anterior resection while 29 (22.1%) underwent laparoscopy anterior resection. 18 (13.7%) of the patients who had rectal tumor underwent neoadjuvant concurrent chemoradiotherapy.

Table 1: Sociodemographic of study participants

	N (%)
Age (years) Median [Range]	61 [16-81]
Gender	
Male	65 (49.6)
Female	66 (50.4)
Ethnicity	
Malay	72 (55.0)
Chinese	48 (36.6)
Indian	10 (7.6)
Others	1 (0.8)
Type of surgery	
Open sigmoid colectomy	3 (2.3)
Open anterior resection	40 (30.5)
Laparoscopy anterior resection	29 (22.1)
Open low anterior resection	15 (11.5)
Laparoscopy low anterior resection	20 (15.3)
Laparoscopy converted to open anterior resection	13 (9.9)
Laparoscopy converted to open low anterior resection	7 (5.3)
Open left hemicolectomy	3 (2.3)
Laparoscopy left hemicolectomy	1 (0.8)
Setting	
Elective	120 (91.6)
Emergency	11 (8.4)
On table scope	
Yes	62 (47.3)
No	69 (52.7)
CT done post surgery	
Yes	24 (18.3)
No	107 (81.7)
CT noted leak	
Yes	11 (8.4)
No	12 (9.2)
Unsure	1 (0.8)
Tumour type	
Benign	16 (12.2)
Malignant	115 (87.8)
Radiotherapy given	
Yes	18 (13.7)
No	113 (86.3)

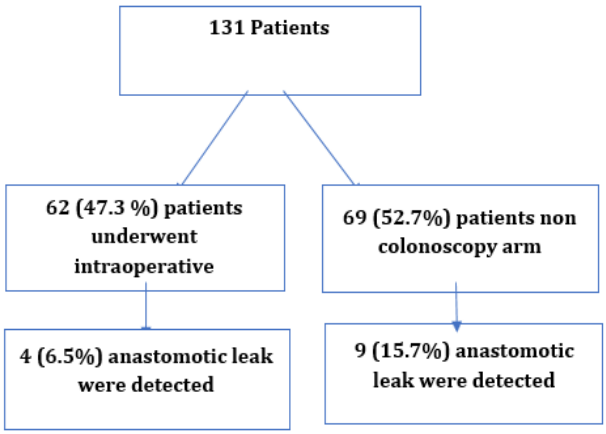
Figure 2.



Out of 131 patients, 47.3% (62) underwent on table colonoscopy after the construction of anastomosis and 52.7% (69) were in the non-colonoscopy arm. In the colonoscopy arm group 4 leakage was detected intraoperatively and was oversewn. However, 1 patient still had anastomotic leak even after the anastomosis was rectified intraoperatively. During the post operative period 1 patient had a leak detected in spite the intraoperative colonoscopy was normal.

In the non-colonoscopy group, 9 had early post operative anastomotic leak which required surgery.

Figure 3.



The Pearson Chi-Square test value for the association between performing on table scope and surgery outcome was 4.092 (p=0.043) which is statistically significant. Based on the results presented in Table 2, it can be deduced that occurrence of leak post-surgery is significantly lower in patients who underwent intra-operative scope compared to those who did not.

Table 2 : Association between performing on table scope and surgical outcome in patients undergoing colorectal surgery

Surgery outcome	On table scope performed	
	Yes [N (%)]	No [N (%)]
No leak	60 (50)	60 (50)
Leak detected	2 (18.2)	9 (81.8)

Discussion

Post operative anastomotic leak carries a major burden in terms of morbidity and mortality [6],[7]. It causes the need for re–surgery, stoma creation, longer hospital stays and delay in adjuvant treatment, leading to poor oncological outcome [6]. Despite identifying several risk factors, intraoperative technical considerations and development of prognostic indexes it is still a challenge to predict and prevent the occurrence of anastomotic leak [3],[4],[6],[7].

Numerous studies have been conducted in the past on application of intraoperative colonoscopy [2],[8]. However,

no clear consensus regarding the benefit of this method has been established till date. In a retrospective study by Shamiyeh et al. from May 1999 to July 2007, impact of intraoperative endoscopy after creation of circular-stapled anastomoses was examined in a cohort of 253 patients. Endoscopic examination allowed intraoperative identification of anastomosis line disruption in 2.4% of patients allowing immediate revision. Nonetheless, no statistically significant reduction in leak rate was appreciated in the endoscopic subset [2],[8]. Additionally, non-randomized controlled trials by Lieto et al., Lanthaler et al., Schmidt et al., and Saknoue et al. featuring application of intraoperative endoscopy were included in a meta-analysis by Nachiappan and colleagues [9]. Of the 950 patients included in this meta-analysis, intraoperative endoscopy permitted detection and immediate repair of anastomotic disruption in 13.8% of the endoscopy subset. Despite this effect, no significant differences in postoperative leak rates were established between test and control subsets [9].

In contrast our study has clearly shown the usefulness of intraoperative colonoscopy in reducing the anastomotic leak rate postoperatively. Intraoperative colonoscopy in a newly formed anastomosis is well tolerated by the patients and does not cause weakness in the integrity of the stapled line. This method of testing is very reliable and its results are reproducible. It is quite easy to perform and does not cost much delay in operative timing. Studies have shown it is relatively a safe procedure and does not cause harm to the anastomosis.

Intraoperative colonoscopy allows the surgeon to assess perianastomotic mucosal viability, mechanical disruptions and intraluminal bleeding. The colonic mucosa is less tolerant to under perfusion compared to the serosa. Therefore, intraluminal view allows one to visualize areas of mucosal ischemia. Furthermore, any bleeding from the stapler line after construction of an anastomosis can be dealt with intraoperative colonoscopy. Air leak test is also possible to be done through intraoperative colonoscopy. Intraoperative measures taken once abnormal colonoscopy findings will reduce the total number of anastomotic leaks postoperatively.

In the past, surgeons were concerned as to the safety and potential complication related to intraoperative colonoscopy. It was speculated that intraoperative colonoscopy can damage the anastomosis due to elevated intraluminal pressure. However, studies have proven that this procedure is safe and well tolerated as the maximum pressure in the neorectum after resection and the colorectal anastomosis can reach up to 200mmhg [1], [10]. The mean maximal pressure during intraoperative colonoscopy in humans is about 42mmHg, while at least 2-fold higher pressure is necessary to cause leakage in experimental large animal studies [1],[10].

Air leak test which is commonly performed using a catheter or syringe did not effectively reduce the incidence of clinical anastomotic leak. Yang et al. has evaluated the benefit of air leak test with intraoperative colonoscopy [11]. They reported a lower overall incidence of anastomotic leak in the intraoperative colonoscopy group than in the conventional air leak test group. Intraoperative colonoscopy is able to provide air insufflation with adequate and steady pressure for air leak test compared with other methods thus able to detect potential air leakage. Hence, we recommend performing air leak test with intraoperative colonoscopy.

In our present retrospective study air leak test was routinely performed in all patients who underwent left sided colorectal anastomosis. However, the choice of air leak test through syringe or intraoperative colonoscopy is the choice of the operating surgeon. Our results clearly show air leak test using intraoperative colonoscopy is a more reliable method for detecting technical defects in the anastomosis compared to conventional air leak test through syringe method. The higher positive intraoperative leak test in the intraoperative colonoscopy group could indicate that leak assessment through intraoperative colonoscopy is the more efficacious method for detecting defects in the anastomosis.

Furthermore, a retrospective study conducted by Carannante, Filippo, et al. investigated whether implementing a quadruple assessment approach during colorectal anastomosis could help reduce the rate of anastomotic leakage in rectal cancer patients. The protocol involved four key evaluations: an air leak test; indocyanine green fluorescence angiography (ICGFA) to determine the proximal resection margin and assess the rectal stump; endoscopic examination combined with ICGFA; and inspection of both anastomotic doughnuts following circular stapling. A total of 293 patients participated in the study. The group that underwent the quadruple assessment showed a significantly lower incidence of anastomotic leakage compared to the control group (7.7% vs. 16%; $p = 0.001$). This reduction remained significant [12]. This study demonstrates how the structured application of a quadruple assessment during colorectal anastomosis may enhance awareness of anastomotic integrity and help lower the incidence of anastomotic leakage.

There were some limitations in our study. Firstly, it was a retrospective study without randomization of patient selection. Second, relatively small sample size may have impacted overall power and the ability to discern effect on

other key endpoints. The decision to perform intraoperative colonoscopy was dependent on surgeons' preference. There was no documentation on mucosal grading which determines a well perfused anastomosis. Furthermore, the salvage procedure was not highlighted once leak was noted intraoperatively. Future prospective studies with a larger population size are warranted.

Conclusion

Our study has clearly showed the effectiveness of intraoperative colonoscopy in preventing anastomotic leak following left-sided colorectal surgery. We were able to rectify the anastomosis intraoperatively if leak is detected and thus reduce the postoperative leak rate. It has gained popularity among surgeons at our institution as anastomosis done in 2020 has routinely undergone intraoperative colonoscopy.

Conflicts of Interest

The authors declare that they have no conflicts of interest regarding this study.

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SCIENTIFIC ARTICLE

Assessment of the anatomical position of the vermiform appendix in a Sri Lankan cohort using contrast enhanced computed tomography imaging

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Keywords: Appendix, Contrast-Enhanced Abdominal CT (CECT), Anatomical position

Abstract

Introduction: Proper and advanced knowledge regarding the anatomical position of the appendix is important for radiologists, surgeons, and clinicians in diagnosing pathological conditions of the appendix.

Objectives: To assess the anatomical position, length, diameter, and luminal contents of the appendix in Contrast-Enhanced Abdominal CT (CECT) scans.

Methodology: A descriptive cross-sectional study was conducted at the Department of Radiology at Teaching Hospital Peradeniya over a period of one year, from May 2022 to April 2023. A total of 275 patients were included in the study. All abdominal CECTs among the patients who fulfilled the inclusion criteria during the study period were included. Post-contrast, a 70-second delay in the portal venous phase with a slice thickness of 1.0 mm for 3D reconstructed images was used to assess the anatomical position of the appendix. The CT scans were evaluated based on the anatomical details of the appendix, which included length, the maximum values of inner and outer diameter, and the position of the base and tip of the appendix. Descriptive statistics were used to analyze the demographic profile of the study sample.

Results: The mean age of patients was 57 years, with the majority being male (54.2%). The appendix was identified in only 87% of the abdominal CECT scans. The mean length of the appendix was 6.45 cm, and the mean inner and outer diameters were 3.90 mm and 5.49 mm, respectively. The mean length from the ileocecal valve to the base of the appendix was 2.31 cm. Approximately 42% of the appendices were located in the pelvic 5 o'clock position, while the pre-ileal 1-2 o'clock and retrocecal 11 o'clock positions were identified in approximately 28% and 11%, respectively. A statistically significant association was demonstrated between gender and the mean outer diameter of the appendix ($p < 0.05$).

Conclusion: The findings of the present study provide information about anatomical details of the appendix which is useful for radiologists as well as clinicians for diagnosis and treatment planning

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https://orcid.org/0000-0002-6289-1780
Received: 04-05-2025 Accepted: 14-07-2025
DOI: https://doi.org/10.4038/sljs.v43i2.9248

Introduction

The vermiform appendix is a small but significant abdominal organ, often assessed by radiologists during abdominal CT scans in patients with various abdominal complaints. A thorough understanding of its anatomy, including common variants and unique characteristics, is critical for effectively visualizing and diagnosing conditions related to the appendix through imaging techniques [1],[2]. Accurate identification of the appendix is essential for managing diseases that involve this organ.

Typically, the vermiform appendix measures between 8-10 cm in length and has a thin wall with a diameter of about 6 mm. It is attached to the posteromedial surface of the cecum, located approximately 1-3 cm below the ileocecal valve [3],[4],[5]. Research indicates that the length and anatomical positioning of the appendix can vary significantly, influenced by demographic factors such as age, sex, and ethnicity [6].

The commonest anatomical position of the appendix is retrocecal (74%), followed by pelvic (21%). Other less common locations include para-cecal (2%), sub-cecal (1.5%), pre-ileal (1%), and post-ileal (0.5%) [7]. Understanding these variations is crucial for accurate diagnosis and management of appendiceal pathologies, especially in patients presenting with abdominal pain or suspected appendicitis.

The normal appendix can contain varying contents, including air and substances with either low or high density. A fluid-filled appendix with increased diameter (greater than 6 mm) along with features such as peri-appendiceal fat inflammation

or calcified appendicoliths, may indicate underlying pathology like appendicitis. This condition can be diagnosed with a high sensitivity of 94% and specificity of 95%[8]. Multidetector computed tomography (CT) scans successfully identify the appendix in at least 80% of cases[9], although it remains unvisualized in approximately 15% of reported scans [10].

Conducting a study to assess the anatomical position, length, diameter, wall thickness, and luminal content of the vermiform appendix would be invaluable for identifying anatomical variations specific to the Sri Lankan population. By applying radiological knowledge, this research aims to enhance the identification of both normal appendices and anatomical variants. Currently, similar studies are scarce both locally and internationally, making this research a potential pilot for future multicenter study.

The primary objective of this study was to determine the common anatomical positions of the base and tip of the vermiform appendix among patients undergoing contrast-enhanced abdominal CT scans at Teaching Hospital Peradeniya (THP). Additionally, the study assessed the length and diameter of radiologically normal appendices, the nature of luminal contents, and variations in length and diameter concerning patient gender and age.

Methodology

This descriptive cross-sectional study was conducted in the Department of Radiology at Teaching Hospital Peradeniya over a one-year period, from May 2022 to April 2023. Ethical clearance was obtained from the Ethical Review Committee of the Faculty of Medicine, University of Peradeniya, and administrative approval was granted by the director of Teaching Hospital Peradeniya. The study population comprised patients undergoing abdominal contrast-enhanced computed tomography (CECT) scans at the Department of Radiology during the study period. All included abdominal CECT scans were originally performed for various diagnostic indications unrelated to this study, and the images were retrospectively reviewed to evaluate the appendix.

Patients aged 16 years and older were included in the study, whereas those presenting with acute appendicitis, appendicular abscess, or appendicular mass were excluded. Additionally, individuals who had previously undergone appendicectomy or had a history of abdominal surgery, as well as CTs with poor image quality, were also excluded from the study.

The sample size calculation was performed using the Lwanga and Lemeshow formula, based on a prevalence of appendicitis identified through multidetector CT scans of 0.8 [9], a 95% confidence level, and an absolute precision of 5%. According to the sample size calculation, a minimum of 246 participants was required. To account for potential sampling errors, a total of 275 patients were ultimately enrolled in the study.

Patients' demographic details, including age, gender, and relevant clinical history, were collected through an interviewer-administered questionnaire to assess the inclusion and exclusion criteria. Patients who fulfilled the inclusion criteria were recruited for the study after obtaining informed written consent. Low-osmolar iodinated contrast (300 mg I/ml) was administered as intravenous contrast, with the dose calculated according to body weight (1 mg/kg). Axial images were acquired using a Siemens® 16-slice multiplanar CT machine in the post-contrast portal venous phase with a 70-second delay, at a slice thickness of 1.0 mm. Reformatted sagittal and coronal images were obtained using the multiplanar reconstruction method.

All studies were reported by a consultant radiologist, and the findings were documented. The CT scans were evaluated based on anatomical details of the appendix, which included the length, maximum inner and outer diameters, position of the base and tip, and density of the intraluminal contents. The anatomical orientation of the tip of the appendix was recorded using a 'clock-face' analogy, where the position was determined relative to the base of the appendix. The base was considered as the centre, and the direction of the tip was assigned accordingly. The Hounsfield (HU) value of the luminal contents was obtained by averaging the HU value at the most dilated part of the cross-section of the appendix in the axial image.

All data were entered and analyzed using SPSS (version 26). Descriptive statistics were employed to analyze the demographic profile of the study sample, and the results were presented using graphs and tables where necessary. The mean value with standard deviation was used as the measure of central tendency and dispersion to calculate representative values for the length and diameter of the normal appendix. Separate mean values with standard deviations were calculated for males and females to obtain representative values for each group. An unpaired t-test was utilized to examine the possible relationships between gender and the length of the appendix, as well as between gender and its

diameter. Pearson's correlation coefficient was applied to assess the potential relationships between age and the length of the appendix, and between age and its diameter. For luminal contents, the results were expressed as percentages. A statistically significant p-value was defined as ($P < 0.05$).

Results

Demographic correlation

The total study sample was 275, of whom 144 (52.5%) were male and 131 (47.5%) were female. The mean age of the study population was 57.4 years. In terms of age distribution, 44% of participants were under 40 years old, 41% were between 40 and 60 years old, 11% were aged 60 to 80 years, and only 1% were over 80 years (Figure 1). Appendix was identified in 87% of abdominal CECTs, whereas it could not be visualized in 13% of CECTs.

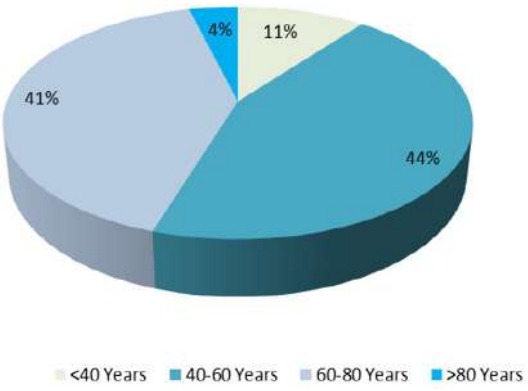

Figure 1: Age distribution of the study sample

Anatomy of the appendix

The mean length of the appendices was 6.45 cm (SD = 1.60). The mean inner diameter measured 3.9 mm, while the mean outer diameter was 5.49 mm (see Table 2).

Position of the appendix

The position of the base and tip of the appendix was observed. The base of the appendix was found below the ileocecal valve in all patients, with a mean distance of 2.31 ± 0.851 cm from the ileocecal valve to the base of the appendix. The clock-face analogy used in this study refers to the position of the tip with respect to the base of the appendix. For instance, a 5 o'clock position indicates that the tip lies in the pelvic direction when the base is considered as the centre point. According to that, the most common position of the tip of the appendix was in the pelvis at the 5 o'clock position (41.8%, n = 100). The second most common position was preileal at the 1-2 o'clock position (27.6%, n = 66). The paracecal position was the least common position of the tip of the appendix identified in our study (1.7%, n = 4) (see Table 1).

To ensure the evaluation of anatomically normal appendices, all cases with suspected or confirmed appendiceal pathology (such as acute appendicitis, appendicular abscess, or mass) and previous abdominal surgery cases were excluded during sample collection. Therefore, pathological presentations were not assessed or discussed in this study.

Table 1: Frequencies and percentages of different positions of the tip of the appendix.

Position of the tip of the appendix	Frequency (%) (N=275)
Retrocecal 11 o'clock	25(10.5)
Para-caecal	4(1.7)
Sub caecal 6 o'clock	39(16.3)
Pelvic 5 o'clock	100(41.8)
Post -ileal 1-2 o'clock	5(2.1)
Pre -ileal 1-2 o'clock	66(27.6)

Luminal contents of the appendix

Luminal contents were categorized into five groups based on the Hounsfield value (Hu) of the contents. Most appendices contained low-density material (61.1%), while 4.2% of the appendices contained fat, which was the least common type. High-density material was found in 5.4% of the cases, and fluid was present in 11.7% of the cases (Figure 2).

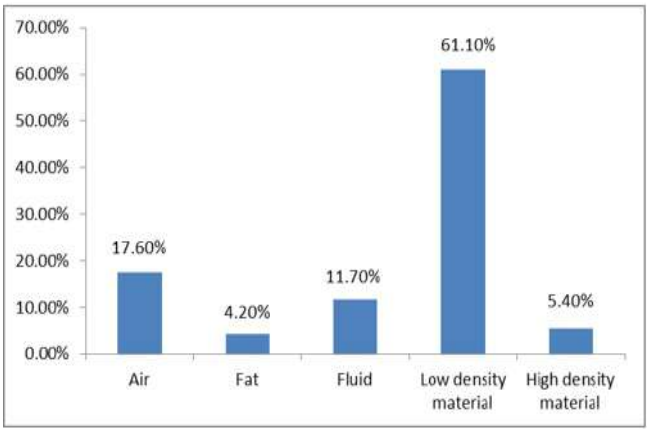

Figure 2: Distribution of luminal contents

Association between length of the appendix with demographic factors.

The Kruskal-Wallis H Test was used to assess the association between age and gender with the length of the appendix. The p-value was > 0.05, indicating that there was no statistically significant association between the length of the appendix and age or gender (Table 2).

Table 2: Correlation between the length of the appendix with demographic factors

Demographic factors	Length (cm) (Mean ±SD)	p Value
Age		
<40 Years	6.35±1.62	0.150
40-60 Years	6.66±1.40	
60-80 Years	6.37±1.73	
>80 Years	5.41±1.97	
Gender		
Male	6.55 ±1.49	0.297
Female	6.34±1.72	

Association between inner diameter of the appendix with demographic factors

The p-value for the inner diameter of the appendix with age and gender was > 0.05, leading to the conclusion that there was no statistically significant association between the inner diameter of the appendix and age or gender (Table 3).

Table 3: Association between demographic factors and the inner diameter of the appendix.

Demographic factors	Inner Diameter (mm) (Mean ±SD)	p Value
Age		
<40 Years	3.85 ±0.77	0.815
40-60 Years	3.94 ±0.69	
60-80 Years	3.89 ±0.88	
>80 Years	3.77 ±0.71	
Gender		
Male	3.94 ±0.78	0.450
Female	3.86±0.78	

Association between outer diameter of the appendix with demographic factors

Although there was no association between age and the outer diameter of the appendix ($p > 0.05$), a statistically significant association was observed between gender and the outer diameter of the appendix ($p < 0.05$). The mean outer diameter of the appendix in males was greater than that in females, with values of 5.61 mm and 5.36 mm, respectively (Table 4).

Table 4: Association between demographic factors and the outer diameter of the appendix

Demographic factors	Outer Diameter (mm) (Mean ±SD)	p Value
Age		
<40 Years	5.44 ±0.81	0.772
40-60 Years	5.50±0.72	
60-80 Years	5.52±0.93	
>80 Years	5.33±0.95	
Gender		
Male	5.61 ±0.81	**0.020**
Female	5.36±0.83	

Discussion

In our study, the appendix was identified in 87% of CECT abdominal scans, which is similar to some studies [11] slightly higher than in some studies [12],[13],[14] and slightly lower than in others [15],[16]. The study by Narayan V et al. reported 100% visualization of the appendix in 120 patients who had undergone CECT abdomen; however, unlike our study, oral and rectal contrast were administered to all patients [25]. The use of only intravenous contrast may have contributed to the non-visualization of 13% of cases in our study. According to Willekens et al., the accuracy of appendix visualization is 82%, which is slightly lower than our findings [12]. Another study conducted on multidetector computed tomography identified the normal appendix in 92% of patients [16]. Visualization of the appendix is lower in non-contrast CT studies, as reported by Benjaminov O et al. [14]. This study indicated that the interobserver agreement for visualization of the normal appendix ranged from 69% to 75%. These findings are likely due to the poor visualization of structures in non-contrast CT, especially smaller structures like the appendix. Poor visualization or non-visualization of the appendix can also be influenced by other factors in the abdomen, such as ascites or inadequate pericecal fat [16].

The most common position of the tip of the appendix in our population was the pelvic 5 o'clock position (41.8%). This finding is consistent with the study conducted by Willekens et al., in which the most common location of the tip of the appendix was in the pelvis in 66% of cases [12]. The study conducted by Ahmed et al. using laparoscopic findings also shows that the most common position of the appendix is

the pelvic (51%) [5]. According to Narayan V et al., the most common location of the tip was retrocecal (37%), with the pelvic location identified in 32% of cases [15].

Another descriptive study was conducted in India in 2018 with the aim of studying the variation in the anatomical features, length, and external diameter of the appendix and its association with age and sex in the Indian population, which was similar to ours. Out of the 418 cases included in this study, the majority (55.5%, n=111) demonstrated an appendix situated in the retrocecal position. The pelvic position was observed in 47 cases (23.5%). In addition to these two positions, retroileal (9.0%, n=18), subcecal (6.5%, n=13), paracecal (5.0%, n=10), and subhepatic positions were also identified (0.5%, n=1). The methodology of this study was quite different from ours, as it was conducted on patients who were clinically diagnosed with acute appendicitis. Diagnosed patients underwent thorough clinical examinations, laboratory investigations, and ultrasound scans (USS) of the abdomen, and the appendiceal specimens were sent for histopathological examination after surgery [18]. The inclusion of inflamed appendices in this study, as opposed to the normal appendices evaluated with CECT in our study, could explain the discrepancy in results regarding the position of the appendix in the two studies.

In our study, the mean length of the appendix was 6.45 cm, which is less than the range described in international literature, which is 8-12 cm [3], [4], [8]. A Brazilian cadaveric study reported the mean length of the appendix to be 11.4 cm [4], which is significantly greater than the findings of our study. The body habitus of the individuals may contribute to this discrepancy.

A retrospective study evaluating 186 patients undergoing CT with no suspicion of acute appendicitis demonstrated a statistically significant correlation between gender and appendiceal length, with men having longer appendices than women [12]. These findings are consistent with those of our study as well.

An Iranian cadaveric study shows a significant difference in diameter ($p = 0.002$) between females and males [19], supporting the statistically significant association between gender and outer diameter detected in our study.

No significant association was identified between age and gender with the mean length of the appendix in our study.

The mean outer diameter of the appendix in males and females in our study was 5.61 ± 0.81 cm and 5.36 ± 0.83 cm, respectively, which is consistent with the findings of the study conducted by Jan et al. [16].

According to Jan et al, luminal contents of the appendix were unrecognizable in 35 (39%) of 91 patients, because the lumen collapsed, or the contents had the same attenuation as the wall. In contrast to our study, the major substance in the lumen in the visualizing cases of this study was air (48%, n=44) Contrast medium (4%, n=4), and high-density material (9%, n=8) was also detected. Ten of the 44 air-filled appendices also had some high-density material in the lumen. Therefore, high-density material was present in 18 (20%) of 91 patients in Jan et al. [16].

High-density material was detected only in 5.4% of cases in our study.

In a retrospective review of 186 patients undergoing abdominal CT without suspicion of acute appendicitis, it was shown that normal appendices contained air and low-density material in 44.7% (42 of 94), low-density material in 22.3% (21 of 94), were completely air-filled in 17% (16 of 94), contained air and high-density material in 13.8% (13 of 94), and contained high-density material in 2.2% (2 of 94) [12]. In our study, combinations like these were not demonstrated, as we obtained the average HU value at the most dilated part of the appendix and predicted the density of material based on that HU value.

It is important to note that our study exclusively included radiologically normal appendices, and cases with suspected appendiceal pathology were systematically excluded. Therefore, although variations in anatomical positioning can influence clinical symptoms, these implications were not explored in our study. Future research involving pathological cases could assess how these anatomical variations correlate with clinical presentations, especially during episodes of acute appendicitis.

Limitations and recommondations

One of the limitations of this study was the smaller sample size, which may account for some discrepancies in the findings compared to international literature. To standardize the conclusions for the Sri Lankan population, a study involving a larger sample size is recommended.

A primary limitation of using CT to detect pathologies in the appendix is radiation exposure. Several modifications to the CT protocol have been attempted to reduce this exposure,

including low-dose CT, non-contrast CT, and focused CT of the appendix/right iliac fossa. Therefore, with the increased CT visualization rate of the appendix and the reduced radiation exposure resulting from these modifications, CT may be used more freely in the evaluation of suspected appendicitis in the near future.

Conclusion

In this study, we found that the appendix was visualized in 87% of abdominal CECT scans, consistent with previous literature but slightly variable compared to other studies. The mean length of the appendices was determined to be 6.45 cm, which is less than the international average but may reflect demographic factors unique to the population studied. The most common position of the tip of the appendix was noted to be the pelvic 5 o'clock position, aligning with findings from other studies.

Notably, our research revealed no significant associations between the length or inner diameter of the appendix and demographic factors such as age or gender. However, a statistically significant correlation was observed between gender and the outer diameter of the appendix, with males exhibiting a larger mean diameter compared to females.

The findings regarding luminal contents also suggest variability, with low-density material being the most common type identified in our study compared to other studies which reported air or high-density material as prevalent.

While our results provide valuable insights into the anatomical features and visualization characteristics of the appendix within the Sri Lankan population, the study is limited by its relatively small sample size and potential biases inherent in using CT imaging. Future research with a larger cohort will be essential to validate these findings and establish a more comprehensive understanding of appendiceal anatomy and pathology.

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SCIENTIFIC ARTICLE

Lumbar isthmic spondylolisthesis: comparative insights into patient selection, surgical techniques, and clinical outcomes

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Keywords: Spondylolysis, Spondylolisthesis, Spinal motion segment, Interbody fusion, Spinal decompression

Abstract

Background: Lumbar isthmic spondylolisthesis (SL), often resulting from underlying spondylolysis, is a prevalent cause of chronic lower back pain and radiculopathy. The optimal surgical strategy—particularly in relation to the severity of SL and sequence of intervention—remains a topic of clinical interest. This study aims to compare one-stage versus two-stage surgical approaches in patients with Grade 1–4 SL, with a focus on functional outcomes, complication rates, and sagittal alignment.

Methods: A retrospective observational study was conducted involving 80 patients (49 women, 31 men; aged 18–89 years) diagnosed with spondylolysis and SL. Patients were stratified into four groups (1A, 1B, 2A, 2B) based on SL grade and surgical strategy (single- or two-stage). Surgical interventions included transforaminal lumbar interbody fusion (TLIF), minimally invasive TLIF (MISS-TLIF), and posterior lumbar interbody fusion (PLIF), with decompression and interbody fusion using autograft and cages. Outcomes were assessed using the Frankel Scale, Karnofsky Index, ECOG/WHO Performance Status, and McCaffrey Pain Assessment.

Results: Sagittal alignment was restored in most cases. Group 1B (single-stage TLIF) showed complete balance restoration, while 1A (two-stage) showed sustained correction with minimal complications (3.75%). Group 2A achieved stability through staged decompression and fusion, with a 5% complication rate. Neurological improvements and reduced pain perception were noted across all groups.

Conclusion: Tailored surgical planning based on SL grade and neurological status is critical. One-stage TLIF is effective in lower-grade SL, while staged surgery is preferred in advanced cases with instability or neurological compromise. Interbody fusion significantly enhances sagittal alignment and functional outcomes.

Introduction

Low back pain (LBP) is a frequent occurrence in neurosurgical practice and can affect patients of all ages [1]. Spondylolysis, which results from a disruption of the pars interarticularis portion of the vertebral arch, is a common etiology of LBP and predisposes individuals to isthmic spondylolisthesis (SL), which typically develops in young adolescent athletes.

Approximately, 90% of patients with spondylolysis either present with or will eventually develop spondylolisthesis; According to recent research, SL affects 5-7% of the population. [3]. Spondylolysis most commonly affects the L5 vertebral level, with the L4 being significantly less affected. [11]. Radiological techniques such as AP and lateral lumbar X-rays play a crucial role in the diagnostic process. The grades for SL are assigned based on the degree of slippage, starting at 25% in grades I-IV and rising by one quartile in subsequent grades [5]. This study aims to compare spondylolisthesis in two groups (A and B, grades 1-4).

Materials and methods

This retrospective observational study involved 80 patients, with an age range of 18 to 89 years, comprising 49 women (61%) and 31 men (39.2%). The patients were admitted to our Spine rehabilitation center, part of the Vertebrology Division at NCC No. 2, Petrovskovo Academy, Moscow, Russia, between January 2020 and March 2025. The study was

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https://orcid.org/0000-0001-6484-6775
Received: 20-06-2025 Accepted: 12-07-2025
DOI: https://doi.org/10.4038/sljs.v43i2.9257

conducted in accordance with the principles of the Declaration of Helsinki. The study was conducted with the official permission of the Ethics Committee of the Petrovsky National Research Center of Surgery and Traumatology (Petrovsky NRCS) in Moscow. (Ref. ESN/6_1222).

Inclusion criteria

The study included patients aged 18 years and older who were diagnosed with spondylosis or spondyloarthritis and had progressed to lumbar isthmic spondylolisthesis, anterolisthesis, or retrolisthesis requiring surgical correction. The following surgical techniques were employed: transforaminal lumbar interbody fusion (TLIF) as the primary technique, minimally invasive surgical TLIF (MISS TLIF), and posterior lumbar interbody fusion (PLIF), for better fixation of pedicle screws, stabilization, and decompression to restore the spine's dynamics.

Exclusion criteria

Patients were excluded if they had no spondylolisthesis, were under 18 years of age, or had extraforaminal disc herniation without vertebral displacement.

Statistical Analysis

The data analysis was conducted using Excel and R software (https://www.r-project.org), distributed according to the following scales: Frankel scale, Karnofsky index, and the Eastern Cooperative Oncology Group/World Health Organization Performance Status (ECOG/WHO PS). The results were presented as mean ± standard deviation (SD) values. To estimate outcome measures based on individual data from included studies, statistical analyses were conducted. A p-value of less than 0.05 was deemed significant.

Results

In this study, 80 patients were included, and those with spondylolysis and spondylolithesis of the lumbosacral spine were diagnosed and treated. In group 1A, N=19 patients, or 23.7%, were present via consultation, with a percentage of ≥90 based on the Karnofsky index scale. No noteworthy circumstances were observed. Group 1B, N=14, at the same level, 17.5%. Between 70 and 89, group 1A had three patients (3.7%) and group 1B had four patients (5%). Groups 2A and 2B, N=17 and N=5, respectively, represent 21% and 6%. 50–69; N=3, 3.7%; only found in group 2A. N=9, or 11%, in group 2B, the same category. 5% is represented by group 2A, which is 30-49 on the scale. Group 2B; 2.5%, N=2. 10-29, no information, no fatalities. Shown in table 2. Prior to surgery, the clinical and neurological symptoms of the patients were rated using the Frankel, Eastern Cooperative Oncology Group-World Health Organization (ECOG-WHO), and Karnofsky performance scales. The McCaffrey Initial Pain Assessment Tool (MCIPAT) was used to assess the level of pain a person was experiencing. The surgical intervention in all groups involved reducing the dislocated spinal segment and interbody fusion in addition to repositioning and stabilizing the lumbar spine using transpedicular reduction screws. The groups that underwent TLIF and MISS-TLIF procedures experienced varying degrees of nerve root decompression, spinal alignment reduction, and an algorithm for ordering the operations.

Patients were divided into groups 1A and 1B and 2A and 2B, according to the sequence in which spondylosynthesis and interbody fusion were performed. Patients in Group 1 had SL grades of 1 or 2, an unstable spinal motion segment, and bearable discomfort from a slight radiculopathy. Patients in Group 2 had SL grades 3 and 4 [7].

A two-stage operation was used in patients in group 1A. By reducing the dislocated vertebrae, spondylosynthesis was corrected, and the spine was realigned without damaging the spinal cord. Anterior fusion was then performed using autologous bone. In group 1B, a single-stage procedure was used. Through the TLIF approach, vertebral reduction and anterior interbody fusion were achieved, as shown in Tables 1 and 2 and Figures 1, 2, 3, and 4. While 19 patients in group 1A maintained restoration of sagittal balance after spondylolythesis correction, with a rate of 23.75%, only 3 patients in this group experienced complications, at a rate of 3.75%. In total, 22 patients in this group underwent surgery, with a rate of 27.75%.

Postoperative problems affected a total of 9 individuals, or 11.25% of the participants. For 14 patients in Group 1B, the sagittal alignment of the SL section was restored to decompress the nerve roots. Interbody fusion implants were implanted using autologous bone and implants via a posterior approach during the same session or via a ventral approach during the following 7 to 10 days. Only 4 patients were excluded, representing 5%, and in total, 18 patients were excluded, accounting for 22.5%.

Table 1: Age and gender distribution of patients included in the study.

Age	Male		Female		Total number of patients
	Number of patients	Percentage %	Number of patients	Percentage %	
16–20	1	1.25	2	2.50	3
21-30	2	2.50	4	5	6
31-40	5	6.25	5	6.25	10
41-50	4	5	10	12.50	14
51-60	9	11.25	14	17.50	23
61-70	7	8.75	8	10	15
71-80	3	3.75	6	7.50	9
Total	31	38.75	49	61.25	80

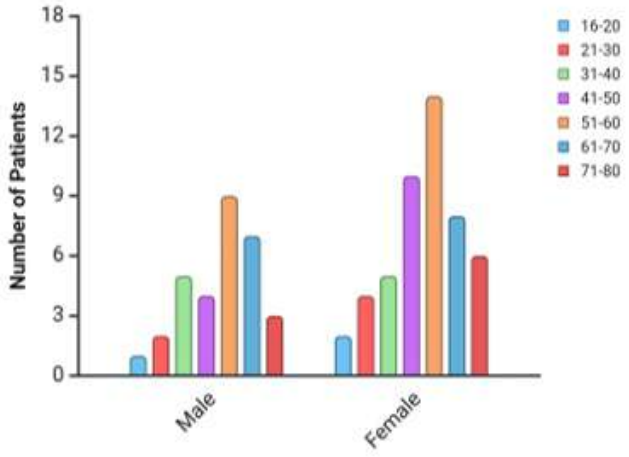
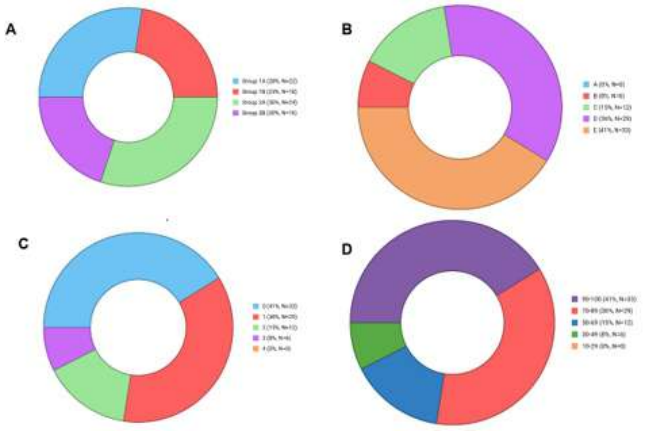


Figure 1: Patient distribution in the study according to age and sex

Table 2: Distribution of patients based on the severity of their neurological symptoms and the surgical procedures they underwent, categorized according to different scales.

Frankel scale	Karnofsky index, %	ECOG -WHO	Number of patients							
			1A	%	1B	%	2A	%	2B	%
E	≥90	0	19	23.75	14	17.50	0	0	0	0
D	70-89	1	3	3.75	4	5	17	21.25	5	6.25
C	50-69	2	0	0	0	0	3	3.75	9	11.25
B	30-49	3	0	0	0	0	4	5	2	2.5
A	10-29	4	0	0	0	0	0	0	0	0
(Total no of patients= 80)			22	27.50	18	22.50	24	30	16	20



Figures 2: Distribution of patients included in the study according to the assigned groups (A), the Frankel Scale (B), the ECOG-WHO Scale ©, and the Karnofsky Performance Scale (D).

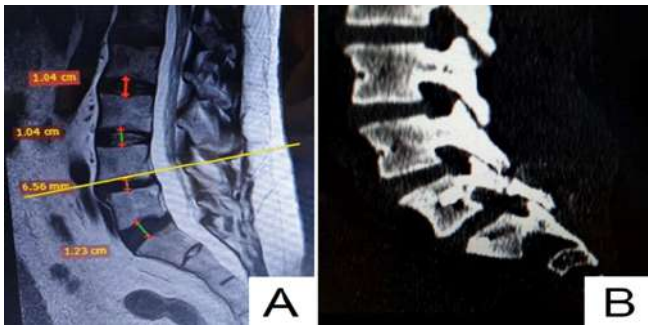


Figure 3: Case example of a 66-year-old female patient with bilateral isthmic spondylolisthesis, presenting with chronic lower back pain radiating to both legs. She was diagnosed with Grade 1 spondylolisthesis and bilateral pars defects at the L5–S1 level.

A) T1-weighted sagittal MRI of the lumbar spine showing narrowing of the intervertebral disc spaces.

B) Sagittal non-contrast CT scan of the same patient demonstrating bilateral pars interarticularis defects at the L5–S1 level.

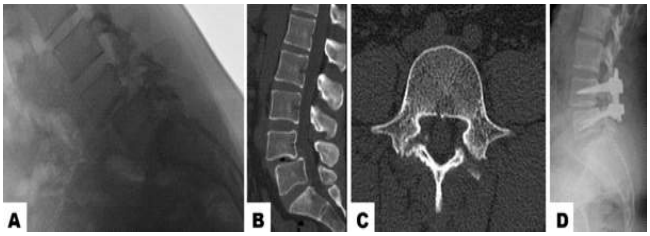


Figure 4: A case example of a 40-year-old female patient who presented with chronic low back pain (LBP) radiating to her left leg.

Despite undergoing multiple conservative treatment modalities, she experienced no pain relief.
A) Preoperative lumbar lateral flexion X-ray showing Grade II spondylolisthesis at the L4-5 vertebral level.
B) Preoperative sagittal non-contrast-enhanced CT scan confirming spondylolisthesis and detecting a vacuum phenomenon in the intervertebral disc space between the L4 and L5 vertebrae, which may indicate spinal instability.
C) Preoperative axial non-contrast-enhanced CT scan revealing a bilateral pars interarticularis defect (L4-L5).
D) Postoperative lateral lumbar X-ray after lumbar stabilization depicting the correction of the deformity.

Group 2 included patients characterized by grade III and IV SL, instability of the spinal motion segment confirmed by dynamic X-rays, and severe neurological disorder. These patients underwent bilateral laminectomy, foraminotomy, and flavectomy. We allowed decompression of the spinal roots; the vertebral reduction was performed in the displaced area, accompanied by visual neuromonitoring of the spinal roots (or by electroneuromyography (ENMG)) [9].

In all patients, interbody fusion was performed using autologous bone and various implants. The sequence of implementation of spondylosyndesis and interbody fusion varied between subgroups 2A and 2 B in this category of patients. They underwent TLIF and MISS-TLIF, which yielded excellent results after surgery [10].

Subgroup 2A patients received a two-level surgical procedure. The first stage involved posterior spondylosyndesis, open decompression of the operated vertebrae, and restoration of the normal function of the spinal cord neurons. A discectomy was carried out from the ventral access on the seventh to tenth day following the initial procedure, along with anterior interbody fusion utilizing autologous bone or an implant.

Patients in subgroup 2B got posterior decompression, correction, and stabilization. The decompression of the spinal nerve roots with spinal reduction was followed promptly by interbody fusion and final transpedicular spondylosyndesis. This group generally consisted of patients whose morbidity would be significantly increased by a second intervention and complications after the first surgery [11].

While 17 patients in group 2A recovered their sagittal balance, only four patients required postoperative intervention, resulting a rate of 5%. Meanwhile, three patients in this group experienced postoperative complications, corresponding to a rate of 3.75%. The percentage of patients in group 2A, out of the 17 patients who underwent restoration of sagittal balance with SL, was 21.25%, corresponding to a total of 24 patients, or a rate of 30%. While the percentage of patients in group 2B who had uncomplicated restoration of balance and a normal pain threshold was 20%, with a total of 16 patients, or 20%.

Patients underwent follow-up exams for 12 months and 2-3 years after surgery. Three years is a limiting time indicator because the supporting interbody bone or bone-fibrous block has fully developed. In the process of analyzing the results of surgical intervention for patients with spondylolysis and SL in both categories, pain perception dynamics, neurological deterioration pre- and postoperatively, and changes in labor function following therapy were assessed [12].

According to changes in radicular sensitivity, a total of 21 patients (26.25%) experienced paresthesia, hypesthesia, and hyperalgesia. In 14 people (17.5%), there were sensory changes, including hypoesthesia and paresthesia in the extremities with the corresponding dermatome.[13]. Only nine patients (11.25%) said they had severe pain that only narcotic analgesics (i.e., McCaffee of 3 points) could manage. Other patients assessed their pain as satisfactory (i.e., McCaffee of 1-2 points) [14].

In contrast to group 2B, where the majority of patients showed improvement (n=12), all patients in group 1B experienced a complete restoration of sagittal equilibrium. Lower pain scores were seen once after therapy. Additionally, a 20% improvement in the Karnofsky Performance Index and a one-point decline on the ECOG-WHO scale were both achieved. Only 16 (12.8%) and 10 (8%) of the patients in groups 1A and 2A, respectively, demonstrated restoration of sagittal equilibrium after one level of therapy, which has been shown high success by reclining the disc to restore lordosis.

Patients in groups 1A and 2A underwent anterior lumbar interbody fusion postoperatively to enhance stability at the second level. 11.25% experienced postoperative complications. In group 2A, 5 cases (6.25%) of postoperative sagittal imbalance syndrome were reported. The grade 4 SL long-term subtype present in this group of individuals, surgical decompression of the spinal canal composition, further transpedicular SL, and corpodesis were performed. Approximate signs of surgical therapy for people with spondylolysis and SL were evaluated many years after surgery was finished. Computed tomography (CT) was conducted on each patient after the postoperative period [15].

Discussion

Clinical and radiological characteristics

In this study, patients with grade I and II SL are managed conservatively, with the primary goals of lowering LBP and stoping the slippage from getting worse. If conservative therapy is unsuccessful, neurological symptoms may get worse and the slippage may get unstable (grade III or above), necessitating the need for surgery. Grade 2–3 spondylolisthesis, including L4–L5 disc protrusion and L5 anterolisthesis, who did not respond to conservative treatment, were selected for surgical evaluation. On clinical examination, marked paravertebral tenderness was consistently observed at the L2–L5 and S1 levels. Cervical spine involvement was limited to only three patients, presenting with tenderness at the C5–Th4 levels and muscle hypertonicity in both cervical and thoracic regions, suggesting compensatory musculoskeletal strain.

Radiological analysis revealed that 87% of patients exhibited foraminal stenosis at the L5–S1 level due to listhesis of the L5 vertebra. Among the patients with vertebral displacement, 13% demonstrated L4–L5 anterolisthesis, while 35% had retrolisthesis. Furthermore, post-traumatic vertebral deformities affecting L1–L3 were seen in 9% of cases, typically associated with vertebrogenic and radicular syndromes.

Postoperative observations

Following surgery, the majority of deformities at the L1–S1 levels were successfully corrected. In particular, cases involving listhesis caused by L5 spondylolysis and foraminal narrowing at L5–S1 showed substantial improvement. Most patients also presented with degenerative spinal changes, including osteochondrosis, spondyloarthrosis, and spondylosis. Painful vertebrogenic and radicular syndromes were resolved in a high percentage of patients after deformity correction.

Surgical technique and approach

The surgical interventions employed included nerve root decompression at the L4, L5, and S1 levels, intervertebral disc resection, and interbody fusion using cages and autologous bone grafts. Rigid posterior fixation at L4–L5 or L3–L5 was performed based on the extent of instability. Decompressive laminectomy with instrumentation was the most frequently used procedure.

The TLIF technique, performed under fluoroscopic guidance, allowed for precise instrumentation. After a midline incision and exposure of the spinous processes and facet joints, pedicle screws were placed, and bilateral decompression was achieved through facetectomy and interlaminectomy. Interbody fusion was performed with properly sized cages (10–12 mm) filled with autologous bone, ensuring spinal stability. No canal compression was observed postoperatively, and radiological control confirmed optimal implant positioning.

Clinical outcomes and neurological status

Surgical treatment resulted in a significant reduction in radicular pain and neurogenic claudication. Approximately 86.6% of patients expressed satisfaction with their recovery. Neurological deficits were observed in only 2.5% of cases, all of whom had chronic, long-standing spondylolisthesis (type B). These patients failed to improve, presenting with persistent neurological symptoms and paraparesis. In such cases, decompressive surgery was only partially successful, likely due to irreversible chronic changes.

The majority of Grade I and II spondylolisthesis cases were initially managed conservatively. However, progression to instability or neurological deterioration necessitated surgical intervention. When surgical decompression, vertebral reduction, and stabilization were applied in a timely and technically appropriate manner, outcomes were favorable, with restored sagittal alignment and improvement in both pain and function.

One-stage vs. Two-stage surgery

In our cohort, both one-stage and two-stage surgical protocols demonstrated comparable success. One-stage TLIF was effective in Grades I and II, allowing vertebral reduction and stabilization without the need for cauda equina decompression. In higher-grade spondylolisthesis (Grades III–IV) or in the presence of neurological deficits, staged surgery—with initial neural decompression followed by reduction and fusion—was preferred to minimize the risk of traction injury to the spinal cord and nerve roots.

Fusion, function, and rehabilitation

Complete interbody fusion was achieved in all patients. Six individuals required revision surgery due to recurrent slippage, but no adjacent segment disease was observed during the follow-up period. Postoperative rehabilitation enabled most patients to return to their preoperative levels of activity within two years. The overall outcome was classified as excellent in 26.4% of patients and satisfactory in 33.6%. Persistent deficits were observed in only 6.25% of cases and were associated with long-standing disease or adhesions.

Current perspectives and literature comparison

Our findings align with recent literature highlighting the effectiveness of interbody fusion techniques such as TLIF and MISS-TLIF in restoring vertebral height, correcting instability, and achieving solid fusion. Anterior cage placement during TLIF has been associated with improved postoperative lordosis and spinal alignment. Although the North American Spine Society has addressed the potential role of anterior fusion in supporting posterior instrumentation, no definitive consensus has yet been reached.

Dynamic assessments suggest that reduction of neurological deficits and nociceptive pain are the most reliable indicators of surgical success. Several authors have emphasized the importance of balancing spinal realignment with the risk of overcorrection and potential neurological deterioration, especially in patients undergoing aggressive vertebral reduction.

Clinical implications

The results of this study highlight the importance of individualized surgical planning, based on the spondylolisthesis grade, neurological status, and spinal stability. One-stage TLIF offers a reliable and efficient solution for lower-grade cases. When performed with appropriate technique, interbody fusion and posterior fixation can restore sagittal alignment, decompress neural elements, and significantly improve patient quality of life. These findings support the ongoing refinement and application of tailored surgical strategies in the treatment of lumbar isthmic spondylolisthesis.

Conclusion

In the surgical management of spondylolisthesis, it is recommended that the patient be positioned prone on non-abrasive pads that provide adequate support while accommodating instrument dynamics. This helps avoid excessive lumbar lordosis and reduces the risk of canal compromise during screw placement.

In our study, Group 1A maintained spinal balance following sagittal restoration. In contrast, Group 2A exhibited initial instability, which resolved postoperatively. Group 2B demonstrated straightforward balance restoration, with 20% of patients reporting a normal pain threshold. Postoperative complications were observed in 11.25% of cases. In Group 1B, the sagittal alignment of the spondylolisthesis segment was restored to achieve nerve root decompression. Interbody fusion was performed using autologous bone and implants, either during the same session via a posterior approach or within 7 to 10 days via an anterior (ventral) approach.

Surgery in Group 1A was performed in two stages: first, skeletonization and spinal decompression; followed by vertebral reduction and spondylosynthesis, which realigned the spine without compromising the spinal canal. Anterior fusion using autologous bone was then completed. In contrast, Group 1B underwent a single-stage procedure. Vertebral reduction and anterior interbody fusion were achieved via a transforaminal lumbar interbody fusion (TLIF) technique. Postoperative pain was managed conservatively, and the majority of patients were discharged without major complications.

Ethics approval

Ethical approval was obtained, and this study was carried out according to the latest revision of the Helsinki

Funding Statement

No funding was received for this study.

Conflict of Interest Statement

The authors declare no conflicts of interest.

Acknowledgement

N/A

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CASE SERIES

Iatrogenic abdominal wall non-tuberculous Mycobacterial infections: a case series

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Keywords: Atypical mycobacterium, Microbiology, Abdominal wall, Laparoscopic surgery

Introduction

Non tuberculous mycobacteria are opportunistic pathogens [1]. These organisms are implicated in delayed postoperative wound infections, most common being the Mycobacterium fortuitum [2]. Other frequently encountered rapidly growing atypical mycobacteria include *Mycobacterium abscessus* subsp. *abscessus*, *M. abscessus* subsp. *massiliense*, *M. chelonae*, and *M. porcinum*. These organisms are commonly found in environmental sources such as soil, dust, water, animals, and healthcare settings. Nosocomial transmission typically occurs through the use of inadequately sterilized medical equipment, particularly laparoscopic instruments[3]. The most common source being unsterile water used for cleaning the instruments [4]. A high degree of clinical suspicion is essential in cases of chronic postoperative wound infections to ensure timely diagnosis and prevent delays in initiating appropriate treatment [2]. Clinical features commonly include abscess formation, subcutaneous nodules, and draining sinuses [3]. Definitive diagnosis is established through culture of the causative organism from wound discharge or tissue biopsy. Management typically requires surgical intervention combined with antibiotic therapy guided by in-vitro sensitivity testing [2],[3].

This study aims to evaluate the demographic characteristics, clinical features, imaging sensitivity, and treatment outcomes in patients with iatrogenic non-tuberculous mycobacterial infections of the anterior abdominal wall.

Patients and methods

This was a retrospective study conducted in the Department of Abdominal Wall and General Surgery, in a tertiary care center from April 2012 to March 2015. All the patients who presented with multiple sinuses in the abdominal wall, or with a clinical diagnosis of iatrogenic abdominal wall atypical mycobacterial infections were included in this study. The data was collected retrospectively from the hospital's electronic database. The data included demographic, investigations and treatment profile. A total of 52 patients were included in this study based on the inclusion criteria. As institutional review board. Data was entered in Epidata and analysis was done in SPSS software version 18.0 (licensed by IBM) with the help of the statistician. Data was collected for the following variables like age, sex, Place, type of previous operation, duration of symptom from the time of operation, presence of multiple branching tracts, intra-peritoneal extension of operation, computerized tomography of abdomen, operative and antibiotic treatment received in our institution, microbiological and histopathological findings and recurrence of the disease over a follow up period of two years. All study variables were described using descriptive statistical methods. Continuous variables were summarised using the mean with standard deviation. For skewed variables the median with range was used. For categorical variables frequencies with percentages were used. Sensitivity and specificity of computerise tomography in predicting the presence of multiple sinuses and intra – peritoneal extension were analysed.

Results

As seen in Table 1, A total of 52 patients were included in this study, out of which 43 were females and 9 were males. The median age was 34 years with a range of 22 to 63 years. All 52 patients presented with discharging sinuses on the anterior abdominal wall. The median time to develop symptoms was 4 weeks. However, the duration to develop symptoms after operation or intervention ranges from 2 weeks to 7 weeks. The median time to present to our hospital was 7 months with a range of 2 months to 48 months. Out of 52 patients, one had infection following insulin injection, 28 patients had infections following laparoscopic surgery and 23 patients had infections following open surgery. All patients who developed infection following an operation had been operated in a secondary hospital. Ten patients have had initial treatment with anti-tuberculous drugs with no symptom relief. The other 42 patients did not have any previous treatment. Fifty patients

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Received: 05-02-2025 Accepted:04-07-2025
DOI:https://doi.org/10.4038/sljs.v43i2.9229

were evaluated with abdominal imaging. As per Table 2, 41 patients had CT Sinusogram of the abdomen and 9 patients had ultrasonography of the abdomen. Two patients did not have any imaging done. Of the 41 patients who underwent CT scan, multiple branching tracts (Figure 1) were found in 23 patients and 9 patients had intra-peritoneal extension (Figure 2). Out of the 9 patients who underwent ultrasonography of the abdomen, multiple branching tracts were seen in 2 patients and intra-peritoneal extension was not seen any of the patients. All 52 patients underwent wide local excision of the anterior abdominal wall. Intra-operatively, 29 patients had multiple tracts and 8 patients were found to have intra-peritoneal extension. Intra-peritoneal extension and multiple branching are essential as removal of these tracts is important to prevent recurrence.

Table 1: Descriptive parameters of patients with atypical mycobacterium of the anterior abdominal wall

Parameter	Value
Total Patients (n)	52
Gender (Female: Male)	43:9
Median Age (Range)	34 years (22–63 years)
Median Time to Develop Symptoms	4 weeks (Range: 2–7 weeks)
Median Time to Present to Hospital	7 months (Range: 2–48 months)
Initial Treatment with Anti-TB Drugs	10 patients (No symptom relief)
No Prior Treatment	42 patients
Multiple Tracts	29 patients
Intra-peritoneal Extension	8 patients
Mycobacterium fortuitum	7 patients
Mycobacterium tuberculosis	1 patient
Histopathology	Non-necrotizing granulomatous inflammation (51 patients)
Recurrence	3 patients (1 without antibiotic therapy)

Figure 1: Figure depicting single and multiple tracts (white arrows) on CT Sinusogram

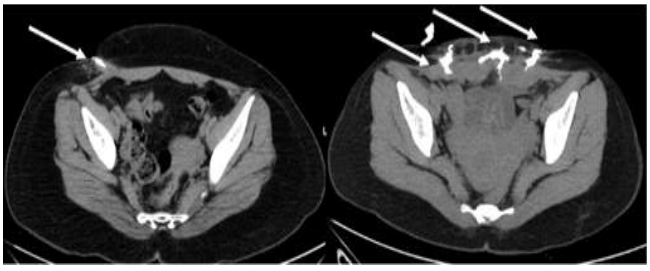

Figure 2: Figure depicting extraperitoneal and intraperitoneal extension on CT Sinusogram

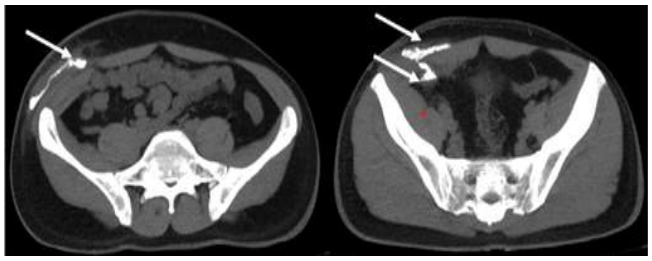

Table 2: Analysis of findings of multiple branching tracts and intraperitoneal extension on Computerized Tomography and ultrasonography

Imaging Modality	Total Patients	Multiple Branching Tracts	Intra-peritoneal Extension
CT Sinusogram	41	23	9
Ultrasonography	9	2	0
No Imaging Performed	2	-	-

Correlating the CT and intraoperative findings, we found that out of 9 patients who had intraperitoneal extension on CT, 4 patients actually had intraperitoneal extension in the operative findings. Similarly, out of 23 patients who had multiple branching tracts in CT, 22 patients had multiple tracts intraoperatively. As seen in Table 3, we found that the sensitivity, specificity, positive predictive value and negative predictive value of CT in detecting intra-peritoneal extension were 50.00, 84.84, 44.44 and 87.50 respectively. Similarly, the sensitivity, specificity, positive predictive value and negative predictive value of CT in detecting multiple sinus tracts were both found to be 75.86, 91.66, 95.65 and 61.11. Sensitivity and specificity for ultrasonography was not performed due to the decreased number for analysis.

Table 3: Analysis of findings of Computerized Tomography compared with intra-operative findings.

Finding	CT Finding	Intraoperative Finding	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	Negative Predictive Value (%)
Intra-peritoneal Extension	9	4	50	84.84	44.44	87.5
Multiple Branching Tracts	23	22	75.86	91.66	95.65	61.11

All 52 patients underwent debridement, followed by antimicrobial therapy in 51 patients. One patient did not take antibiotic therapy due to personal reasons. Tissue cultures showed 8 patients were positive for MGIT (Mycobacterial Growth Indicator Tube) culture, of which 1 was positive for

TbPCR as well. Of these 8 patients, Mycobacterium fortuitum was noted in 7 and *Mycobacterium tuberculosis* was seen in 1. The remaining 44 patients did not show any growth on tissue culture or PCR. Histopathological examination showed evidence of non - necrotizing granulomatous inflammation in 51 patients. There was recurrence in 3 patients. Out of the 3 patients, one patient was the one who did not take the antibiotic therapy.

Discussion

Atypical mycobacterium is classified based on its rate of growth and pigmentation [2]-[4]. The most common among these is *Mycobacterium fortuitum* and *Mycobacterium Chelonae*, both belonging to the rapidly growing species [2]. They are predominantly present in the water and soil [5]. The common source of infection to human beings is predominantly by iatrogenic methods [2],[3],[6]. The most common being laparoscopic instruments.

Laparoscopic instruments have sleeves in which the bacteria can colonise. As most of the laparoscopic instruments are disinfected and not sterilised, the spores survive to cause the infection [2],[3],[6],[7]. In our series 28 out of 52 patients developed infections post laparoscopic procedure, 23 developed infections post open operation, and one patient developed infection following insulin injections. There are case reports of atypical mycobacterium following major abdominal general surgical procedures, abdominoplasty, liposuction and even reduction mammoplasty [6],[8],[9].

There is a predisposition for females with 43 out of 52 patients being females. This comprises 82.69%. This is similar to the literature as described [8],[10]. However, as per one study there was equal gender predisposition [2]. The median time to develop symptoms in our study was 4 weeks as compared to 3to 4 weeks as cited in the literature [3],[10]. This happens with a cutaneous manifestation after 4 weeks of colonisation. The median time to diagnosis in our study was 7 months. However, the median time to diagnosis was 103 days as per the literature [8].

They have an affinity towards skin and subcutaneous tissues. There are 4 stages of this disease described where it starts as a nodule and becomes a sinus [3],[5],[8]. There was not much literature on the incidence of intraperitoneal extension for this disease. According to literature, intraperitoneal extension is not commonly seen because there seems to be protective factors preventing intraperitoneal extension [2]. However, in our series, we found that 8 out of 52 patients had intraperitoneal extension, which comprises of 15.38%. The reasons are not known. Other than our case series, intraperitoneal extension is not described in the literature till date. This infection usually starts with one port and spreads to other areas by multiple tracts and subdermal tracts. Multiple tracts were found in 29 out of 52 patients in our series. This comprises of 55.76% of the population with the disease. Similarly, multiple tracts though present are not appreciated or highlighted in any other literature search till now. Most of the literature documents multiple sinuses but not multiple tracts except for one documented in literature [2].

Surgical debridement (extensive and aggressive removal of all tracts identified radiologically and intra-operatively) followed by antibiotics is essential for the removal of all tracts and to prevent recurrence [2],[3],[7]. As depicted in our study, multiple tracts and intraperitoneal extension can be detected by doing a CT Sinusogram. Surgical therapy should be complete despite it causing a huge raw surface. We allow the wound to heal with secondary intention.

Antimicrobial therapy is a must. There are reports of recurrence despite surgical and antimicrobial therapy but the frequency is very rare [2]. Poly-antimicrobial therapy is advocated for this pathology [1]-[3],[6],[11]. The common antibiotics to which these microbes are susceptible are quinolones, amikacin and doxycycline. In our institution our protocol is to give Amikacin, Clarithromycin and Ciprofloxacin for 3 months based on the antibiogram which is similar to the literature [2],[3],[6],[12]. Antimicrobial therapy is recommended for at least 3 months [1],[2],[12]. Recurrence rate in our series was 5.76% whereas in literature the recurrence rates are about 13-16% [2],[8].

Our series is the first to analyse the predictive values of CT in detecting intraperitoneal extension and multiple tracts, as removal of complete disease is essential in the treatment process. The specificity of CT in detecting intraperitoneal extension (84.84) and multiple tracts (91.66) was very high. Similarly, the positive predictive value of CT to identify multiple tracts (95.65) was also high. Hence, we recommend CT as the best modality of choice for the evaluation of this pathology. This will help in planning the operation and aid in the complete removal of all foci of infection. This will decrease the chances of recurrence.

Although the majority of cases in this series are post-surgical in origin, we have included one case of severe infection following an insulin injection. This case was retained due to its rarity and clinical relevance, as it highlights that even minor, routine procedures such as subcutaneous insulin

administration can result in serious infectious complications. We must send regular tissue cultures of tuberculous cultures, TBPCR and also for histopathology [2]. Proper sterilisation technique of instruments and needles is the best way to prevent this disease. We recommend autoclaving of metal instruments. For reusable instruments we recommend plasma sterilization or ethylene oxide sterilization [2]-[4].

Conclusion

The incidence of non-tuberculous Mycobacterial surgical site infections has increased in the laparoscopic era. A strong clinical suspicion is imperative in diagnosing this entity. Histopathological examination and mycobacterial cultures are mandatory for diagnosis. We recommend imaging with CT for all patients. Treatment involves wide excision of all lesions and administration of a combination of antibiotics for 3-6 months based on in vitro susceptibility. As per our hospital infection control guidelines, a combination of amikacin, clarithromycin and levofloxacin is the preferred antibiotic regimen.

External Funding: None
Conflict of Interest: None
Ethical Clearance: Not done as this was a retrospective analysis

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CASE SERIES

Submucosal Tunneling Endoscopic Resection (STER) for esophageal sub mucosal tumors: report of two cases

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Keywords: STER, Sub mucosal tumours, Esophageal Leiomyomas

Introduction

Submucosal tumors (SMTs) are defined as masses originating below the normal overlying mucosa and protruding into the gastrointestinal (GI) lumen. SMTs can be seen in any part of the gastrointestinal tract and are usually asymptomatic. The American Society for Gastrointestinal Endoscopy (ASGE) recommends that all SMTs arising from the GI tract larger than 3cm need to be removed. Those less than 3cm in size and without any signs of risk of malignancy on imaging can be managed with active surveillance [1]. With the advancement of endoscopic resection techniques and the advent of third-space endoscopy, these lesions are primarily resected endoscopically [2]. Endoscopic submucosal dissection (ESD) and endoscopic submucosal resection (EMR) are endoscopic techniques that are used to resect neoplasia from the mucosal and superficial submucosal layers while maintaining the integrity of the bowel wall. However, lesions arising from deeper submucosal layers or the muscularis propria traditionally needed surgery or thoracic enucleation for complete resection. Submucosal tunneling endoscopic resection (STER) has emerged as a therapeutic tool for the management of the SMTs which cannot be safely and completely removed by conventional endoscopic resection techniques and would have otherwise needed surgery.

In 2012 the technique of STER was first introduced, as a minimally invasive alternative to 1, 2 1 Open Access Case Report How to cite this article surgery for the removal of neoplasia from muscularis propria and deep submucosal layers, while still having the mucosa intact and without perforation [2,3]. STER combines the techniques of Endoscopic submucosal dissection (ESD) and Per Oral endoscopic myotomy (POEM) to remove SMTs arising from the esophageal wall.

We report two cases of large esophageal wall SMTs resected completely by STER, which is the first time such a technique has been used for the resection of SMTs in Sri Lanka.

Case Presentation

Case 01

01 52-year-old female patient with a history of dysphagia for the past two years, presented with worsening of symptoms over five months. Dysphagia was more for solids than liquids and was associated with loss of appetite. She underwent esophagogastroduodenoscopy (OGD) where a polypoidal growth of 5.5 cm was noted just above the gastroesophageal junction (GOJ). (Figure 1)

Histopathological investigations done on a biopsy sample from the mass revealed a leiomyoma, without any evidence of malignancy. Upon further investigation by endoscopic ultrasonography (EUS), a submucosal mass of 55mm was noted in the lower esophagus, arising from the third (submucosal) layer. The patient was assessed to be ASA class II with chronic autoimmune thyroiditis and had a MET score of more than four. Submucosal tunneling endoscopic resection was done under general anesthesia in a tertiary care hospital by NF. (Figure 2) Follow-up endoscopy done at 6 and 15 months showed no recurrence. (Figure 3)

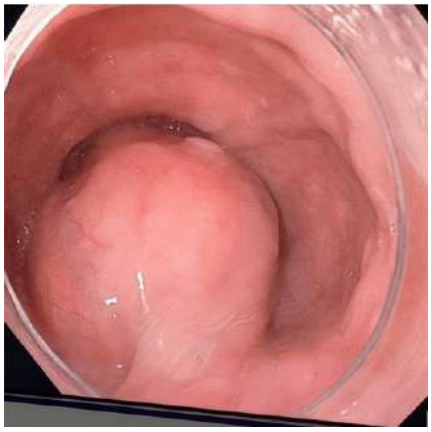

Figure 1: Polypoidal mass noted during OGD

OGD- Oesophagogastroduodenoscopy

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Received: 10-03-2025 Accepted:12-07-2025
DOI:https://doi.org/10.4038/sljs.v43i2.9238

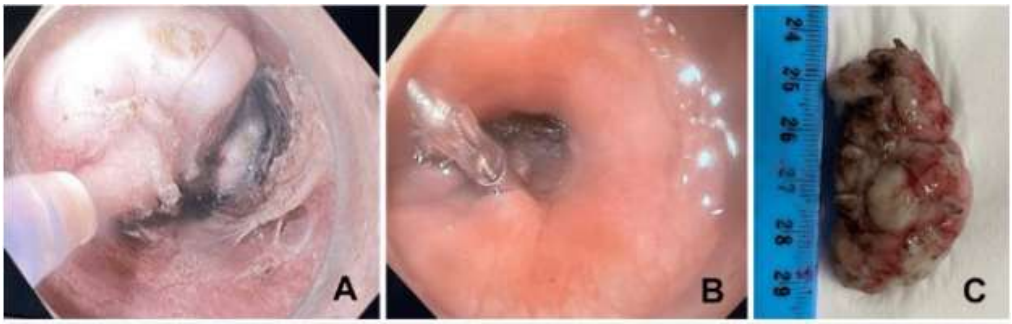

Figure 2: Submucosal Tunneling Endoscopic Resection (STER) Procedure

A- Tunneling through submucosa

B-Closure of incision

C-Specimen retrieved during procedure

Figure 3: OGD done during follow up at 6 months

OGD- Oesophagogastroduodenoscopy

Case 02

A 55-year-old male patient presented with progressively worsening dysphagia for the past one year. He underwent an OGD and a polypoidal growth of 4 cm was noted just above the gastroesophageal junction. Endoscopic ultrasonography revealed a submucosal mass of 45mm by 20mm in the lower esophagus, arising from the third (submucosal) layer. The patient was assessed to be ASA class II without comorbidities and had a MET score of more than four. Submucosal tunneling endoscopic resection was done under general anesthesia in a tertiary care hospital by NF. Follow up endoscopy done after 6 and 12 months did not show any recurrence.

Histology of both resection specimens confirmed a benign leiomyoma which was completely resected and patient remained completely asymptomatic during the follow up period.

Technique of Submucosal tunneling endoscopic resection.

The accessories and equipment needed for the STER are similar to an ESD or POEM. The important steps in performing STER are mentioned below.

1. A longitudinal mucosal incision of 15-20mm is initially made approximately 5 cm away from the oral side of the lesion to create the submucosal tunnel.
2. A tunnel similar to POEM is created until the lesion is reached with similar electrosurgical settings to POEM – Triangular tip knife (TT Knife by Olympus) with spray coagulation (Electro surgical device ERBE^{TM})
3. The lesion is dissected around and freed from the submucosal and deep muscularis attachments. Any intervening vessels are coagulated with a coag-grasper to have clean dissecting planes.
4. Once the lesion is completely dissected around it is held from a snare and removed through the mucosal opening
5. The mucosal opening is closed using endo clips.

There were no intraoperative complications and no significant blood loss. The patient was given peri operative and post operative intra venous cefuroxime and metronidazole for 72 hours and observed in the ICU for 24 hours. Both patients were discharged three days after endo surgery without any complications.

Discussion

SMTs include leiomyomas, schwannomas, gastrointestinal stromal tumors (GIST), fibrous tumors of which leiomyomas are the most common SMT in the esophagus. With the advancement of radiological imaging techniques and more frequent use of endoscopy for the evaluation of upper GI symptoms, SMTs are more frequently detected with a 3% incidence rate in the literature [4]. Biopsy techniques such as tunnel or biopsy on biopsy have proven to have a very poor yield in SMTs. Endoscopic ultrasound-guided fine needle aspiration (EUS-FNA) and biopsy would be the most reliable method to obtain a histological diagnosis. As done in most SMTs, lifelong follow-up not only increases the psychological stress to the patients, but it may also delay the

diagnosis in potentially malignant lesions which otherwise, would have curative treatment options [5].

Resecting these lesions surgically either by open surgery or video-assisted thoracoscopic surgery (VATS), would be invasive and associated with morbidity and mortality [6,7]. In comparison, STER can be regarded as the effective and safe method for resecting SMTs originating from the deep submucosal layers and muscularis propria with the advantage of high en bloc resection rates. Lesions arising from these layers and less than 4cm in size can be resected by STER, although the size criteria can be expanded as seen in our patient. [8].

Complications related to STER range from 5% to 25% with no reported deaths. Gas related complications (subcutaneous emphysema pneumomediastinum, and pneumothorax) are the most common (19.8%) reported significant complications with most other complications being mild [9].

Conclusion

In conclusion, submucosal tunneling endoscopic resection (STER) has emerged as a safe and effective alternative to surgery for large esophageal submucosal tumors (SMTs), particularly those originating from the deep submucosal layers and muscularis propria. The technique allows for complete resection while preserving mucosal integrity and minimizing complications such as perforation. In the two cases presented, STER was successfully performed for the first time in Sri Lanka, with both patients experiencing uneventful recoveries, minimal intraoperative blood loss, and no significant postoperative complications. Compared to traditional surgery, STER offers the advantages of shorter hospital stays, fewer adverse events, and quicker recovery times, making it an ideal treatment option for large SMTs. While some risks, such as gas-related complications, exist, they are typically mild and manageable, underscoring the potential of STER as a preferred modality in managing esophageal SMTs.

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BRIEF REPORT

Histological analysis and revisiting the diagnostic accuracy of acute appendicitis

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Keywords: Appendicitis, Appendectomy

Abstract

A retrospective study conducted at a tertiary-care hospital in Sri Lanka analyzed 429 appendectomy samples from patients suspected of acute appendicitis. The mean age was 21 years; 58% were male. Intraoperatively, 80.4% had acute appendicitis, mass formation (2.1%) and rupture (0.4%). Histology showed lymphoid hyperplasia(58.7%), suppurative appendicitis(8.6%), granulomatous changes [tuberculosis (2.3%), Crohn's(0.7%)], and neoplasms [mucinous dysplasia(3%), carcinoid(0.5%)]. Malignant or premalignant lesions showed no age or gender specificity and were not always evident during surgery. The 12% negative appendectomy rate highlights the need to revise diagnostic criteria.

Introduction

From 1990 to 2019, global appendicitis rates rose by 0.58% annually, with South Asia seeing the largest increase [1]. Appendicitis is caused by luminal obstruction from lymphoid hyperplasia in children and by faecoliths, fibrosis, neoplasms, or foreign bodies in adults. We report unique causes of acute appendicitis in a Sri Lankan cohort and emphasize the need to reassess diagnostic criteria due to a high rate of negative appendectomies.

Materials and methods

A retrospective study was conducted at the National Hospital of Sri Lanka. Consecutive appendicectomy samples from patients diagnosed with acute appendicitis between June 2021 and December 2022 across all surgical units, were analysed. Cases with clinical features of chronic appendicitis and incidental appendectomy were excluded. Acute appendicitis diagnosis relied primarily on clinical signs like right iliac fossa pain, fever, tenderness, positive Rovsing and Psoas signs, and an Alvarado score of seven or more. Priority was given to the clinical diagnosis over biochemical or ultrasound scan findings.

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Received: 02-02-2025 Accepted:01-07-2025
DOI:https://doi.org/10.4038/sljs.v43i2.9206

Results

The study included 429 patients (mean age 21 years; 58% male). Intraoperatively, 80.4% (n=345) showed acute appendicitis, 6.7% (n=29) abscess formation, 2.8% (n=12) mass formation, 2.1% (n=9) ruptured appendix, and 0.4% (n=2) large bowel intussusception. Luminal obstruction by faecoliths (n=64) and *Ascaris lumbricoides* (n=1) was noted. Microscopy revealed lymphoid hyperplasia with serositis (58.7%, n=252), suppurative appendicitis (8.6%, n=80), necrosis (1.4%, n=6), fibrosis (2%, n=9), granulomatous changes of tuberculosis (2.3%, n=10), Crohn's (0.7%, n=3) or sarcoidosis (0.2%, n=1), mucinous neoplasms (3%, n=13) and carcinoid tumours (0.5%, n=2). Mucinous dysplasia was classified as non-invasive low-grade dysplasia (1.6%, n=7) and high-grade dysplasia (0.9%, n=4) and infiltrative mucinous dysplasia (0.5%, n=2). High grade mucinous dysplasia, infiltrative dysplasia and carcinoid tumours were considered premalignant and malignant. Most (pre)malignant lesions (62.5%, n=5) were suspected as acute appendicitis during surgery, but lacked distinct radiological or intraoperative features beyond this suspicion. There were no significant differences in age distribution (Mann-Whitney U test, p=0.052) or gender distribution (Pearson's Chi-Square test, X2= 0.012, p=0.913) between benign and (pre)malignant lesions. However, 12% (n=53) of specimens did not exhibit microscopic evidence of any lesions.

Discussion

Diagnosing acute appendicitis is challenging, especially in children, with missed diagnoses in 20–40% of adults and 10–34% undergoing unnecessary appendectomy [2]. Negative appendectomies can lead to surgical site infections as a complication of unnecessary surgery [3]. A 2014 Sri Lankan study found that 46% of 125 appendectomy specimens showed no microscopic features of appendicitis [4]. We found a 12% rate of negative histology, indicating a decline over the past decade likely due to improved diagnostics, though the rate remains high. Clinical symptoms of appendicitis may subside following the removal of a negative appendix [5], implying the possibility of missed underlying pathologies. While clinical and biochemical findings are important in the diagnosis, imaging techniques

such as ultrasound scan and computed tomography (CT) significantly improve diagnostic accuracy. Changes of fat around the appendix/cecum, fluid or gas around the appendix/cecum, appendiceal abscess formation, increased cecal wall thickness, dilated intestinal arches are considered positive findings of acute appendicitis and associated complications [6]. Ultrasound has a sensitivity of 77% and specificity of 60% [7], while CT has a sensitivity of 87% and specificity of 82% in diagnosing appendicitis [6]. Artificial intelligence-based algorithms have been shown to enhance the diagnostic accuracy of acute appendicitis [8]. Due to our resource limitation, CT scan is used when the biochemical and ultrasonographic evidence is inconclusive of acute appendicitis.

Acute appendicitis can vary in its presentation (Table 1). Sarcoidosis-induced appendicitis is rare, with under 20 cases

Tabel 1.

Study	Number of participants	Clinical presentation	Histology
Jones, A.E et al., 2007 (United Kingdom) [14]	1225	Acute appendicitis (n=941)	Normal appendix (n=284) Intraluminal parasites (n=11) Tumours • Benign tumours (hyperplastic polyps, low grade appendiceal mucinous) (n=10) • Primary malignant (n=3) • Carcinoids (n=13) • Secondary deposits (n=1) Crohns disease (n=6) Endometriosis (n=3)
Connor, S.J., et al., 1988 (New Zealand) [13]	7970	Acute appendicitis (n=36) Appendicular abscess/mass (n=5) Bowel obstruction (n=1)	Tumours • Benign tumours (n=12) • Primary malignant (n=2) • Carcinoids (n=27) Tumours • Benign tumours (n=1) • Primary malignant disease (n=1) • Carcinoids (n=3) Tumours • Carcinoids (n=1)
Ranaweera, C., et al., 2019 (Canada) [15]	5059	Uncomplicated acute appendicitis (n=24) Perforated appendicitis (n=48)	Carcinoid (n=32)
Charfi, S., et al., 2014 (North Africa) [16]	24697	Acute appendicitis (n=24697)	Normal appendix (n=3723) Intraluminal parasites (n=1599) Tumours • Benign tumours (n=60) • Primary malignant (n=15) • Carcinoids (n=90) Crohns disease (n=28) Tuberculosis (n=4) Endometriosis (n=2)
Emre, A., et al., 2013 (Turkey) [17]	1255	Acute appendicitis (n=1255) -Phlegmonous (n=880) -Gangrenous and perforation (n=148)	Normal appendix (n=76) Intraluminal parasites (n=8) Tumours • Carcinoids (n=11) Granulomatous (n=6) Tuberculosis (n=4) Endometriosis (n=2)
Kadi, M., et al., 2022 (Saudi Arabia) [18]	940	Acute appendicitis (n=805) -Perforation (n=153) -Suppuration (n=583)	Normal appendix (n=135) Tumours (n=5) Crohns disease, Granulomatous, Endometriosis and Parasites (n=37)
Lal, D.P.C.K.A., et al., 2014 (Sri Lanka) [4]	125	Acute appendicitis (n=125)	Normal appendix (46%) Faecoliths (49%) Lymphoid hyperplasia (38%) Fibrosis (8%) Parasites (3%) Endometriosis (3%) Neoplasm – not common finding
Present study (Sri Lanka)	429	Acute appendicitis (n=345) -Abscess formation (n=29) -Mass formation (n=12) -Ruptured appendix (n=9) -Large bowel intussusception (n=2)	Normal appendix (n=53) Tumours • Carcinoids (n=2) • Mucinous dysplasia (n=13) Granulomatous • Tuberculosis (n=10) • Crohns disease (n=3) • Sarcoidosis (n=1) Intraluminal parasites (n=1)

reported worldwide. While gastrointestinal involvement is typically asymptomatic [9], it can occasionally manifest as acute appendicitis, necessitating surgical exploration due to the risk of perforation [10].

Gastrointestinal tuberculosis (8 to 24% of all tuberculosis), mainly affects the ileocecal region, especially in young Asian and Black females [11]. Although the appendix lies adjacent to the cecum, tuberculosis involvement of the cecum is relatively uncommon [11]. The higher rate of tuberculous appendicitis in our study likely reflects the region's elevated tuberculosis prevalence. Our study identified *Ascaris lumbricoides* as a rare cause of acute appendicitis, a phenomenon seldom reported in the literature.

In the West, appendiceal tumours are rare (2.14% annually), with carcinoid tumours being the most common, followed by mucinous neoplasms, serrated adenomas and adenocarcinomas [12]. Unlike in the West, where secondary malignancies and carcinoid tumours are more common, our study found a higher prevalence of primary mucinous neoplasms and high-grade mucinous dysplasia [13]. Acute appendicitis was the most frequent presentation of appendiceal tumours, with 9.5% of malignancies detected incidentally [13]. Appendicular masses may be evident in 2% to 6% of cases and are known to increase the risk of appendiceal malignancies [12]. These findings are in line with our results; however, intraoperative appendicular abscess formation exhibited a higher prevalence of appendiceal malignancies in our cohort.

Conclusions

Standardization of clinical criteria in diagnosing acute appendicitis is needed due to the high prevalence of negative appendectomies in our cohort. We have identified rare etiologies such as sarcoidosis, tuberculosis, and infestations by *Ascaris lumbricoides* that manifest as acute appendicitis. Malignant lesions of the appendix may not always manifest conspicuously during surgery, such as abscesses or mass formations, nor are they necessarily associated with a specific age or gender. Therefore, it is important to routinely submit the appendicectomy specimens for histology.

Conflicts of interests

The author(s) declare that they have no competing interests.

Ethics approval statement

Ethical clearance for this study was obtained from the ethics review committee of the National Hospital of Sri Lanka (ERC No: AAJ/ETH/COM/2024).

Funding

There were no funding sources for the study.

Authors' contributions

MP, YM, RC and JE conceived the study. MP, YM, JS, RC and JE collected, analysed the data, drafted and referenced the article. MP, YM, RC and JE reviewed the draft, made corrections and suggestions for improvement. MP, JE, YM, RC and JS revised the article. All authors read and approved the final draft.

Data Availability Statement

The original contributions presented in the study are included in the article. Further inquiries can be directed to the corresponding author.

Acknowledgements

There are no additional acknowledgements.

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TECHNICAL NOTE

Chest wall perforator flaps for partial breast reconstruction: a novel approach for a better outcome

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Keywords: Partial breast reconstruction, Chest wall perforator flaps, Breast conservative surgery

Introduction

Breast cancer surgery has evolved since William Halsted's radical mastectomy. Currently the oncoplastic breast surgery plays a vital role in both breast conservative surgery (BCS) and breast reconstruction (implant or autologous based) after mastectomy. There are different volume displacement and volume replacement techniques in BCS, and volume replacement techniques lead to partial breast reconstruction (PBR). The main decisive factor of a volume displacement or volume replacement depends on the breast size to tumour size ratio. Hence, wide local excision of a larger tumour in a small to medium-sized breast (cup size A to D) imposes a challenge in restoring the original breast shape and volume.

Volume replacement with chest wall perforator flaps (CWPF) is an emerging novel technique with aesthetically appealing outcomes being reported in recent literature [1],[2],[3]. However, a fascio-cutaneous flap derived from lateral thoracodorsal vessels, to assist implant-based breast reconstruction, was first described in 1986 by Holmstrom et al [4]. Later, Hamdi et al [5],[6],[7] described the use of pedicled and free fascio-cutaneous flaps based on the lateral chest wall perforators as volume replacement techniques in breast reconstruction

This article intends to give an update, including the surgical technique and outcome of CWPF in partial breast reconstruction following surgery for breast cancer and benign conditions of the breast.

Indications for CWPF

Wide local excision in a small breast or quadrantectomy in a medium-sized breast is the most common indication to use a CWPF. Also, these flaps can be used to protect an implant, in the sub-pectoral plane, in implant-based reconstruction after mastectomy.

CWPF is also useful as a salvage option in partial flap failure in free or pedicle flap breast reconstruction.

Apart from breast cancer surgery, CWPFs are of value in breast augmentation with autologous tissue and correction of congenital deformities of breast. Furthermore, patients undergoing excision/quadrantectomy for granulomatous mastitis CWPF"s would certainly be a great option for the breast surgeon in restoring the breast volume and shape integrity.

Contraindications for CWPF

There are very few contra-indications for CWPFs. If one of the parent vessels, from which each designated perforator originates is damaged, CWPF's are contraindicated. For example if, thoracodorsal vascular pedicle is damaged by previous axillary surgery (usually due to axillary clearance), performing a TDAP flap is a contraindication. Yet the lateral chest wall perforator-based flaps (Li CAP or LTAP) can be done in such situations. Patients who have undergone ipsilateral lateral thoracotomy may not be suitable for lateral chest wall perforator flaps (Li CAP or LTAP). These patients can be offered TDAP flap after preoperative Doppler confirmation.

Previous radiotherapy to the lateral and anterior chest wall is not an absolute contraindication for CWPF's, but should be cautious. Defects in post-irradiated breast tissue tend to be larger, and the viability of the perforators tends to be lower. Therefore, a much better option in such scenario would be distant free flaps (i.e. TUG or DIEP flap) as they carry their own blood supply and can harvest wider area of tissues for adequate reconstruction.

Surgical anatomy and pre-operative marking

The course of an intercostal vessel can be divided into 4 segments: (i) vertebral, (ii) inter-costal, (iii) inter-muscular and (iv) the rectus segment. (Figure1).

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Received: 11-04-2024 Accepted: 16-07-2025
DOI: https://doi.org/10.4038/sljs.v43i2.9131

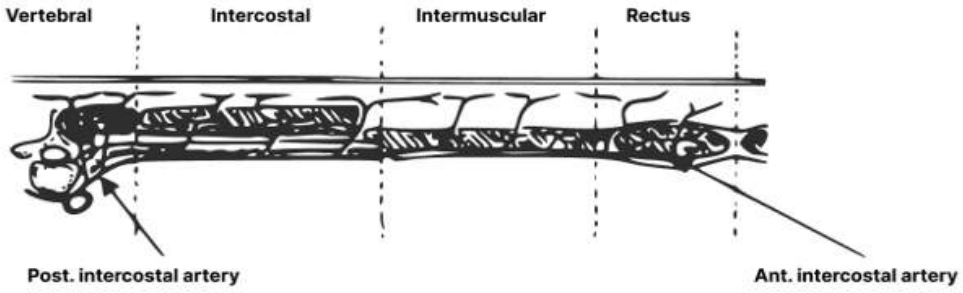

Figure 1 : The course of an intercostal vessel

For breast reconstruction the CWPFs are designed based on perforators arising from all segments of an intercostal vessel except the vertebral segment.

1. Thoracodorsal artery perforator (TDAP) flap

This flap is based on the Musculo-cutaneous perforators originating from the thoracodorsal vessel. Thoracodorsal (TD) vessel is the main vessel supplying the latissimus dorsi (LD) muscle. After giving its branch to serratus anterior (medially), the TD vessel divides into a descending branch vertically and a horizontal branch laterally. These branches give rise to perforators that supply the surrounding overlying skin and subcutaneous tissue. Cadaveric studies have shown 2 to 3 cutaneous perforators arising from the descending branch [1],[3],[5],[6].

A fairly constant perforator from this descending branch, that perforates the LD muscle, can be skin marked (with a Doppler device) 8 cm inferior to the posterior axillary fold and 2 cm medial to the lateral border of the LD muscle. A flap can be designed based on this perforator as an ellipse lying horizontally or sometimes vertically, depending on the tumour location and the surgeons' preference. (Figure 3)

2. Lateral thoracic artery perforator (LTAP) flap

The lateral thoracic artery descends down along the lateral chest wall mostly as a direct branch form the axially artery or sometimes as a branch form the thoracodorsal artery. It gives rise to perforators in the mid-axillary line from 3rd to 5th inter-costal spaces. This flap can be used to fill defects in the lateral half of the breast. Unlike the TDAP and Li CAP the LTAP perforators are not constant and can be smaller in caliber to enable it to perfuse the harvested flap on its own. Thus, in clinical practice LTAP will be used mostly to augment the perfusion of a LICAP flap.

3. Lateral inter-costal artery perforator (Li CAP) flap

This flap is based on the lateral perforator vessels arising from the costal segment of an intercostal vessel. Usually, there are two to four Li CAP perforators arising in an arbitrary triangle demarcated anteriorly by the anterior axillary fold, posteriorly by the mid axillary line and inferiorly by the upper border of the 6th rib. (Figure 2 and 3). This perforator flap is valuable, especially for upper outer quadrant, outer central and lower outer quadrant tumours.

The flap can be either propelled or flipped over into the WLE cavity for insetting. If the flap is raised on a single perforator, then it is easy to either flip over or propel it into the WLE cavity. However, if the flap is raised on more than one perforator, it is difficult to propel the flap but can be flipped over. Yet it should be stressed that in comparison to a TDAP flap, the perforator length in a LICAP flap is less, restricting the freedom of flap movement to a certain degree.

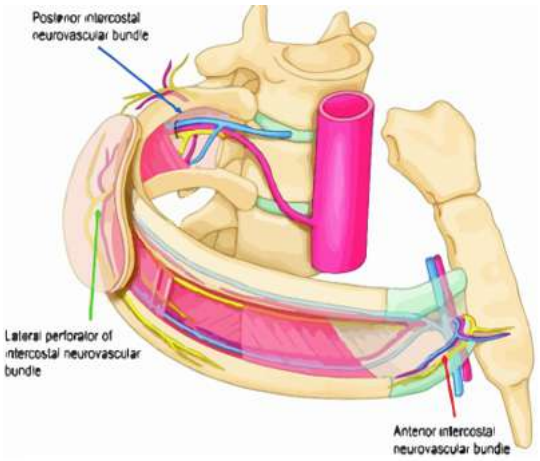

Figure 2: Anatomy of the intercostal neurovascular bundle

4. Anterior inter-costal artery perforator (AiCAP) flap

This flap is based on the inter-muscular and rectal segments of an vessel. As the name implies, these perforators arise anteriorly in the chest wall and lie along a horizontal line. For partial breast reconstruction the perforators arising below the infra-mammary crease are utilised. infra-mammary crease are utilised. The perforators arising from the middle 1/3 are

named as **Ai CAP** flaps. The Ai CAP perforators are not constant and can vary in their caliber. Thus, pre-operative mark-up with hand-held doppler is mandatory.

Ai CAP flaps are preferred for partial reconstruction of lower central volume defects.

5. Medial inter-costal artery perforator flap (MI CAP) flap

This flap is based on the perforators that arise medially from the rectal segments of an inter-costal vessel below the infra-mammary fold. Unlike the Ai CAP the MI CAP perforators are fairly constant and have the capacity to perfuse a lengthy flap. Thus, pre-operative Doppler mark-up may not be mandatory for a surgeon experienced in these perforator flaps. MI CAP flaps are preferred to replace a volume defect in the medial half of the breast; upper inner, lower inner or inner central.

Surgical technique

Pre-operative markup and flap design

As a principle, patient markup should be always done pre-operatively with the patient in the standing position. A hand-held uni-directional Doppler is helpful to locate the perforators and fine adjustments to the flap design can be made after marking the perforators. During flap raising, and later tunnelling into the recipient site, it may be necessary to sacrifice some of the marked perforates in order to reduce the tension on the perforators and to ease the flap inset without undue tension. Thus, it is important to mark all the perforators that can be detected via the Doppler device. Usually, one good perforator is adequate to maintain the vascularity of the flap.

Apart form perforator mark-up it is important to mark the infra-mammary fold and the breast footprint. The intended skin incision of the wide local excision to remove the tumor should also be marked if not using incisions marked for the flap.

Flap raising and perforator dissection-
Li CAP and LTAP

If PBR is done for a breast cancer; wide local excision (or quadrantectomy) and axillary surgery can be completed prior to raising the flap.

A long, elliptical shaped flap is marked starting from the anterior axillary fold to a point 3-4cm lateral to the spine. Usually there is a natural skin fold in this region and the width of the flap is around 6-8 cm as decided by the pinch test (Figure 3). It is noteworthy to pay attention to incorporate the perforators marked. Next, the skin incision is made down to the deep fascia along the pre-operatively marked lines. Flap raising is started medially and proceed laterally, with electrocautery dissection, until about 5 cm lateral to the marked perforators. Here onwards bipolar diathermy (set at 10 to 15) and tenotomy scissors are used for more delicate fine dissection under loupe magnification.

It is important to preserve all perforators marked pre-operatively. If the preoperatively marked perforators cannot be visualized during dissection it is advisable to use a unidirectional doppler device intra-operatively to locate the perforators. The perforators should be carefully dissected but should not be skeletonised at this stage. Once all the perforators are dissected, in order to ensure a tension-free flap inset into the wide local excision cavity, a decision can be made to sacrifice one or two perforators without hindering the vascularity to the flap. The biggest perforator close to the pivot point of the flap should be preserved. Usually, perforators of a Li CAP and LTAP are seen in at the mid-axillary fold. Retracting the anterior border of the latissimus dorsi muscle will enable to dissect perforators to gain adequate length. De-epithelialization of the flap skin is done after dissecting the perforators. Usually, the entire flap is de-epithelialized unless there is a need to replace a skin loss in the breast.

The Li CAP flap can be either flipped over or propelled into the wide local excision cavity after de-epithelialization. The vascularity can be assessed during de-epithelialization. If healthy arterial bleeding is noted from the de-epithelialized flap, especially at the distal end, the flap will survive without fat necrosis or flap failure. If venous congestion or no arterial bleeding noted, especially at the distal end (which is the furthest away from the perforators), this part of the flap can be excised.

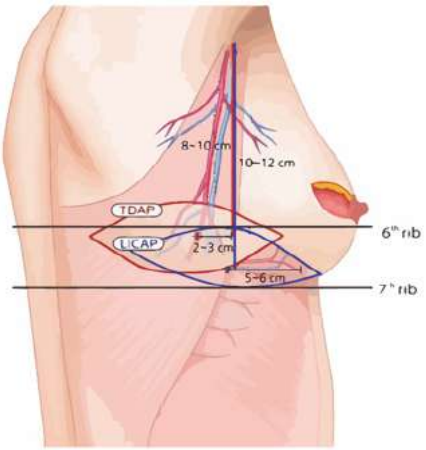

Figure 3: Flap design and range of locations for LICAP with a schematic depiction of the location in relation to the TDAP flap.

TDAP's

The flap design is mostly similar to a Li CAP flap and the dissection starts medial to lateral. When getting closer to the marked perforator the mono-polar diathermy has to be replaced with bi-polar forceps. The dissection should proceed under loupe magnification carefully. The perforator can be seen as a pulsatile vessel and if the surgeon is happy about the caliber of the perforator can continue to dissect it with small cuff of fascia of the LD muscle. The length of the perforator has to be assessed carefully as it may not be adequate, depending on the locality of the defect in the breast. Once the dissection is complete the flap can be much easily propelled or flipped over to the WLE defect in comparison to a Li CAP flap. Usually during a medial to lateral directed dissection a TDAP will be encountered prior to Li CAP. As the TDAP is usually larger in caliber it would be better to preserve this perforator whenever possible.

MiCAP's

A crescent shaped flap is marked using the IMF as the upper border of the crescent. MiCA perforators are located with the hand-held Doppler device. These are usually seen 2-3cm lateral to the sternal edge and 2-3cm inferior to the IMF. Therefore, these perforators are eccentric in location in relation to the flap. Hence, perfusion decreases towards the distal end increasing the likelihood of fat necrosis or even partial flap failure. However, it gives adequate flap mobility to fill the defects of the inner half of the breast.

After making the skin incision and deepening it to the external oblique aponeurosis, flap dissection starts at the lateral end, raising towards the medial end with mono-polar electrocautery. Closer to the marked perforators mono-polar is replaced with fine bipolar diathermy forceps and the dissection proceeds under loupe magnification. The perforators; usually two, can be seen emerging from the intercostal space at the medial end.

Pros and cons of different CWPFs

LTAP flap is a good choice for the outer central and upper outer quadrant breast defects. Yet as mentioned earlier LTAP is not constant and highly variable in presence as well as calibre. Therefore, it is not uncommon to augment the LTAP flap with Li CAP perforators to ensure adequate vascularity and perfusion. On the other hand, as the perforator of the LTAP flap is relatively long, the flap inset into the breast defect would be easier.

LiCAP's are relatively constant in comparison to the LTAP's. Henceforth there is good chance that a Li CAP flap can be raised solely on these perforators without the need to augment with other perforators. Yet in practice rarely these flaps can get the help of additional vascular supply from LTAP's as LiCAP's and LTAP's are in close proximity.

The TDAP is a constant perforator than LTAP or Li CAP. But as it is emerging through the LD muscle, dissection of this perforator, to gain adequate pedicle length, can be technically demanding. In return as the TDAP is relatively medial, than LTAP/Li CAP, the perfusion of the flap is relatively better. This helps to reduce the possibility of fat necrosis in distal part of the flap.

For tumors in the lower central part of the breast an AiCAP flap is preferred. The distance that the flap needs to be mobilized is short and as the perforator in an AiCAP flap is centrally located the perfusion of the distal two ends are much better. This lowers the risk of fat necrosis and partial flap loss. However, during the recreation of the neo-IMF (inframammary fold) the perforator location of the AiCAP flap can be a problem. If not adequately dissected and mobilized, inadvertently the tendency is to create a lower neo-IMF in comparison to the contralateral breast which is not cosmetically pleasing or acceptable.

The constant presence and wider caliber of the MiCAP's make it one of the reliable CWPF's. Creation of the neo-IMF is straight forward than the AiCAP as well. Although commonly it is used to fill defects of the medial-half of the breast it can be used for lower central or rarely for central tumors too.

Discussion

Pedicled chest wall perforator flaps have become a promising option for partial breast reconstruction. Although commonly utilized following surgery for breast cancer, these flaps can be surely used to fill defects following surgery for benign (i.e. benign Phyllodes) or inflammatory conditions (i.e. idiopathic granulomatous mastitis) of the breast. It provides very pleasing aesthetic and functional outcomes for the patient [6].

In conservative communities such as South-East Asia and Sri Lanka, where staged approach or re-excision following WLE for breast cancer is not acceptable by patients; CWPF's provide the answer. The breast surgeon can confidently make a wider excision (especially for T2 tumors and patients with DCIS) as filling the defect of the WLE can be easily done using a CWPF.

Apart from the aforementioned uses, CWPFs can be

harvested for autologous breast augmentation and to correct breast deformities such as tuberous breasts. In an era where the safety of silicone gel implants has been questionable due to the risk of implant associated anapestic large cell lymphoma (BIA-ALCL) [8] the value of these CWPF's could reach new heights. This is more truer to our part of the World as patients nor the Government cannot afford the cost of the silicone implants.

Furthermore, as these are muscle-sparing fascio-cutaneous flaps, the donor-site morbidity and complications are minimal. The incidence of donor-site wound dehiscence and seroma formation is not seen in our series which will be published once the study is concluded. As the latissimus dorsi (LD) muscle is spared it gives the opportunity for a LD or ELD (extended latissimus dorsi) flap in the future if required. Thus, by utilizing these CWPF's the breast surgeon do not burn the bridges but preserves the options for future. As many surgeries it does require structured training and would be best done in high volume centers dealing with these flaps on a regular basis. The learning curve for CWPF's have not specifically defined yet, but in general should not be too long for general surgeon with refined skills. More studies are needed from different centers and would like to highlight the importance of collaboration of breast surgery units, at least in the teaching hospitals, in order to uplift the standards of these CWPF's.

Conclusion

CWPF's should be popularized for partial breast reconstruction due to a multitude of benefits including safety, less donor site morbidity and providing the surgeon with freedom for a wider excision. It is a safe and promising alternative for partial breast reconstruction following breast-conservative surgery in more conservative communities where multiple procedures are not preferred. The knowledge of the perforator anatomy and meticulous surgical technique cannot be overemphasised in mastering these flaps for a reliable outcome.

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CASE REPORT

Non-surgical resolution of colonic perforation with endoscopic clipping after PCNL

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Keywords: PCNL, Endoscopy, Minimally invasive

Introduction

Colonic perforation following percutaneous nephrolithotomy (PCNL) is a rare but significant complication, [1] often presenting with pneumo-retroperitoneum and sometimes pneumomediastinum. This complication typically results from unintentional bowel injury, usually involving the descending colon when nephrostomy tracts are placed too medially [2]. Although traditional management involves open surgery, advances in endoscopic techniques have introduced less invasive alternatives. This case report illustrates the successful non-surgical resolution of colonic perforation using endoscopic clipping and conservative management, highlighting a novel approach that avoids the morbidity of surgical intervention.

Case Report

A 56-year-old female presented with left-sided nephrolithiasis. Preoperative imaging confirmed a large staghorn calculus in the left kidney, and PCNL was planned. The patient was positioned prone for the procedure, which was performed under fluoroscopic guidance. The procedure was uneventful, and the stone was successfully fragmented and extracted. She was discharged in stable condition on postoperative day one.

Two days later, the patient presented to the emergency department with complaints of left loin pain, distention, and mild chest pain. On examination, she was afebrile but had tachycardia with a heart rate of 110 beats per minute. Abdominal palpation revealed mild tenderness, especially in the left upper quadrant without features of peritonism and Inflammatory markers were elevated. (White cell count 1210^9/L and C-reactive protein 46 mg/L) Chest auscultation was normal, with no signs of respiratory distress.

Initial imaging, including a chest X-ray, revealed sub diaphragmatic free air suggestive of pneumoretroperitoneum [3]. A subsequent non-contrast CT scan of the abdomen confirmed the presence of pneumo-retroperitoneum and

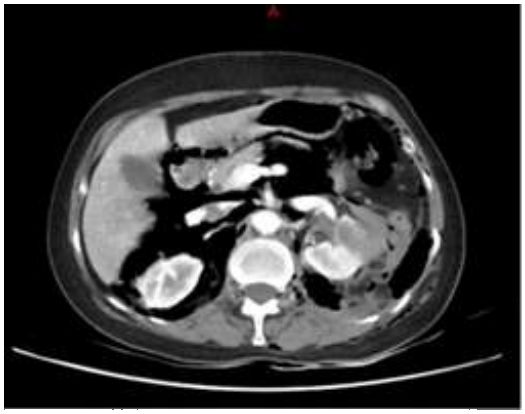

Figure 1: Pneumo-retroperitoneum and pneumomediastinum -CT images

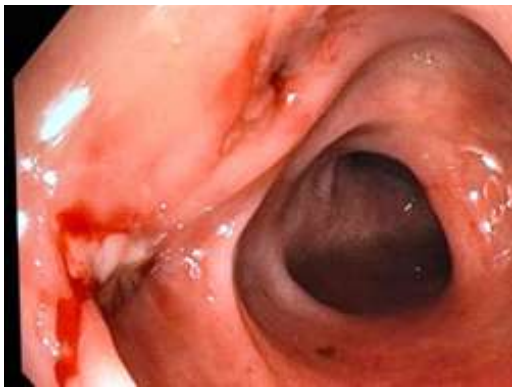

Figure 2 : Endoscopic images of the perforation

Figure 3 : Endoscopic images of the perforation (clips applied)

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Received: 04-12-2024 Accepted: 05-05-2025
DOI:https://doi.org/10.4038/sljs.v43i2.9209

pneumomediastinum, raising suspicion of retroperitoneal colonic perforation (Figure 1) and the patient remained hemodynamically stable.

Given the suspected clinical diagnosis of colonic injury, sigmoidoscopy under sedation was performed with minimal low flow air insufflation, which identified a perforation in the descending colon near the splenic flexure, approximately 1 cm in size (Figure 2). The perforation sites were identified with its sloughy edges and tiny air bubbles popping out of it. The perforation was successfully closed with three through-the-scope endoscopic clips (TTS) (Figure 3). The patient was then managed conservatively with bowel rest, intravenous fluids, and broad-spectrum antibiotics (piperacillin-tazobactam). She was kept on nil per oral (NPO) status for 72 hours and closely monitored for any signs of deterioration.

Over the course of the next few days, the patient's symptoms improved significantly. Abdominal pain resolved, and follow-up imaging showed a reduction in pneumo-retroperitoneum. Oral feeding was gradually reintroduced on postoperative day six, and the patient tolerated this well. She was discharged on postoperative day ten, having made a full recovery.

Discussion

Colonic perforation is an infrequent but serious complication of PCNL, with an incidence ranging from 0.2% to 0.8% [3]. It occurs when the nephrostomy tract traverses the bowel wall, most commonly the descending colon due to its proximity to the left kidney. Pneumo-retroperitoneum and pneumo-mediastinum are radiological markers of such injury. Traditionally, colonic perforations following PCNL require surgical exploration, bowel resection, and anastomosis, [4] leading to increased patient morbidity, prolonged hospital stays, and higher healthcare costs.

In recent years, less invasive strategies have been explored, particularly for small perforations and stable patients. Conservative management of the bowel perforation has been described with percutaneous drainage and bowel rest, however endoscopic clipping allows direct closure of the perforation and avoiding open surgical intervention. This approach provides a definitive solution and avoids morbidity of an open procedure.

The endoscopic clipping during iatrogenic perforation in colonoscopies is well documented but its applications in post PCNL bowel injures is less common.

However Early detection of the perforation and prompt endoscopic management were key to avoiding complications such as peritonitis or sepsis.

Our case highlights importance of multidisciplinary approach involving, surgical, gastroenterology, and radiology expertise in managing surgical complications and reducing its morbidity and mortality [5]. Minimally invasive treatment with endoscopic intervention should be considered in hemodynamically stable patients with small perforations.

Conclusion

This case report is the first documented instance of successful management of a colonic perforation following PCNL using only endoscopic clipping. The patient recovered completely. This experience suggests that selected cases of colonic perforation following PCNL can be managed with endoscopic techniques, offering a minimally invasive alternative to traditional open surgical management.

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Learning Points:

- Colonic perforation is a rare but dreaded complication of PCNL, usually requiring surgical intervention, with or without de-functioning procedures.
- Endoscopic clipping can be used as a minimally invasive alternative for managing colonic perforations, especially in stable patients with small perforations.
- Early recognition and prompt intervention can prevent the need for open surgery, reduce morbidity, and shorten hospital stays.
- A multidisciplinary approach involving urology, radiology and gastroenterology can optimize outcomes.