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Original Article

Randomized Controlled Study Comparing Diathermy and Scalpel Incisions for Elective Midline Abdominal Access in Jos University Teaching Hospital.

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ABSTRACT

Introduction: Surgeons have traditionally made skin incisions with the scalpel. The introduction of diathermy for coagulation of bleeding vessels, cutting and fulguration of soft tissue has been used as an alternative to the scalpel for making skin incisions. Comparative studies have shown varying outcomes, and there are limited studies carried out in the Nigerian context. The objectives of this study were to compare wound outcomes and complication rates following the use of cutting mode diathermy and scalpel skin incisions for elective midline laparotomy. **Methods:** In this prospective, hospital based, randomized controlled non-inferiority study, consenting patients undergoing elective open laparotomy were randomized into interventions of diathermy incision or scalpel incision using sealed envelopes with intraoperative allotment disclosure. Participants, care givers and outcome assessors were blinded to group allotment. Demographic characteristics and wound outcomes including incision time, incision blood loss, post-operative pain, and complications (infection, haematoma, and wound dehiscence) were observed and recorded. Primary end point was 30-day post-operative follow up. Data were analysed using the Fisher's exact and independent sample t-test, with results represented in tables and figures. **Results:** Forty-two of 50 enrolled patients (84%) attained the primary end point and were included in the final analysis with 21 patients analysed in the diathermy (Group A) and scalpel incisions (Group B). The two groups did not differ significantly with respect to age ($p = 0.725$), BMI ($p = 0.904$), wound length (cm) ($p = 0.065$), wound depth (cm) ($p = 0.334$), and wound area (cm^2) ($p = 0.985$). The use of diathermy for skin incision for intraperitoneal access was significantly faster than the use of scalpel ($p < 0.001$). The total skin incision wound blood loss was significantly less in the diathermy group compared to the scalpel group ($p < 0.000$) as well as the wound blood loos per unit wound area ($p = 0.002$). There was no significant difference in post-operative wound pain assessed using the Visual Analogue Scale on Day 1 ($p = 0.270$), Day 2 ($p = 0.592$), and Day 3 ($p = 0.770$). The post-operative wound complication rate did not differ significantly between the two groups ($p = 1.000$). **Conclusion:** The use of diathermy incision for access in midline laparotomy significantly reduced wound incision time and incision blood loss compared to that of the scalpel incision. However, there was no significant difference in post-operative wound pain and complication rate between the two groups.

Key words: Diathermy, Scalpel, Laparotomy, Incision.

INTRODUCTION

Skin incisions for access in surgeries have traditionally been made with the aid of the scalpel. The scalpel is an extremely sharp bladed instrument historically used to cut the skin and underlying tissue[1]. However, with the introduction of diathermy in the early twentieth century, some surgeons now use the cutting diathermy as an alternative for making skin incisions.[1,2] Diathermy electrosurgery is a method of separating

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tissues using electrical energy.[3] An electrical current passing from the tip of the active electrode causes the tissue to rapidly heat up, and the cells explode and vaporize. As the surgeon moves the instrument along the skin, more cells are destroyed, and an incision is created.

While diathermy is extensively used for dividing subcutaneous tissues, muscles, fascial layers, and for haemostasis, its application for skin incisions has been controversial, as its safety and efficacy have been questioned.[1,4] There is disagreement among surgeons in the use of diathermy for surgical skin incisions. Many fear that it causes skin burns, poor wound healing, increased incidence of surgical site infection and excessive scarring,[5-8] while those in favour of its use describe the advantages of faster incisions, less blood loss with dry and rapid separation of tissues, reduced post-operative pain, and a reduced risk of iatrogenic injury to the surgeon.[1,2,9,10,11,12] In the few published studies, most of which come from far East Asia and high-income countries, there is no consensus concerning whether use of scalpel or diathermy results in better wound outcomes, shorter incision time, lower blood loss, and less pain.[1]

The general objectives of this study were to compare the outcome of scalpel and diathermy incisions in patients undergoing elective abdominal laparotomy at the Jos University Teaching Hospital, Nigeria from September 2019 to October 2020. Specific objectives were to compare incision time in minutes, blood loss in millilitres during incision, postoperative pain as measured by the visual analogue scale, and incisional wound complications (including reactionary bleeding, infection, or dehiscence) for both methods.

MATERIALS AND METHODS

This was a randomized controlled non-inferiority study conducted at a single tertiary hospital- the Jos University Teaching Hospital, Plateau State in North-Central Nigeria.

Participant Recruitment

Participants were recruited from the surgical out-patient department, while the intervention was carried out in the modular operating suites and subsequent data collected on the wards and during follow-up at the out-patient department.

Inclusion and Exclusion Criteria

We included male or female patients above the age of 17 years undergoing elective abdominal laparotomy between September 2019 and October 2020. We excluded patients undergoing emergency laparotomies, patients with previous midline laparotomy scars, infections at the operative site, and high-risk patients with American Society of Anaesthesiologists (ASA) physical status classification system grades III and IV. Patients with severe comorbidities (diabetes mellitus, severe cardiac or airway disease, liver disease, uncontrolled hypertension, or sickle cell anaemia) were also excluded. We also excluded patients with bleeding disorders, and those on anticoagulants, steroids or cytotoxic medication.

Sample Size, Sampling, and Randomization

Sample size was determined from the formula for comparison of 2 proportions (two-sided) as follows: - n = [A + B]2 * [(p1*(1-p1)) + (p2 * (1-p2))]/[p1-p2] 2. A total of sample size of 21 for each arm was arrived at using the formula.

Patients were randomized prospectively into diathermy (Group A) or scalpel (Group B) incision groups. Randomization was by sealed envelope upon patient's arrival in the operating suite. Group A patients had incisions made with cutting diathermy while group B had incisions made with scalpel The method of incision to be used was determined by the outcome of randomization. A sequence generated from a table of random numbers was used to determine the order of the cards placed in the envelopes. As eligible patients were recruited for the study, the next in the pile of sealed, serially numbered envelopes were opened, and the patient was assigned accordingly into Group A (diathermy) or B (scalpel).

Study Procedure

Recruited patients were admitted to the hospital following evaluation in the Surgical Outpatient Department where a detailed history was obtained and the following data related to age, sex, comorbid illness, and any previous surgery were recorded. A thorough examination was conducted to determine variables such as general health, weight, anaemia, jaundice and any previous scars or wounds. Investigations for general fitness, including full blood count, blood sugar and serum urea, creatinine and electrolytes were performed. When indicated by patient's age or clinical condition, electrocardiography, chest X-ray, and other individualized investigations were performed.

Both groups received intravenous antibiotic prophylaxis: ceftriaxone 1g and metronidazole 500mg at induction of anaesthesia and postoperative antibiotics were administered appropriately (for at most 72 hours depending on the class of the wound).

Along the midline, the skin, linea alba, to peritoneum was incised either with scalpel or diathermy based on randomization. Scalpel incisions were made using a size 20 blade mounted on a sterilized metal reusable size Bard Parker handle. The diathermy incisions were created using a standard diathermy pen electrode, set on cutting mode to produce a pure sine wave current of 35 to 50 W.[13] Bleeding points for both

groups were controlled with coagulation diathermy set at 35 to 50 W. TEKNO TOM 201 electrosurgical generator (Tekno-Medical Optik Chirurgie GmbH & Co.KG, Tuttlingen/Germany) was used to generate the required current.

Incision time was defined as the time from the inception of the skin incision until access was gained into the peritoneal cavity along with time for wound haemostasis for both groups. It was measured in seconds using a stopwatch and recorded by an independent observer in the operating theatre.

The dimension of the incision was measured with a flexible sterile tape. The length of the skin incision and the depth of the wound were assessed and recorded at the end of the procedure to account for the wound edge stretch during intraoperative retraction. The wound area was calculated as a product of the wound length and depth.

Incisional blood loss was calculated by weighing the gauze swabs used exclusively while making the incision for access. No suction was used on the skin incision while making the abdominal incision for access. Using the gravimetric method, the gauze swabs were weighed before and after use, using a digital electronic weighing scale. Each increase in 1 gram was considered equivalent to 1 mL[14]. Other parameters, including total operative blood loss and total operating time were recorded.

At the end of the procedure, wound closure for both groups was achieved by technique of mass closure using nylon-1 (Ethilon; Ethicon Ltd.) suture to approximate the fascia, peritoneum, and superficial layers of the abdominal wall, and interrupted 2/0 Prolene (Ethicon Ltd.) suture for skin.

In the post-operative period, all patients received intravenous (IV) Pentazocine 0.5mg/kg every six hours and IV Acetaminophen 10mg/kg every eight hours for pain control until oral intake resumed, (additional IV analgesics only given for breakthrough pain) and subsequently they received oral analgesics in the form of Acetaminophen tablets 1g eight hourly as appropriate. Objectively to assess pain, the total number of intravenous doses of Pentazocine and Acetaminophen given within 72 hours of surgery were recorded on the Proforma. Wound related pain was evaluated by Visual Analogue Scale daily for three days by blinded observers on the ward.[15] These observers were resident doctors in surgery not involved with the procedure at surgery.

Wound complications like wound infection, wound bleeding, and wound dehiscence occurring at any stage after operation were observed for one month and recorded at week one, week two, and one month (at follow up) by independent observers blinded to the method of incision used. Wound infection was defined by the local tissue damage (erythema, swelling, discharge of pus or fluid containing pathogenic organisms) which impedes wound healing.[16,17]

Data Collection

Surgery interns were trained and allocated to observe different components of the process and record the data for each individual patient. All the data were recorded in the structured proforma.

Data Analysis

All data obtained were subjected to statistical analysis using the statistical package for social sciences (SPSS) version 20 statistical software. Results were reported as mean and presented in tables, and appropriate inferential statistics were performed with assistance of a statistician. Independent t-test and Fisher's exact test were used to assess patient parameters, measured operative parameters and postoperative wound outcomes.

Ethical Considerations

Ethical approval was obtained from Research and Ethics Committee of the Jos University Teaching Hospital (JUTH/DCS/APM/127/XXIX/1440). Study procedures were done in compliance with the Declaration of Helsinki. Written informed consent was obtained from all participants. Individuals who declined consent were not enrolled in the study, with no consequence to their clinical care, and only those who consented to participate were enrolled. Participation was voluntary, with no incentives. Participants maintained the right to withdraw from the study at any time, and without any reason with no effect on their clinical care.

RESULTS

A total of 50 participants who met the inclusion criteria were included for the study. A total of 42 patients, 21 participants in each study arm, attained the primary endpoint and were included in the final analysis (Figure 1).

Most participants randomized to the scalpel group were females (n=18; 85.7%), while most of those randomized to the diathermy group were males (n=15; 71.4%) resulting in a statistically significant difference in sex representation by group ($p < 0.01$) (Table 1). The mean age of study participants was 44.1 years, and most participants were students in both study arms (n=5; 23.8%) with normal BMIs. There was no statistically significant difference in age by study arm (p=0.725), occupation (p=0.363), or body mass index (p=0.904).

In terms of wound characteristics, for the diathermy group, mean wound length is 22.5 cm, while it is 19.8 cm in scalpel group. The diathermy group has a wound depth and incision speed of 2.7cm and 5.78s/cm^2, scalpel group has 3.1cm (wound depth) and incision speed (time to complete incision) of 11.2

s/cm^2. Wound blood loss of 21.71 ml was recorded in diathermy group while 73.57 ml of average wound blood loss was recorded in scalpel group Also, mean value of wound area and wound average blood loss was 61.1 cm^2 and 0.5 ml/cm^2 in diathermy group while it is 61.3cm^2 and 1.3ml/cm^2 in scalpel group. (Table 2)

There was a statistically significant difference in incision time, incision speed, wound blood loss, and average blood loss, while there was no statistically significant difference between the two groups regarding wound length, wound depth and wound area (Table 2). Comparison between diathermy and scalpel groups showed higher levels of pain in the scalpel

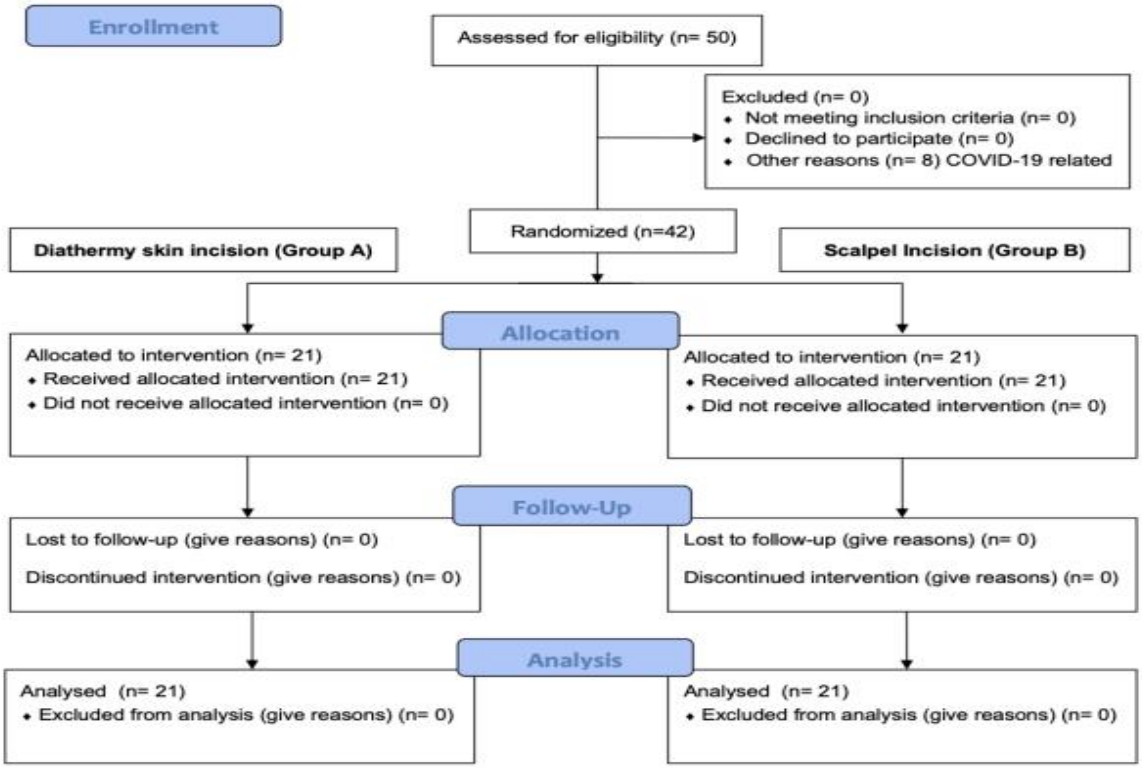

Figure 1: CONSORT 2010 flow diagram for randomized controlled study comparing diathermy and scalpel incisions for elective midline abdominal access in Jos

Table 1: Sociodemographic characteristics of the respondents

Characteristics		Incision Type					p-value
		Diathermy (n=21)		Mean ± SD	Scalpel (n=21)	Mean ± SD	
		N	(%)		N	%	
Sex							
	Male	15	71.4		3	14.3	<0.01
	Female	6	28.6		18	85.7	
Age				40.8 ± 18.2		45.8 ± 20.0	
	15-25	3	14.3		2	9.5	0.725
	26-35	7	33.3		6	28.6	
	36-45	0	0.0		5	23.8	
	46-55	4	19.0		2	9.5	
	56-65	3	14.3		4	19.0	
	66-75	3	14.3		2	9.5	
	76-85	1	4.7		0	0.0	
Occupation							
	Student	5	23.8		5	23.8	0.363
	Housewife	4	19.0		10	47.6	
	Business	3	14.3		5	23.8	
	Farmer	4	19.0		1	4.7	
	Police	2	9.5		0	0.0	
	Civil Servant	2	9.5		0	0.0	
	Retired	1	4.7		0	0.0	
Body Mass Index				23.3 ± 2.9		23.2 ± 4.07	
	< 18.5	1	4.8		2	9.5	0.904
	18.5-24.9	13	61.9		14	66.7	
	25.0-29.9	7	33.3		3	14.3	
	30.0 & above	0	0.0		2	9.5	

group on postoperative days 1 to 3, but no statistically significant difference (Table 2).

The data in table 3 revealed that the wound infection rate of patients in the diathermy group is 19.0 percent with the mean of 5.0 while the wound infection rate in the scalpel group is 4.8 percent with the mean of 5.

of analgesic given to patients was 5.67 on the first postoperative day while the scalpel group has a mean value of 6.05. On the second day, the mean value of analgesics given to patients was 6.30 in the diathermy and scalpel groups regarding wound infection (P = 1.00) at 0.05 level of significance.

Table 2: Comparison of wound incision characteristics using diathermy versus scalpel

Study arm (N=42)	Diathermy n=21	Scalpel n=21	Independent t-test	p-value
	Mean ± SD	Mean ± SD		
Incision time (s)	255.8	578.5	-6.776	<0.001
Wound length (cm)	22.5	19.8	1.897	0.065
Wound depth (cm)	2.7	3.1	-0.979	0.334
Wound area* (cm^2)	61.1	61.3	-.0.019	0.985
Incision speed** (s/cm^2)	5.8	11.2	-3.165	0.003
Total wound blood loss (ml)	21.7	73.6	-4.711	<0.001
Wound average blood loss per wound area (ml/ cm^2)	0.5	1.3	-3.394	0.002
Pain on Visual Analogue Scale				
Day 1	3.5 ± 0.7	3.8 ± 0.7	-1.118	0.270
Day 2	3.1 ± 0.6	3.2 ± 0.5	0.540	0.592
Day 3	2.2 ± 0.6	2.4 ± 0.5	-0.295	0.770

*Wound length x wound depth = area ** Incision time divided by the area of the wound

Early post-operative wound complication rate						
	N	%	Mean	Std. Deviation	Fishers exact	P value
Incision group						
Diathermy	4	19.0	5.0	1.6	0.0	1.0
Scalpel	1	4.8	5.0	0.0	0.0	1

Table 4: Comparison between Diathermy and Scalpel group regarding early Analgesic requirements

Analgesic Requirements					
		n	**Mean**	**Independent t-test**	**P valu**
	Incision group				
Day 1	Diathermy	21	5.67	-1.047	0.301
	Scalpel	21	6.05		
Day 2	Diathermy	21	6.30	-1.002	0.323
	Scalpel	21	6.57		
Day 3	Diathermy	21	6.30	-.259	0.797
	Scalpel	21	6.38		

Independent t-test was used to compare between diathermy group and scalpel group as indicated the Table 4 above. In the diathermy group the mean value

group while scalpel group has the mean value of to 6.57. The mean value of analgesics given to diathermy patients on the third day was 6.30 and 6.38 in the

scalpel group. The independent t test conducted also revealed that there is no significant difference in the analgesics administered to the patients in the two groups on day 1, day 2 and day 3.

DISCUSSION

In our study, use of diathermy resulted in significantly reduced mean incision time (255.8 vs. 578.7 seconds; $p < .001$) and significantly increased incision speed when diathermy was used as against the scalpel (5.78 vs 11.16 s/cm^2; $p = 0.003$). The study also showed significant lower blood loss per unit area of the incision wound (0.5 vs 1.3ml/cm^2; $p = 0.002$), in favour of use of diathermy. However, there was no statistically significant difference in pain or incisional wound complications. These results suggest the non-inferiority of diathermy compared to scalpels for skin incisions in elective abdominal surgery.

Chalya et al[20] in a similar East African study that compared diathermy versus scalpel incisions in elective midline laparotomy, showed that the mean incision time with scalpel was longer in comparison to diathermy incisions (9.21 ± 1.40 sec/cm^2 vs 7.84 ± 0.82 sec/cm^2; $p = 0.001$). Shorter incision times found in their study for similar elective abdominal surgical incisions was due to a more restricted definition of incision time than the one used in our study.[20] They also reported significantly less bleeding with diathermy incisions ($p = 0.012$). Our findings are also comparable to those reported by Ayandipo et al[9], in which they compared diathermy to scalpel incision in heterogenous group of general surgery patients. Similarly, Talpur et al[19], reported that diathermy incision is safe with added advantages of making faster incisions with less blood loss than scalpel incisions. Similarly, Ly et al in their systemic review and meta-analysis of 14 randomized trials comprising of 2541 patients (1267 undergoing abdominal wall incision), found that diathermy may offer significant advantages in many variables including, operative blood loss, incision time, wound complication and postoperative pain.[18]

The reduction in incisional blood loss in diathermy group agreed with the studies by Ayandipo et al[9], Kearns et al[21], Telfer et al[22], Prakash et al[23] and Chalya et al[20] where there was a significant reduction in incision related blood loss with the use of diathermy. Guru and Sathiah in their comparative study on diathermy versus scalpel skin incisions in abdominal surgeries at a tertiary care teaching hospital in India reported similar findings and concluded 'that diathermy is the ideal method of incision in high-risk patients, where both the blood loss and operating time are at a premium'[24].

In contrast to the result of our study, Drew PJ[26] in his systematic review and meta-analysis of cutting diathermy and scalpel skin incisions reported that there was no significant difference in the wound characteristics. Likewise, a Cochrane review by Charoenkwan et al[1] concluded that there was insufficient reliable evidence regarding the effects of electrosurgery compared with scalpel incisions on blood loss, pain, and incision time, due to the limited number of studies that reported these outcomes, and the difference in outcome measures. This Cochrane review was published in 2012 using studies that spanned from 1970 to 2011, there are more recent studies which may provide more data for more definitive conclusions.

Wound related pain measured by the Visual Analogue Scale for the first three post-operative days showed no statistically significant differences between scalpel and diathermy (p, 0.270, 0.592, 0.770, respectively). The analgesic requirement for the two groups also showed no significant difference (p, 0.301, 0.323, 0.797). This finding is consistent with the study by Prakash et al[23] that compared the diathermy incision with scalpel incision for midline laparotomy and reported that the two techniques were similar with regards to postoperative pain. Shammin[13] similarly reported no statistical difference with regards to pain between diathermy and scalpel incisions. On the other hand, this contrasts with results from the studies by Kearns et al[21], and Talpur et al[27] which reported that diathermy is associated with lesser post-operative pain and wound complication rate than the scalpel incision, this is thought to be due to the thermal effect of diathermy on the sensory nerve fibres with the subsequent disruption of transmission of nerve impulses. Cell vaporization caused by the application of a pure sinusoidal current leads to immediate tissue and nerve necrosis without significantly affecting the adjoining structures.[9]

Regarding post-operative wound infection, in this study, there was no significant difference between the two groups ($p = 1.000$) at 30 days post operatively, and this agrees with the study by Ali et al. that compared rate of superficial surgical site infection following use of diathermy and scalpel for making skin incision in inguinal hernioplasty, $p=0.378$[28]. Guru and Sathiah, similarly, reported that diathermy incisions heal in similar way to scalpel incisions in terms of inflammation, wound strength, and scarring.[24] Furthermore, this research finding is consistent with the study by Shammin[13], and Prakash et al[23] whose results revealed that post-operative wound infection rate was comparable between the diathermy and scalpel incisions. Conversely, Talpur et al[27] reported that the incisional wound complication rate was lower in the diathermy group, they however did their study on all general surgical operations in both emergency and elective cases, this may inform the alternate finding. Other wound complications like dehiscence and reactionary bleeding were not recorded in both arms of the study.

Implications for Clinical Practice

For elective midline laparotomy procedures, diathermy skin incision is recommended as a safe and effective alternative to traditional scalpel incision in this clinical

context. Evidence demonstrates that diathermy significantly reduces incision time and intraoperative blood loss without increasing post-operative wound pain, infection, hematoma, or dehiscence rates. By shortening incision time and reducing blood loss, diathermy may lead to overall cost savings in operating room use and resource consumption. Future studies will include formal cost-effectiveness studies to demonstrate cost savings. Surgical teams should adopt diathermy techniques where equipment and training are available, optimizing operating room efficiency and patient outcomes. Ongoing monitoring of wound healing outcomes is advised to ensure continued quality and safety as this technique is integrated into clinical practice.

This locally generated evidence supports context-appropriate innovation and challenges the automatic default to scalpel use, encouraging evidence-based adaptation of diathermy for elective abdominal surgery skin incisions in low- and middle-income country settings. Surgical training programs in Nigeria and similar settings should consider including diathermy techniques as a standard part of surgical skills education, ensuring familiarity with safe and effective use.

Limitations

There was no significant difference between the two comparative groups with respect to, sex (p=0.725), body mass index (p=0.904), or occupation (p=0.363) in our study. However, there were more women compared to men in the scalpel incision group (p<0.001). A larger sample size study may correct the disparity experienced. Although the impact of age, gender, and obesity on the post-operative wound outcome have been studied, we cannot say if gender disparity affected our study results. Further comparative studies with participants matched by gender should be performed in the context in the future.

CONCLUSION

While the use of diathermy incision for access in midline laparotomy significantly reduced wound incision time and incision blood loss compared to that of the scalpel incision in patients undergoing elective midline abdominal access in Jos University Teaching Hospital, there was no significant difference in three-day post-operative wound pain and 30-day surgical site infection rates or wound complication rates with regards to reactionary bleeding or wound dehiscence between the two groups. For the studied patient population in our setting, diathermy is non-inferior to scalpel skin incisions and can be safely used to improve speed, reduce blood loss during elective laparotomies.

Conflict of Interests

The authors declare no conflict of interest.

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