

Comparison of cutting diathermy with cold scalpel incision in midline abdomen surgery

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Abstract

Introduction: The role of electro-surgery has gradually evolved over the last century. Widespread concerns regarding application of electro-surgery remain with regard to wound infection and pain due to thermal burns continue to persist in surgical circles. Such concerns have been proven baseless in studies conducted around the world, which have come in support of using electrocautery in view of better outcomes related to hemostasis and pain and equivocal outcomes in terms of wound infection risk. We sought in this study to establish the validity of these results in the setting of a government teaching hospital. **Objectives:** To analyze and compare the midline laparotomy incision made using cutting diathermy and cold scalpel with respect to post-operative pain and wound infection rates. **Methods:** A prospective study comprising of patients undergoing midline laparotomy in the General Surgery Department chosen by purposive sampling were divided into 2 groups of 50 each depending on whether they underwent skin incision by diathermy or cold scalpel. They were observed daily for ten days in the post-operative period. **Results:** Patients who underwent cautery incision had lower mean NRS value of 5.64 ± 2.22 as compared to those who underwent cold scalpel incision with a higher mean NRS of 6.18 ± 2.18 . There was an incidence of 30% purulent infections in scalpel incisions compared to 14% of cautery incisions. These differences were not statistically significant. **Conclusion:** There is no contraindication for the use of cutting cautery in midline laparotomy.

Keywords: Cold scalpel, Diathermy, Electrocautery, Wound incision, Wound infection

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Introduction

The term "cautery" itself derives from the Greek *kauterion* meaning "branding" iron. Ancient Egyptians and Greeks used heat for the removal of tumors. In c.a. 1000 BCE, Sushruta Samhita had documented the use of heat or *dahana* as a means to cauterize bleeding vessels in addition to ligation and packing as methods to attain haemostasis [1].

Through the centuries the term cautery implied the application of heat or caustic substances to tissue. Goldwyn describes the evolution of electro-surgery in 3 historical eras [2]: such as Discovery and experiments with static electricity; Galvanization and electrophysiology (late 18th century: conduction of lightning through frog's legs by Luigi Galvani); and Radiofrequency induced electricity (early 19th century: discovery of induction by Faraday). The medical applications of electricity were explored by Benjamin Franklin in his many experiments in the 18th century [3]. The initial use of electricity in surgery involved the heating of an instrument which was then applied to the tissue. Direct currents (DC) were used for the purpose.

Morton (1881) and d'Arsonval (1891) studied the effects of electric current passing through the body and developed frequencies of alternating current that could pass through the body without burns, spasm or pain.

However majority of ailments managed with electric shocks remained limited to the realm of physiology, neurology and psychiatry [2].

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A process called farado-electrolyzation was developed which claimed to be benefit a wide variety of ailments by passing electric current through human tissue.

The term *diathermy* was coined by Franz Nagelschmidt (1897) to describe the heating effect studied by d'Arsonval [4].

The application of electricity in surgery was inspired by French physician Joseph Rivere who incidentally noted sparking and subsequent skin coagulation in a patient undergoing diathermy for insomnia. Subsequent techniques such as "fulguration" (Pozzi), "desiccation" (Clark) and "electrocoagulation" (Doyen) were developed by alteration in the amperage, frequency and the circuits and the subsequent varied effects on tissue were studied. They were used largely in the management of malignancies.

Bovie, of the ESU fame, was Assistant Professor of Biophysics at Harvard.⁵ His momentous contribution to the field of electro-surgery was to develop an ElectroSurgical Unit whereby both mechanisms of coagulation and cutting were combined side-by-side and could be attained in a single "cutting loop". The use was demonstrated by the surgeon in chief of Peter Bent Brigham Hospital, Dr. Cushing in the excision of a tumor that had been, until a few days previously, inoperable due to its vascularity. This success went on to be replicated in several more cases, thereby earning for itself, over time, with numerous variations and innovations, a place as an indispensable tool in operating rooms across the world [5,6].

With the advent of diverse energy sources, the role of cold scalpel in amotomy is often relegated solely to the incision of skin. Use of diathermy on skin has been impeded by widespread concerns persisting among surgeons regarding charring of skin and resulting wound infection and poor cosmetic outcomes. This can be attributed to the persistence of limited working knowledge among surgeons, regarding the principles underlying these energy devices, despite widespread utilization in operating theatres across the world [7].

Such concerns are the last hurdle to overcome in rendering the cold scalpel obsolete in laparotomy.

The current study aimed to analyse and compare the midline laparotomy incision made using cutting diathermy and cold scalpel. The outcome measurement was post-operative pain and postoperative wound healing.

Materials and methods

This single center, prospective observational study was commenced following approval of the protocol by the Institutional Ethics committee of Government Medical College, Kozhikode. Informed consent of each study subject was obtained. Confidentiality at all stages of study was assured. Participants for the study were chosen by purposive sampling from patients undergoing midline laparotomy in the Department of General Surgery at a teaching hospital from April 2018 to August 2019. They were divided into 2 groups based on whether the skin incision was made with cutting diathermy (D) or cold scalpel (S) until a total of 50 patients was reached in each group

Inclusion criteria: Patients of either sex undergoing major open abdominal surgery through a midline vertical incision in elective and emergency surgical setting. Electrosurgical incisions include those in which the skin is incised with cutting mode of monopolar diathermy. Scalpel incisions include those in which skin is incised with cold scalpel. Patients having undergone previous abdominal surgery, patients having local infection at the planned incision site, and patients having diabetes mellitus were excluded.

Data collection

Incisions were compared on the basis of parameters recorded on every postoperative day for ten days at 7 pm in the respective ward. Pain was assessed using a Numerical Rating Scale (NRS) from 0 to 10. Wound healing was rated using Southampton Wound Assessment Scale (SWAS).

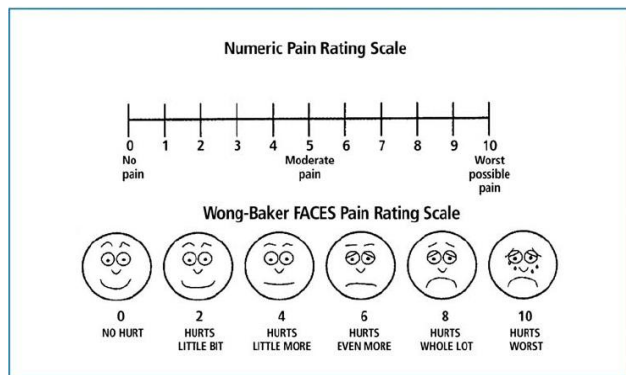


Fig 1: Visual Analogue Scale (VAS) and Numeric Rating Scale (NRS)

Grade Definition

0	Normal healing
I	Normal healing with mild bruising or haematoma
II	Erythema plus other signs of inflammation
III	Clear or haemoserous discharge
IV	Pus
V	Deep or severe wound infection with or without tissue breakdown; haematoma requiring aspiration

Statistical Analysis :Statistical analysis performed using SPSS ver 22.0(SPSS Inc, IL, US). 50 midline laparotomy patients having undergone skin incision by cold scalpel and 50 midline laparotomy patients having undergone skin incision by fulfilling inclusion and exclusion criteria were chosen for the study.

Results

Based on the Method of Incision placed, there were 50% cases of cautery and 50% were scalpel based surgeries performed.

There were 55% males. 75% surgeries performed in elective setting, and 25 % cases performed during emergency.

Study of post-operative pain by NRS:Patients undergoing incision with cautery had lower mean NRS score of 5.64±2.22 as compared to 6.18±2.18 in those undergoing incision with scalpel, although this difference was statistically not significant with a p-value of 0.26 (p<0.05).

Table 1: Comparison of day of maximum pain based on the method of incision placed among study patients using Chi Square Test

Variable	Category	Cautery		Scalpel		χ ² value	P-Value
		n	%	n	%		
Day of Maximum pain	Day 1	25	50%	23	46%	2.249	0.69
	Day 2	22	44%	21	42%		
	Day 3	3	6%	4	8%		
	Day 4	0	0%	1	2%		
	Day 5	0	0%	1	2%		

Maximum pain was experienced on the first day followed by a decreasing trend in both groups of patients. There was no observational or statistically significant difference between the two groups. Chi-square test was used to analyse the pain trends in the two groups. Significance set at p<0.05 (Table 1).

Post-operative pain comparison within each gender

Among males, 27 patients underwent cautery incision had lower mean NRS value of 5.56 as compared to 28 patients who underwent cold scalpel incision with a higher mean NRS of 6.23. Among females, 23 patients underwent cautery incision had lower mean NRS value of 5.74 as compared to 22 patients who underwent cold scalpel incision with a higher mean NRS

of 6.11. Mann Whitney test of significance with p<0.05 was applied and the difference was found to be statistically not significant with p values of 0.32 and 0.58 in males and females respectively (Table 2).

Post-operative pain compared within each setting

Mann Whitney test was applied with p <0.05 to assess the difference in pain in elective and emergency settings. Among 75 cases who underwent elective laparotomy, the 40 patients with cautery incision reported a lower mean NRS of 5.96 as compared to the 35 patients with scalpel incision, who reported a mean NRS of 6.54. However, this difference was not statistically significant (p=0.25).

Table2: Comparison of NRS scores between Cautery and Scalpel. Incisions among genders and comparison of NRS scores between Cautery and Scalpel Incisions based on the type of case using Mann Whitney Test

	Incision	N	Mean± SD	Mean diff	P value
Gender					
Males	Cautery	27	5.56±2.09	-0.68	0.32
	Scalpel	28	6.23±2.36		

Females	Cautery	23	5.74±2.41	-0.38	0.58
	Scalpel	22	6.11±1.99		
Type of Case					
Elective	Cautery	40	5.96±2.12	-0.58	0.25
	Scalpel	35	6.54±2.35		
Emergency	Cautery	10	4.35±2.26	-0.98	0.23
	Scalpel	15	5.33±1.46		

Among 25 cases who underwent elective laparotomy, the 10 patients with cautery incision reported a lower mean NRS of 4.35 as compared to the 15 patients with scalpel incision, who reported a mean NRS of 5.33. However, this difference was not statistically significant (p=0.23).

Postoperative wound assessment:14% of patients in cautery group had normal wound healing as compared to 10% in the scalpel

group. The wound score showed higher trends for the first 3 days in case of cautery incision than scalpel incision. Maximum wound scores were noted on day 4 in both scalpel (24%) and cautery (32%) groups. Chi-square test applied with p<0.05 showed that these differences were not statistically significant (p=0.81).

Table 3: Comparison of day of highest Wound score based on the method of Incision placed among study patients

Variable	Category	Cautery		Scalpel		χ ² Value	P-Value
		n	%	n	%		
Day of Peak infection	No Infection	7	14%	5	10%	5.3	0.81
	Day 1	2	4%	0	0%		
	Day 2	2	4%	2	4%		
	Day 3	10	20%	9	18%		
	Day 4	12	24%	16	32%		
	Day 5	9	18%	11	22%		
	Day 6	4	8%	3	6%		
	Day 7	3	6%	3	6%		
	Day 8	1	2%	0	0%		
	Day 9	0	0%	1	2%		

Distribution of Wound scores based on the method of Incision:Greater proportion of patients undergoing scalpel incision (12%) showed normal wound healing as compared to patients undergoing cautery incision (8%). Features of early inflammation including serous discharge were more in patients undergoing cautery

incision (76%) as compared to scalpel incision (56%).Purulent wound discharges occurred less frequently in patients undergoing cautery incision (14%) as compared to scalpel incision (30%). However, these differences were found to be statistically not significant on applying Chi-square test. (p=0.34)(Table 4).

Table 4:Comparison of Wound scores based on the method of Incision placed among study patients using Chi Square Test

Variable	Category	Cautery		Scalpel		χ ² Value	P-Value
		n	%	N	%		
Wound score	Normal Healing	4	8%	6	12%	5.675	0.34
	Normal Healing with mild bruising or erythema	3	6%	2	4%		
	Erythema plus other signs of inflammation	16	32%	15	30%		
	Clear or Serosanguineous discharge	19	38%	11	22%		
	Pus/purulent discharge	7	14%	15	30%		
	Deep or severe wound infection with or without tissue breakdown	1	2%	1	2%		

Discussion

There was no statistically significant difference in post-operative pain and early wound healing between the two groups of patients in the study conducted for this dissertation. However, several observations were made note of and could have bearing on surgeon preferences. Lower pain scores were reported in patients undergoing cautery incision irrespective of gender and setting of surgery [8]. Normal wound healing occurred in greater proportion of patients undergoing scalpel incision. However, greater proportion of purulent discharge also occurred in patients with scalpel incision [9]. The results of our study parallel those of a randomized controlled trial of 84 patients undergoing midline abdominal surgery published in 2015 by LD Prakash et al. in the International Journal of Surgery, concluding that electrocautery incisions are comparable with those by scalpel incision in terms of pain and wound infections [10]. Several studies point towards a clear advantage provided by electrocautery in reducing postoperative pain and analgesia requirements. A prospective randomized controlled trial published by Kearns et al.[11], in 2001 in the *British Journal of Surgery* (BJS) comprising 100 patients undergoing elective midline laparotomy, concluded no significant difference in infection rates, which was similar to the results of our study but noted significantly reduced pain.A meta-analysis of 16 studies from a Cochrane database comprising 2769 patients undergoing major abdominal surgery by

Charoenkwan et al. in 2017 concluded that "no clear difference in wound infection between the scalpel and electrosurgery." However, no conclusions were formed regarding effects on post-operative pain [12].A 2009 double-blind randomized controlled trial published in the *World Journal of Surgery* by Shamim et al [13]. Found that "diathermy incision had significant advantages compared with the scalpel because of reduced incision time, less blood loss and reduced post-operative pain"Ly et al, in 2012, published in the *BJS* the results of a meta-analysis of 14 RCTs spanning a period of 1980 to 2011 and 2541 patients showed that there was reduced post-operative pain and no difference in wound healing [14].A randomized controlled trial comprising 197 patients matched for Body Mass Index (BMI), age, sex and type of surgery at a teaching hospital in Ibadan in Nigeria was published by Ayandipo et al. in 2015 [15]. The study noted reduced post-operative pain with cautery and no difference in wound healing. Electrocautery was also noted to have the advantage of reduced incision time and incisional blood loss.Studies regarding the relation between use of cautery and post-operative pain have no unanimous consensus, with some suggesting a clear advantage, while others have been equivocal. However, the results of our study regarding wound infections are in line with the findings of meta-analyses comprising large study populations [16,17].The reduced incidence of post-operative pain is hypothesized to be due to the effect of thermal

energy on the sensory nerve fibre endings. The equivocal rates of wound healing are due to the heating and consequent vaporization of individual cells on passage of electrical current and not application of thermal energy as is most often assumed. Thus, there is minimal damage to surrounding structures [10].

Some potential confounding factors that affect wound healing, but have not been matched for in this study include malignancy, obesity, skin preparation techniques and post-operative wound management protocols. Malignancy results in a negative nitrogen balance and wound healing of the patient [18,19]. A higher BMI results in relative hypoxia resulting in delayed wound healing and increased wound infection due to suppression of leucocyte activity [20]. Differences in perioperative protocols of different units, inter-surgeon variation in choice of solution for skin preparation and differences in post-operative wound management among the units are some others.

Other parameters that were initially planned for study included incision time and blood loss during incision, but were then later abandoned due to the technical difficulty in precise measurement of these parameters intra-operatively as well as the gross difference in these parameters, asserted by the operating surgeons.

The procurement of new laparoscopic units affected the number of cases undergoing laparotomy in the elective setting and thereby reduced the sample size, which might affect the validity of the study.

Further studies of this nature could avail a split incision design, where the upper or lower half of the skin incision could be taken by cautery and the remaining by cold scalpel. Similar "split-mouth" design studies for comparing the effectiveness of cautery and cold scalpel for incision in the oral cavity for maxillary osteotomy have been conducted [21]. This would serve to eliminate even those confounding factors that elude the consideration of the observed.

Conclusion

Our study shows no contraindication to the use of cautery for skin incision in midline laparotomy. Reduced pain and reduced incidence of purulent discharge from the wound was noted by cautery incision but was not statistically significant.

References

- McFadden PM, Wiggins LM, Boys JA. A History of Thoracic Aortic Surgery. *Cardiol Clin*. 2017;35(3):307-16.
- Massarweh NN, Cosgriff N, Slakey DP. Electrosurgery: History, Principles, and Current and Future Uses. *J Am Coll Surg*. 2006;202(3):520-30.
- Gensel L. The Medical World of Benjamin Franklin. *J R Soc Med*. 2005;98(12):534-8.
- Nagelschmidt F. The Thermal Effects Produced by High-Frequency Currents, and the Therapeutical Uses of Diathermic Treatment. *Proceedings of the Royal Society of Medicine*. 1911;4(Electro_Ther):1-12
- Ferreira H, Ferreira C. Principle and use of electrosurgery in Laparoscopy. *JSL J Soc Laparosc Surg*. 2015:69-77.
- Fundamental Use of Surgical Energy (FUSE): An Essential Educational Program for Operating Room Safety [Internet]. [cited 2019 Oct 7].
- Williams NS, O'Connell PR, McCaskie AW, editors. *Bailey & Love's short practice of surgery*. 27th edition. Boca Raton, FL: CRC Press; 2017.
- Ismail A, Abushouk AI, Elmarazy A, Menshawy A, Menshawy E, Ismail M, Samir E, Khaled A, Zakarya H, El-Tonoby A, Ghanem E. Cutting electrocautery versus scalpel for surgical incisions: a systematic review and meta-analysis. *Journal of surgical research*. 2017 ;220:147-63.
- Aird LN, Bristol SG, Phang PT, Raval MJ, Brown CJ. Randomized double-blind trial comparing the cosmetic outcome of cutting diathermy versus scalpel for skin incisions. *Journal of British Surgery*. 2015;102(5):489-94.
- Prakash LD, Balaji N, Kumar SS, Kate V. Comparison of electrocautery incision u'ith scalpel incision in midline abdominal surgery- A double blind randomized controlled trial. *Int J Surg*. 2015;19:78-82.
- Kearns SR, Connolly EM, McNally S, McNamara DA, Deasy J. Randomized clinical trial of diathermy versus scalpel incision in elective midline laparotomy. *Journal of British Surgery*. 2001;88(1):41-4.
- Charoenkuan K, Iheozor-Ejiofor Z, Rerkasem K, Matovinovic E. Scalpel versus electrosurgery for major abdominal incisions. *Cochrane Database Syst Rev*. 2017;6:CD005987.
- Shamim M. Diathermy vs. scalpel skin incisions in general surgery: double-blind, randomized, clinical trial. *World journal of surgery*. 2009 Aug;33(8):1594-9.
- Ly J, Mittal A, Windsor J. Systematic review and meta-analysis of cutting diathermy versus scalpel for skin incision. *Journal of British Surgery*. 2012;99(5):613-20.
- Ayandipo OO, Afuwape OO, Irabor D, Oluwatosin OM, Odigie V. Diathermy versus scalpel incision in a heterogeneous cohort of general surgery patients in a Nigerian teaching hospital. *Niger J Surg* 2015;21(1):43-7.
- Shetty K, Shetty D, Nemani PK. Randomised Controlled Clinical Trial of Scalpel Versus Diathermy for Abdominal Skin Incisions. *Indian Journal of Surgery*. 2021:1-6.
- Okereke CE, Katung AI, Adesunkanmi AK, Alatisse OI. Surgical outcome of cutting diathermy versus scalpel skin incisions in uncomplicated appendectomy: A comparative study. *Nigerian Postgraduate Medical Journal*. 2019;26(2):100.
- Fadhila H, Asrul D, Muhar AM. The Role of Prognostic Nutritional Index for Surgical Wound Complications after Laparotomy in Colorectal Cancer in H. Adam Malik Median General Hospital. *Glob J Res Anal [Internet]*. 2019.
- Jamali KS, Khan NA, Jawed M, Shaikh U. Diathermy incisions v/s surgical scalpel incisions. *The Professional Medical Journal*. 2015;22(11):1550-24.
- Pierpont YN, Dinh TP, Salas RE, Johnson EL, Wright TG, Robson MC, Payne WG. Obesity and surgical wound healing: a current review. *ISRN Obes*;2014:638936.
- Wahab PUA, Madhulaxmi M, Senthilnathan P, Muthusekhar MR, Vohra Y, Abhinav RP. Scalpel Versus Diathermy in Wound Healing After Mucosal Incisions: A Split-Mouth Study. *J Oral Maxillofac Surg*. 2018;76(6):1160-1164.

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