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ORIGINAL ARTICLE

Mini-laparotomy versus conventional laparotomy in emergency general surgery: a prospective study from a second-level hospital in Zambia

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ABSTRACT

Background: Mini-laparotomy (ML) is one of the approaches aimed to reduce intraoperative stress and enhance recovery in surgical patients. The objective was to determine how safe and feasible ML access is in emergency surgery.

Methods: This prospective, two-group,parallel active-controlledstudy evaluated adult patients operated on for acute abdominal conditions. Patients explored with the use of ML and those having standard laparotomy (SL) access formed two arms of the study. The ML was defined as open surgical access of less or equal 12 cm. Length of hospital stay and 30-day morbidity/mortality were primary endpoints. Secondary outcomes were operative time, estimated blood loss during the procedure, and postoperative pain control.

Results: Thirty-five patients were explored through ML, and 33 had an SL incision. The size of ML ranged from 6 to 12 cm, with the median being 10.5 cm. Employment of ML was associated with reduced length of stay (p=0.008), shorter operative time(p=0.003), and minimised need for opioid analgesia (p=0.008); however, the difference in postoperative complications was not statistically significant (ML: 20% versus SL: 27%, p=0.48) and mortality was similar in both groups (6%).

Conclusion: Our data demonstrate that ML is a safe technique that could be used for the treatment of urgent abdominal conditions in selected patients. Having comparable postoperative morbidity with the SL approach, it might lead to reduced pain and enhanced recovery after the procedure.

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INTRODUCTION

Despite continuous advances in perioperative care, emergency abdominal surgery still carries a substantial risk of in-hospital complications and death worldwide[1,2]. Metabolic response to intraoperative trauma is considered an important determinant of postoperative complications and the risk of death after major surgery[3,4]. To attenuate operation-induced stress and expedite patient rehabilitation, various mini-invasive methods have been developed[5,6]. Reduced in size laparotomy incision is one of these techniques, which could be applied for visceral general surgery and intraabdominal vascular surgery procedures[7-9].

Keywords: Small-incision laparotomy, standard laparotomy, emergency general surgery, length of hospital stay

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Our institution is a 164-bed second-level referral hospital operating as the main medical centre in the area with a population of around 200,000, and we have a quite heavy workload with acute care surgery. In our efforts to optimise the postoperative recovery of the patients, we have started practising a small-incision approach in selective abdominal procedures in 2020. However, the safety and feasibility of ML incision in emergency surgery remain unclear. Review of the recent literature revealed that 1) vast majority of studies in visceral surgery reported on the use of laparoscopic and actively implementing robotic techniques[10-12], 2) most of the works are restricted by areas of appendicectomy, cholecystectomy and colon surgery with associated conditions[6,13,14], 3) in emergency setting, open laparotomy remains the principal surgical approach[15,16], 4) reports on laparoscopy in abdominal trauma are scarce and still divided on its diagnostic and therapeutic potential[17-19], and 5) those studies assessed the efficacy of different explorative techniques reported comparable outcomes after laparoscopic methods and ML[5,6,20].

In this study, we aimed to evaluate how safe and technically feasible ML is in emergency surgery. We hypothesised that the small-incision laparotomy might bring additional clinical benefits to patients in comparison with the standard surgical approach technique.

MATERIALAND METHODS

The work was conducted according to the ethical principles of medical research disclosed in the Declaration of Helsinki with all respect shown for the privacy and confidentiality of the personal information of the participants. Permission to perform the study and to publish results was obtained from the Roan Antelope General Hospital Ethical Standing Committee (Ref No 01/21).All participants were fully informed of the research and their consent for enrolment in the study and permission for taking pictures and publication were obtained.

All consecutive patients operated on for urgent abdominal pathology from 03 December 2021 to 10 February 2023were assessed for inclusion in this prospective two-group, parallel active-controlled clinical study. The inclusion criteria were as follows: 1) age > 18 years old, 2) Body Mass Index < 30, 3) American Society for Anaesthesiologists class I to IV. Patients under 18 years old were excluded from the study, as most standard abdominal incisions in children are of a small size. We did not include patients operated on for uncomplicated appendicitis for the same reason. Small incisions were not attempted in obese individuals with a Body Mass Index of above 30 due to reduced field of view and difficulties in manoeuvre in a deep operative wound. Patients who need a thorough inspection of the abdominal cavity or who may require mobilization of distant structures were also excluded from the study (Figure 1). To categorise eligible participants into study groups, an alternating allocation method[21] was used, and they were dichotomised based on alternate days of admission to the hospital.

To calculate sample size, we used a formula for cohort study with a two-sided hypothesis test estimating a significance level of5% and the power of the studyof80%[22]. For the reference study, we have chosen a recent meta-analysis of case-control studies[23] comparing outcomes in mini-invasive and open surgery for intestinal obstruction.

$$\text{Sample size} = \frac{2SD^2(Z\alpha/2 + Z?)^2}{d^2}$$

SD – Standard deviation (from the reference study)
$Z_{\alpha/2}$ – Z value for the level of significance (type 1, or α, error)
Z_β – Z value for the power of a study (type II, or β, error)
d – effect size = difference between mean values (from the reference study)

Based on this analysis, we expected an effect size in the main outcome in our patients—length of hospital stay (LOS)—to be 5 days. According to the calculation, each arm should have at least 33 participants. Anticipating drop-outs during follow-up, we increased the sample size to 37 patients in each group.

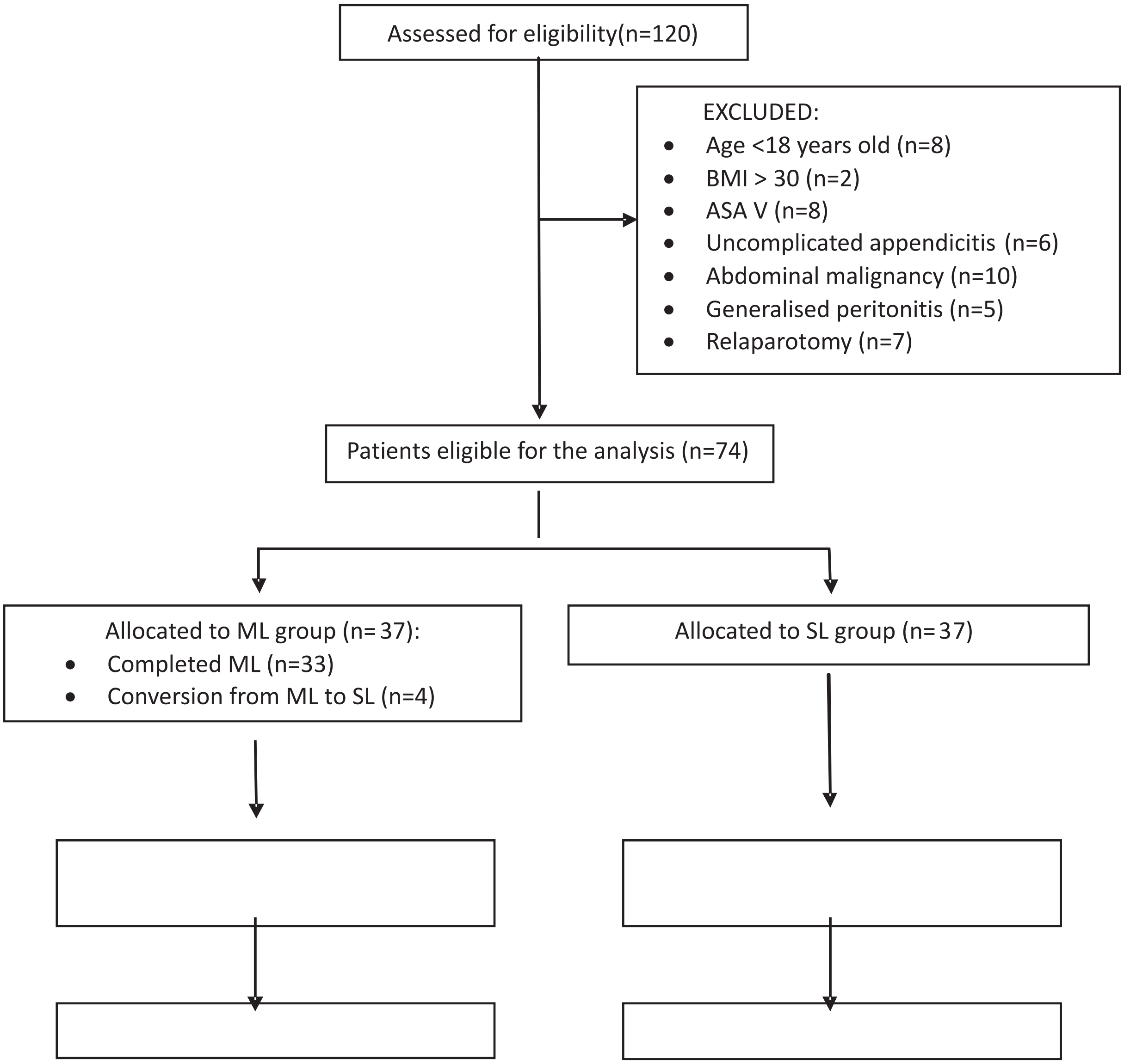

Figure 1: Flow diagram of patient selection
BMI, body mass index; ASA, American Society for Anaesthesiologists, ML, mini-laparotomy, SL, standard laparotomy

We defined ML as surgical approach with skin incision not exceeding 12 cm. The orientation and the length of the ML incisions are presented in Figure 2.We promptly converted the ML into a standard incision by extending the upper and lower edge of the wound in difficulties in intraabdominal visualisation and manipulation; however, in accordance with the methodology of the intention-to-treat principle[24] ,these patients were retained in the originally assigned ML group . The surgical access in the SL cohort was achieved through a conventional midline laparotomy measuring from 13 to 22 cm.

and Ultrasound were used routinely. The patients were operated according to their clinical needs. Operations were performed by two consultant surgeons and one senior registrar surgeon. The plan for the intervention was discussed in detail with an anaesthesiologist and the consensus was achieved in every case.

Gastrointestinal perforations were repaired by the application of interrupted slowly-absorbable sutures. To perform intestinal anastomosis, the hand-sewn technique was used, with one layer for the small bowel and two layers for the colon (Figure

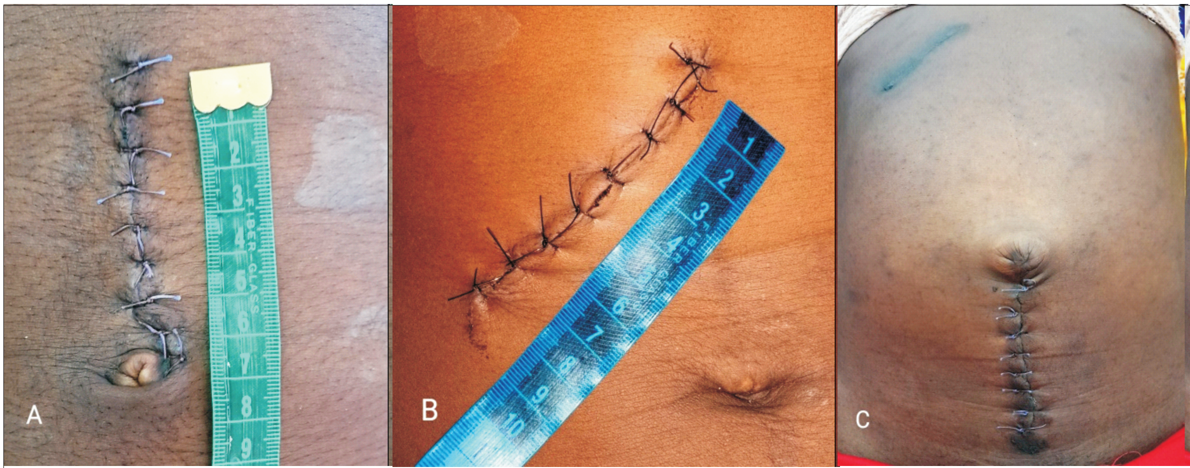

Figure 2: Mini-laparotomy incisions. **A** Upper midline approach(used for splenectomy); **B** Reduced-in-size Kocher incision (cholecystectomy); **C** Lower midline laparotomy; this patient was operated twice with the interval of 7 months; first, for acute cholecystitis, and later, for sigmoid volvulus with resection and primary anastomosis

Patients were treated in line with the concept of Enhanced Recovery After Surgery (ERAS)[25-27], as much as our resources allowed (Supplementary Table). On admission, they received IV resuscitation andweight-adjusted doses of antibiotic, a nasogastric tube and urinary catheter were inserted when necessary.The physical status of patients was assessed bythe American Society of Anaesthesiologists (ASA) classification[29].Cases of acute pancreatitis were categorised according to the Revised Atlanta Classification[30]. The extent of injury in abdominal trauma victims was estimated by the revised Organ Injury Scale for solid organ injuries for the American Association for the Surgery of Trauma[31], and Injury Severity Score (ISS)[32].As diagnostic modalities, abdominal X-ray

3). Cholecystectomy was done by retrograde technique in both groups.At the end of the operation, layers of the abdominal wall were closed with a continuous slowly absorbable suture and the skin was sutured with interrupted sutures. Postoperative care included adequate pain control using Nonsteroidal Anti-inflammatory Drugs and opioid analgesics, early removal of nasogastric tube and urinary catheter, immediate commencement of the physiotherapy, early mobilization, and nutrition. The intensity of postoperative pain was assessed by the demand for opioid analgesics. Patients were followed up 30 days after discharge.

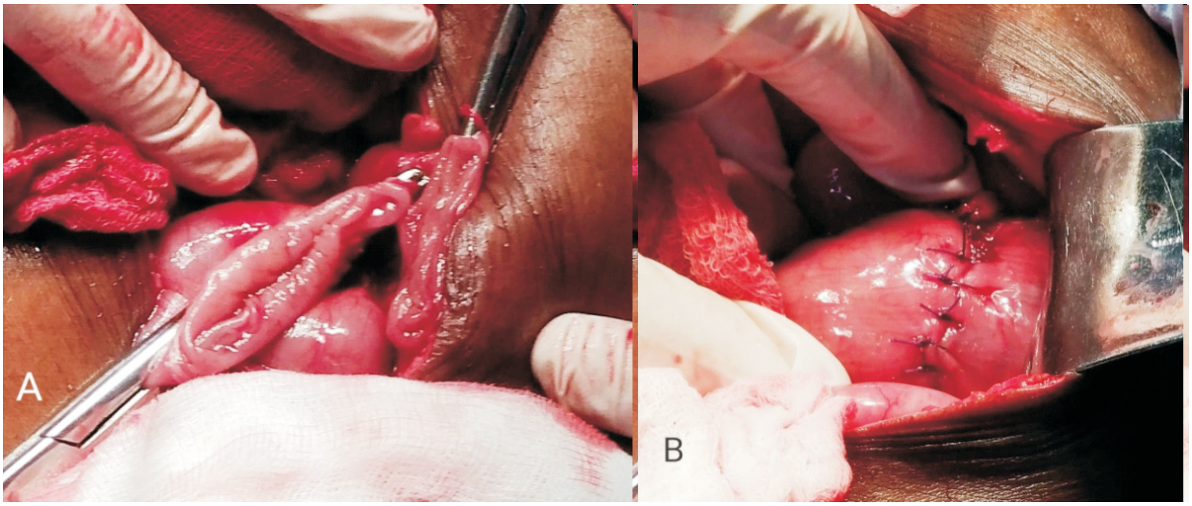

Figure 3: A Sigmoid volvulus resected through lower midline mini-laparotomy; **B** colorectal hand-sewn anastomosis

The primary outcomes were LOS and postoperative morbidity. LOS was calculated from the day of the operation. Morbidity was assessed according to Clavien-Dindo[33]. Mortality was determined as death following surgery during the hospital stay or within 30 days of the procedure, whichever is sooner[34]. Secondary outcomes included operating time (OT), estimated blood loss during the surgery (EBL) and postoperative pain control. OT and EBL were counted by a circulating theatre nurse and anaesthetist. Primary and secondary endpoints were compared between ML and SL subsets.

Descriptive statistics were employed to report the findings obtained. Continuous variables were presented as mean with standard deviation or median with interquartile ranges depending on the distribution of the data andanalysed by t-test. Categorical data were expressed as frequency and percentage and assessed by chi-square analysis or Fisher exact test as appropriate. LOS was compared by log-rank test and presented graphically by Kaplan-Meier survival curves[35]. A *p*-value <0.05 *was considered* significant.

RESULTS

Out of 120 patients operated onfor acute abdomen at the hospital during the study period,68 participantswere recruited with 35 in the ML arm and 33 in theSL arm. Demographics and clinical variables are presented in Table 1.

Indications for surgery were similar in both cohorts; however, it appeared that acute cholecystitis and intestinal obstruction were seen more often in the ML cohort, and complicated acute appendicitis was operated more frequently in the SL group. Characteristics of the ML incisions are presented in Table 2. Intestinal obstruction was the most common presentation in both groups and was caused by adhesions (ML: n=7, SL: n=6), volvulus (both ML and SL: n=6 each), strangulated hernia (ML: n=2), and intussusception of the jejunum caused by the tumour (non-Hodgkin's lymphoma) (ML: n=1). Volvulus developed in the sigmoid colon (ML: n=5, SL: n=4), ileum (both ML and SL: n=1 each), in one patient from the SL cohort we encountered ileo-sigmoid volvulus when a loop of ileum was twisted around the base of the sigmoid colon. Peritonitis developed due to perforated peptic ulcer (ML: n=3, SL: n=2) or distal ileum (ML: n=2, SL: n=4), and complicated appendicitis (ML: n=1, SL: n=4).

Table 1 : Sociodemographic and clinical variables

Variables	ML group (n=35)	SL group (n=33)	*p*
Gender, n (%)			
Male	23 (66)	21 (64)	0.86[a]
Female	12 (34)	12 (36)	
Age, years, mean±SD	38.1±17.0	36.5±14.4	0.68[b]
Aetiology, n (%)			
Intestinal obstruction	16 (46)	12 (34)	0.47[c]
Abdominal trauma	7 (20)	7 (21)	1.0[c]
Gastrointestinal perforation	5 (14)	6 (18)	0.75[c]
Acute calculous cholecystitis	4 (11)	0	0.12[c]
Acute pancreatitis	2 (6)	3 (9)	0.67[c]
Acute appendicitis	1 (3)	4 (12)	0.19[c]
PID	0	1 (3)	0.49[c]
Co-morbidities, n			
Hypertension	3	5	0.47[c]
Acquired Immunodeficiency Syndrome	3	0	0.24[c]
Chronic Obstructive Pulmonary Disease	2	2	1.0[c]
Pulmonary Tuberculosis	2	0	0.49[c]
Congestive Heart Failure	2	2	1.0[c]
Diabetes Mellitus	1	0	1.0[c]
COVID-19	0	1	0.49[c]
ASA physical status, n (%)			
I	9 (26)	12 (36)	0.6[a]
II	10 (29)	8 (24)	
III	4 (11)	4 (12)	0.6[a]
IV	12 (34)	9 (27)	
OT time min, mean±SD	65.5±23.1	93.4±46.0	**0.003**[b]
EBL ml, mean±SD	229.0±102.8	239.1±173.0	0.77[b]
Opioid analgesics used postoperatively, n (%)	18 (51)	28 (85)	**0.008**[a]
LOS days, median; IQR	4.0; 3 – 6	5.0; 4–7	**0.008**[d]
Postoperative morbidity, n (%)	7 (20)	9 (27)	0.48[a]
Postoperative mortality, n (%)	2 (6)	2(6)	0.95[a]

ML, mini-laparotomy, SL, standard laparotomy; n, number of patients; %, percentage; **SD, standard deviation;** IQR, interquartile range; NA, not applicable; PID, pelvic inflammatory disease; COVID-19, coronavirus disease 2019; ASA, American Society for Anaesthesiologists;**OT, operating time; min, minutes; EBL, estimated blood loss; ml, millilitre; LOS, length of stay**

[a]Chi-squared test
[b]t test
[c]Fisher exact test
[d]log-rank test

Table 2: Mini-laparotomy incisions used

Incision	Indication	Number	Size, cm, median, (ranges)
Upper midline	Perforated peptic ulcer Abdominal trauma (spleen rupture) Perforated terminal ileum	10	10.5 (7-11.5)
Right hypochondrium (reduced-in-size Kocher)	Acute cholecystitis	4	7.8 (6-12)
Left hypochondrium	Abdominal trauma (spleen rupture)	1	11.0
Transverse	Strangulated umbilical hernia	1	7.5
Lower midline	Intestinal obstruction Perforated terminal ileum Complicated appendicitis Abdominal trauma (intestinal/bladder rupture)	16	10.5 (6-12)
Oblique in right iliac fossa	Strangulated inguinal hernia	1	10.0
Total		33	10.5 (6-12)

Abdominal trauma led tosplenic laceration(ML:n=3,grade II:n=1, grade III:n=2;SL:n=2, grade II:n=1, grade III:n=1), bladder injury (ML:n=2, SL:n=2) and intestinal rupture (ML: n=2,SL n=1).Trauma was blunt except for two patients, one from each group, who sustained a penetrated stab injury. One trauma victim from the ML group sustained polytrauma with an ISS score of 22. In three trauma patients (ML:n=2, SL:n=1), associated chest and pelvis injuries were diagnosed, though with lower ISS scores ranging from 13 to 18. Natural history of disease complicated by the development of sepsis (ML:n=5, SL:n=6) and hypovolemic shock (ML:n=4, SL:n=3).

The procedures performed are depicted in Figure4.When using the ML approach, manipulations were completed inside the peritoneal cavity in 26 patients, while in 9 cases the segment of the intestine was mobilised outside the abdomen by gentle traction. In 5 patients of this group, an ostomy through the separate skin incision was created as a part of the procedure (ileostomy n=2, sigmostomy n=3). In four cases, we extended the ML access to standard median laparotomy (conversion rate 11%): in two cases of intestinal obstruction caused by complex adhesions, in one patient with perforated terminal ileum and intraabdominal sepsis, and in one patient with penetrated thoracoabdominal trauma and injuries to the spleen and left kidney. Explorative laparotomy was done in acutely incarcerated umbilical hernia (ML: n=1), ruptured tubo-ovarian abscess (SL: n=1), and acute pancreatitis (2 patients in each group). The latter four patients were classified as moderately severe acute pancreatitis and were explored to rule out perforation peritonitis. One more patient with mild acute gallstone pancreatitis from the SL cohort was offered early cholecystectomy.

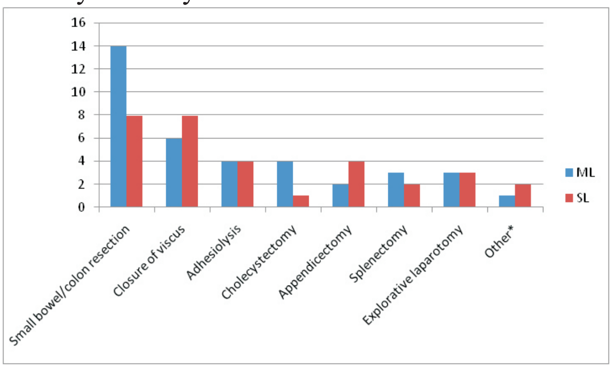

Figure: 4 The procedures performed. ML, mini-laparotomy; SL, standard laparotomy
*included inguinal herniorrhaphy, suturing of the liver/kidney, sigmoidopexy

The time of the procedure ranged from 31 to 126 min in the ML group and from 40 to 210 min in the SL cohort, and the average was significantly shorter in the index group (65.5±23.1 min and 93.4±46.0 min, respectively, p=0.003, 95%CI 9.73 to 46.07). Nonetheless, blood loss during the surgery wassimilar in both groups (ML:229.0±102.8 ml versus SL:239.1±173.0 ml, p=0.77, 95%CI –58.33 to 78.53).Two patients from the ML group and three patients from the SL group needed a blood transfusion intraoperatively. It is not clear why the difference in OT between the two groups was so significant; however, it is evident that more time is needed to close the bigger wound, especially if it is twice as big.

Postoperative complications were less frequent in the MLcohort, but the difference was not significant (Tables1 and 3).Four patients died after operations, two in each group. Causes of death were recorded as follows: sepsis with septic shock (ML, n=1, female, sutured perforated ileum, leakage, relaparotomy via standard approach, ongoing peritonitis), refractory hypotension, and respiratory failure (ML, n=1, straightforward resection of ileum in adhesive intestinal obstruction with necrosis in a medically compromised patient of ASA class IV), colostomy retraction, faecal peritonitis, septic shock (SL, n=1). One patient of the SL cohort died with a sudden cardiovascular collapse on day 4 after an uncomplicated adhesiolysis procedure, and the cause of death remains unknown, as the autopsy was not performed.Cases of postoperative complications and deaths in the ML group were neither associated with missed intraabdominal pathology nor with insufficient exposure and difficulties in manipulations during the procedure. The hospital stay for survived patients was markedly shorter in the ML group (Table 1 and Figure 5).

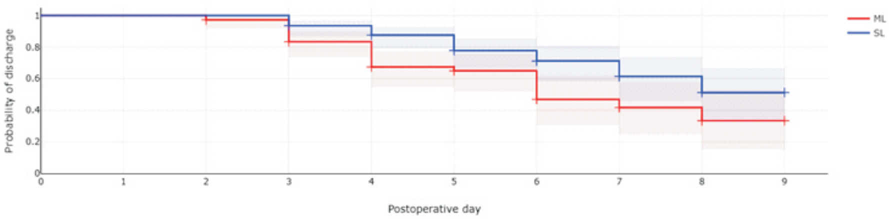

Figure 5: Kaplan-Meier curves of length of hospital stay (with confidence intervals) comparing mini-laparotomy (ML) and standard laparotomy (SL) groups

Table 3 : Postoperative complications

Clavien-Dingo grade and type	Number	
	ML group	SL group
I		
Superficial surgical site infection	2	2
Paralytic ileus	3	3
High-output stoma	0	1
II		
Peristomal irritant contact dermatitis	0	1
Deep surgical site infection	0	1
IIIb		
Early adhesive intestinal obstruction	1	0
Anastomotic leakage	1	0
Surgical wound dehiscence	0	1
V (death)		
Intraabdominal sepsis and septic shock	1	1
Cardiac and respiratory failure	1	0
Acute cardiac failure	0	1
Total	9	11

DISCUSSION

We conducted this study to assess the feasibility of ML incisions in the emergency general surgery population. Analysis revealed that the ML is safe and practicable approach in selected patients with a low conversion rate and favourable short-term outcomes. There is no consensus in the literature about the definition of mini-laparotomy, and the length of the incision, characterised as ML, varies from 3 cm[36] to 18 cm[37]. In agreement with Wang et al.[38], we defined the upper limit of the ML being 12 cm. With this size of the wound, gentle edge traction exposes the operative site sufficiently to perform a procedure, and, besides, it allows the surgeon to insert their hand into the abdominal cavity for tactile feedback. Most commonly, we used lower midline incision and found it sufficiently convenient to operate on different pathologies including, for example, sigmoid volvulus (Figure 3). In our opinion, manipulation with the distal part of the twisted sigmoid is technically easier with this approach. The second advantage is that midline incision can be easily converted into standard laparotomy in case of technical difficulties encountered. This approach for sigmoid volvulus was advocated in one study,[39] nonetheless, other orientations of ML access were described in the literature, namely vertical[40], horizontal[41], and oblique[36] incisions in the left iliac fossa.

To the best of our knowledge, there are no reports describing the application of ML in abdominal trauma. Laparoscopy was introduced to both penetrating and blunt abdominal injuries, but it is not widely used these days[17,42]. It hastherapeutic potential, for example, in situations when non-operative management fails and at the same time the patient remains haemodynamically stable[19,43], when the skill level and experience of a surgeon are sufficient to complete the procedure started laparoscopically[44], and in "special" cases concerning the preferences of the patient[18]. However, laparoscopy in trauma is usually opposed to open exploration and performed in a situation of diagnostic uncertainty to avoid negative celiotomies[42,45]. In this study, ML was used in patients with abdominal trauma as a therapeutic procedure. The employment of the ML incision allowed a surgeon to do fast and easy access to the peritoneal cavity (which is essential in an emergency setting[46]), promptly assess the intraabdominal situation and decide on further manipulations. In our series, six out of seven trauma cases were finished with a small incision when it was chosen as an initial technique.

While the advantages of ML are comprehensively described in the literature[7,9,39], the challenges, and risks associated with this approach should not be underestimated. First, patients with intra-abdominal infections often present in the late stage with a non-specific clinical picture, and this could complicate the diagnosis-making process. This is especially true in resource-scarce settings with limited diagnostic modalities[1]. At the same time, when deciding to perform the procedure using the minimal approach, the operator must precisely locate the anatomical site of interest before the operation starts. Second, inside the small incision, the surgeon is restricted in freedom of manipulation and could find it difficult to properly visualize abdominal organs to reveal associated or unrelated pathology. Third, delivery of the intestinal loops to the outside of the abdominal cavity for manipulation through a small incision can lead to compression of the mesenteric root and subsequent venous congestion of the externalised intestine which we saw in two of our patients.

The following measures were undertaken to alleviate manoeuvres within the small operative area. Before the procedure, a 10 cm high pillow was placed underneath the patient's back. It decreased the depth of the operative wound and expanded the field of view for the surgeon at the site of the operation. In cases of sigmoid volvulus, the over distended loop was initially desufflated by a large bore needle which allowed the surgeon to deliver it easily through a small incision. It was recommended by van der Naald *et al*.[39], and we found this manipulation highly effective. To prevent compression of the mesenteric vessels, we tried to perform manipulations within the abdominal cavity. Exposure of the bowel loops outside the abdomen should be limited in time unless the procedure involves the resection of the delivered intestine. Next, it is crucially important to maintain consistent and cooperative communication between the surgeon and the anaesthesiologist, as the appropriate level of anaesthesia can significantly alleviate manipulations within a limited operative space[26]. Due to the plasticity of the abdominal wall and good muscle relaxation,it is possible, for example, to perform splenectomy through an incision which is smaller in size than the organ removed (Figure 6).

Fig. 6 : Splenectomy done through mini-laparotomy incision

Having a positive experience with ML, we are however confident that even with the optimal surgical technique the clinical benefits for the patient are not just from the reduction in the size of the incision. We think because patients of both groups were equally treated according to the principles of fast-track surgery, an effect size in LOS, albeit significant, appeared to be less than expected initially. Statistically speaking, ERAS components produced a negative confounding effect here underestimating the outcome of the exposure; nonetheless, they were not able to dilute the beneficial effect of the intervention.

Therefore, ML can be considered optimal access in an environment where laparoscopic equipment or training is not yet available and as a viable alternative if the surgeon does not have enough experience with laparoscopy or when it is contraindicated for the patient. In this regard, we propose an algorithm for the selection of exploration method in patients with acute abdomen and trauma(schematically depicted in Figure 7). Of note, a decision to perform ML should be substantially grounded by careful weighting of both associated risks and expected benefits. Sound clinical judgment and sufficient surgical expertise are indispensable in selecting the optimal surgical approach, and the threshold for conversion to a standard laparotomy is to be low. It is vital that the standards of urgent surgical care are not impaired by choosing an ML exploration method. One should realize that making a small incision is not the goal of the management *per sè*, rather it is one of the available methods to perform the procedure in the most efficient and safe way to deliver optimal patient-centred care, and our findings confirm this.

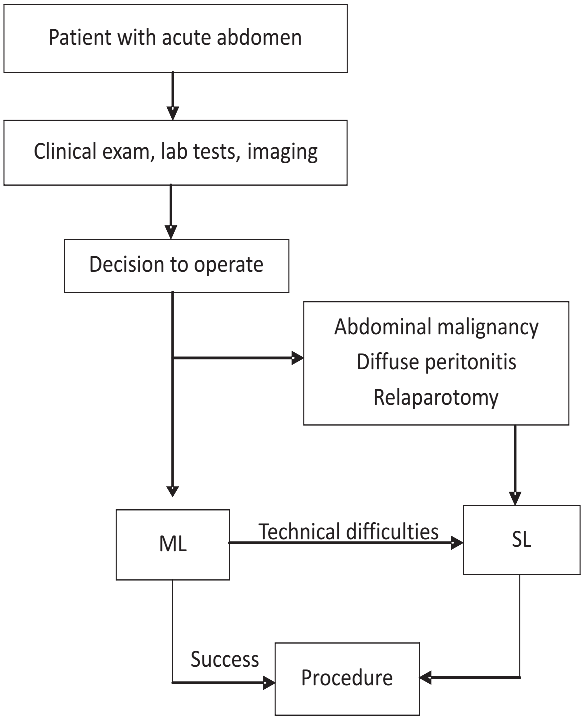

Fig. 7 : Proposed algorithm for the selection of exploration method. ML, mini-laparotomy; SL, standard laparotomy

LIMITATIONS

The results of the study should be interpreted with caution in the context of some considerations. The alternating assignment employed for the allocation of the patients to the groups can lead to selection bias[47]. On the other hand, it is an example of a systematic random sampling method, and thus, according to Ott and Longnecker[48], it could provide a representative sample of a target population. Indeed, there is no reason to assume that there is a cyclic fluctuation of emergency admissions to the hospital within the week, and this notion is supported in the literature[49]. This technique is not uncommon for the evaluation of surgical treatment and can give more accurate evidence of an intervention effect than an observational design[24]. It is applied when practical considerations (for our study there were difficulties in randomisation of participants admitted urgently and a low-volume surgical hospital) and financial restrictions make performing a high-quality Randomised Clinical Trial impossible[50]. Further, a few of the patients were excluded from the analysis and, therefore, the results of the research cannot be extrapolated to all patients with urgent abdominal pathology. It is known, however, that the selection of the appropriate technique is not only expected, rather is necessary in emergency surgery, as not every patient with an acute abdomen could be managed by a minimally invasive surgical approach[11]. Next, the study population appeared to be quite heterogeneous with different indications for the exploration. Finally, as we pragmatically assessed the immediate effect of the exposure of interest, we are not aware of late complications. It is tempting to hypothesise that patients post ML exploration who experienced accelerated postoperative recovery may return to work faster and have less frequent late morbidity and higher aesthetic satisfaction than those operated by a standard laparotomy. Late out comes need to be evaluated by further research with a longer follow-up period.

There are also some strengths of this study to be mentioned. To control the potential confounders, we performed the following. First, we excluded non-eligible participants before the allocation process applying clear and specific criteria for the enrolment in the study. As a result, study cohorts appeared to be well-matched for the main demographic and clinical variables (Table 1). Second, to achieve acceptable statistical power we obtained the required sample size. Third, we applied intention-to-treat analysis anticipating the methodological and practical benefits associated with this strategy[23]. Fourth, quantitative outcomes (OT, EBL) were calculated blindly by independent evaluators not involved directly in the study. Fifth, we have a low proportion of patients who dropped out during follow-up (8%), and this could strengthen inferences from the data evaluated. Last, as the counterargument to the aetiological heterogeneity of the population, this is a clinical study, and the participants are expected to represent a cross-section of the real-world admissions to acute surgical services. Therefore, acknowledging the weaknesses of our analysis, we assume that the findings obtained could be of certain relevance for clinicians working in smaller hospitals and we hope that our work will encourage further research in the field.

CONCLUSION

According to our data, ML is a safe, minimally invasive and attractive alternative to a traditional laparotomy approach in emergency general surgery, and, although demanding, it could be applied for the treatment of a larger number of conditions that are currently practised. Our results suggest that this technique could benefit the patients enhancing their postoperative recovery. Evident limitations of this work warrant large-scale studies to validate the findings obtained. The following questions that could be asked include: 1) Are there specific indications to use the ML in patients with acute abdomenβ 2) What should be the role of ML in abdominal traumaβ 3) Could the employment of ML access reduce the incidence of late postoperative complications compared with the conventional exploration methodβ After all, is there any place for ML incision in the modern laparoscopic and robotic eraβ

What is already known on this topic:

- Mini-invasive surgery has become a standard approach in many elective general procedures
- Open laparotomy remains a predominant access in surgical emergency including abdominal trauma
- Immediate results of laparoscopy-assisted procedures and ML are comparable

What this study adds:

- ML is a safe exploration which is associated with similar morbidity compared with a conventional laparotomy in an emergency setting
- ML could bring additional benefits to patients reducing intra-operative stress and enhancing their recovery

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Competing interests

The authors declared that they have no competing interests

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Authors' contributions

Study concept, design and supervision: SK.

Acquisition, analysis of data, and drafting of the manuscript: both authors.

Both authors critically revised read and approved the final manuscript.

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Supplementary Table Implementation of ERAS program at our hospital

ERAS item	Comments
Pre-admission risk stratification	ASA Physical Status Classification used
Optimization of pre-existing health conditions	Medical optimization performed pre-operatively. Routine preoperative HIV testing.
Antimicrobial prophylaxis and skin preparation	No routine bowel preparation for elective colonic surgery. Single-dose antibiotic given at induction. Chlorhexidine–alcohol-based skin preparation. No routine skin shaving, no adhesive incise sheets available.
Preoperative fasting and carbohydrate loading	All patients fasted before the procedure. No carbohydrate loading preoperatively.
Pre-anaesthetic medication	Long-acting anxiolytic and opioids avoided.
Anaesthetic Protocol	Individualized depending on the ASA grade. Short-acting anaesthetic agents.
Preventing intraoperative hypothermia	Blankets used to cover the patient before procedure started. Ambient temperature in theatre is regulated by air-conditioner.
Surgical access (minimally invasive surgery including laparoscopic/robotic approaches)	Mini-laparotomy used when possible. Laparoscopic technique still not available.
Intraoperative fluid and electrolyte therapy	IV fluid therapy monitored using haemodynamic parameters and urine output. Balanced crystalloid solutions used as routine. Colloid solutions and inotropes considered in haemodynamically unstable patients.
Drainage of the peritoneal cavity and pelvis	Abdominal drains placed in cases belonging to the contaminated/dirty surgical wound classes[28]; removed when output $\leq$100 ml/day. No drains used to prevent or detect anastomotic leakage.
Post-operative analgesia	NSAIDs alone or in combination with opioids used. Spinal/epidural analgesia not used postoperatively.
Nasogastric intubation	Nasogastric tubes removed on POD1-2 when $\leq$300 ml/day.
Urinary drainage postoperatively	Urinary catheter removed in conscious and haemodynamically stable patients
Postoperative fluid management	Balanced crystalloid solutions were preferred. Monitoring of IV fluids aimed to achieve state of zero fluid balance as possible.
Thromboprophylaxis	Unfractionated heparin/LMWH started 8-12 hourly on POD1 and continued till patient discharge.
Early mobilisation	Used in all patients; physiotherapy started on POD1
Post-operative nutritional care	Clear liquids as tolerated after surgery. Softdiet commenced as soon as possible.
Discharge criteria	Afebrile, without tachycardia. Tolerance of meals without nausea or vomiting. Passage of stool. Adequately controlled pain. Patient ambulating independently. Adequate support at home.
Postdischarge follow-up	Reviews in surgical clinic during 30 days after discharge

ERAS, Enhanced Recovery After Surgery; ASA, American Society for Anaesthesiologists; HIV, human immunodeficiency virus; NSAIDs, non-steroidal anti-inflammatory drugs; OT, operating theatre; POD, post-operative day(s); LMWH, low molecular weight heparin