World J Surg (2009) 33:1594–1599
DOI 10.1007/s00268-009-0064-9

World Journal of Surgery

Diathermy vs. Scalpel Skin Incisions in General Surgery: Double-Blind, Randomized, Clinical Trial

Muhammad Shamim

Published online: 7 May 2009

Abstract
Objective This prospective, double-blind, randomized, controlled trial was designed to compare the outcome of diathermy incisions versus scalpel incisions in general surgery.
Methods A total of 369 patients who underwent diathermy incision (group A: 185 patients) or scalpel incision (group B: 184 patients) were analyzed. Variables analyzed were: surgical wound classification, length and depth of incision, incision time, duration of operation, incisional blood loss, postoperative pain, duration of hospital stay, duration of healing, and postoperative complications. The inclusion criteria were all patients who underwent elective or emergency general surgery. The exclusion criteria were only cases with incomplete patients' data and patients who were lost to follow-up. This study was conducted at Fatima Hospital-Baqai Medical University and Shamsi Hospital (Karachi), from January 2006 to December 2007.
Results Incision time was significantly longer for patients in group B ($p = 0.001$). Incisional blood loss also was more for patients in group B ($p = 0.000$). Pain perception was found to be markedly reduced during the first 48 h in group A ($p = 0.000$). Total period of hospital stay ($p = 0.129$) and time for complete wound healing ($p = 0.683$) were almost the same for both groups. Postoperative complication rate by wound classification did not differ markedly between the two groups ($p = 0.002$ vs. $p = 0.000$).
Conclusions Diathermy incision has significant advantages compared with the scalpel because of reduced incision time, less blood loss, & reduced early postoperative pain.

Introduction

Although diathermy is increasingly used for underlying tissue dissection, cutting, and hemostasis, its use for making skin incisions is not gaining favor. Fear of deep burns with diathermy and resultant scarring continues compared with the scalpel, which produces a clean, incised wound with minimal tissue destruction [1]. An experimental and clinical study confirmed that diathermy incision results in slower wound healing and increased infection than scalpel incision [2]. Cutting diathermy incision with an electrode delivering pure sinusoidal current allows tissue cleavage by rapid cell vaporization without damage to surrounding areas; this may explain the absence of tissue charring and the subsequent healing with minimal scarring [3]. Cutting diathermy can make hemostasis quick and satisfactory, save the operative time, and can produce an incised wound that heals as well as one created by cold scalpel [4].

Previous studies have compared electrosurgical and scalpel incisions in terms of wound infection, wound-related pain, and blood loss, but only in selective group of cases; furthermore, they excluded patients with diabetes and coagulopathy [5–7]. No single study to date has focused on diathermy incision on all types of general surgical cases. This is a broad-base study comparing cutting diathermy and scalpel incision in terms of incision time, incisional blood loss, postoperative pain, wound complications, and wound healing.

M. Shamim (✉)
Department of Surgery, Fatima Hospital and Baqai Medical University, Super Highway, Near Toll Plaza, Gadap Town, Karachi 74600, Pakistan
e-mail: surgeon.shamim@gmail.com

Patients and methods

This study was conducted at Fatima Hospital-Baqai Medical University and Shamsi Hospital (Karachi). It was a prospective study using randomized, controlled trial. Blocked randomization was used for allocation of patients in two groups (A and B). The patients were divided in blocks of two, and within each block the first patient was allocated to group A and the second patient to group B. The whole process of generation, allocation (sealed envelops), and implementation of randomization, as well as assessment were done by different groups of interns who were posted in the surgery department for 2–3 months rotation. The patients and interns (assessors) were blinded; the success of blinding was achieved by asking questionnaire to indicate which incision they received and what led to that belief. The surgeon cannot be blinded.

A total of 369 patients were finally analyzed in the study. Group A, 185 patients, underwent operation via diathermy incision. Group B, 184 patients, underwent operation via traditional scalpel incision. The inclusion criteria were patients of both sexes, older than aged 3 years, who were admitted in general surgery for elective or emergency general surgery. The exclusion criteria were only cases with incomplete patients' data and patients who were lost to follow-up.

The findings of patients' history, examination, laboratory, imaging, operative, and postoperative course were recorded. An informed consent was taken and patients were counseled about the merits and demerits of both incisions. All the patients were operated under general, spinal, or local anesthesia. Antibiotic prophylaxis was done, using intravenous cefuroxime, cefotaxime, ciprofloxacin, imipenem, or metronidazole (alone or in combinations), at the time of induction of anesthesia; dose was repeated once after 12 h in clean cases, or longer in other cases. Oral amoxicillin + clavulanic acid was used in patients operated under local anesthesia.

The skin and/or subcutaneous tissue were incised with scalpel (group B) or a diathermy pen electrode set on cutting mode (group A). Hemostasis was performed with coagulation diathermy, and large subcutaneous veins were suture ligated in patients of both groups.

Drains were placed as the case merited. Subcutaneous tissue was sutured using chromic catgut 2/0 suture and skin by subcuticular polypropylene 2/0 suture. Patients of both groups received bupivacaine (0.2%) infiltrated into the wound and diclofenac suppository 50 mg at the end of the procedure; diclofenac 75 mg intramuscular injection was given 12-hourly for 24 h, followed by diclofenac oral 50 mg 8-hourly for next 24 h. The drains (if placed) were removed after discharge decreased to <10 ml per day. Once the drain was removed, patients were discharged from the hospital usually on the third to sixth day. Skin sutures were removed between the sixth and tenth postoperative days, after checking the tensile strength of wound (by gradual lateral traction). Wounds left open for second-intention healing were kept on daily dressing with EUSOL-soaked gauze. The follow-up schedule included initially weakly follow-up during the first month and then monthly follow-up for 3 months and a quarterly follow-up for 1 year.

The hypothesis tested in this study was that the diathermy incisions would be better than scalpel incisions in terms of incision time, incisional blood loss, postoperative pain, and wound complications. Primary outcome variable was the incisional blood loss, calculated by measuring the weight of swabs used exclusively during incision until complete hemostasis was achieved. Its mean given by Chrysos et al. [5] was used to calculate the sample size by G-power software; based on 0.95 power and 0.392 effect size, to detect a significant difference ($p = 0.05$, two-sided). A total of 170 patients were required in each study group. This was increased by 20 patients in each group—anticipating cases that would be lost to follow-up. Secondary outcome variables were incision time, operative time, pain verbal rating scale (VRS), wound healing, and wound complications. Incision time was defined as the time from the beginning of skin incision until deep fascia, aponeurosis, lump, or abscess cavity arrived, with complete hemostasis; it was expressed in s/cm^2. Operative time was defined as the time between the placements of incision to the completion of sterile wound dressing. Severity of pain was defined using VRS. Wound infection was graded according to Southompton wound-grading system: G1, normal healing with mild bruising or erythema; G2, erythema plus other signs of inflammation; G3, clear or serosanguineous discharge; and G4, purulent discharge. Statistical analysis was performed by using SPSS® 16. The inferential statistics were calculated using Pearson's χ^2 and Student's t tests. A value of $p < 0.05$ was considered significant.

Results

Flow of patients through each stage is given in Fig. 1. The patients were enrolled from January 2006 to December 2007, with a 1-year follow-up period. There were no significant demographic differences between the two groups. Group A consisted of 185 patients (79 men and 106 women; mean age, 34.72 (standard deviation: 13.312; range: 4–68) years). Group B consisted of 184 patients (85 men and 99 women; mean age, 36.32 (standard deviation: 14.695; range: 4–70) years).

In group A, 20 patients had associated comorbidity: diabetes mellitus $n = 4$; hypertension $n = 6$; ischemic

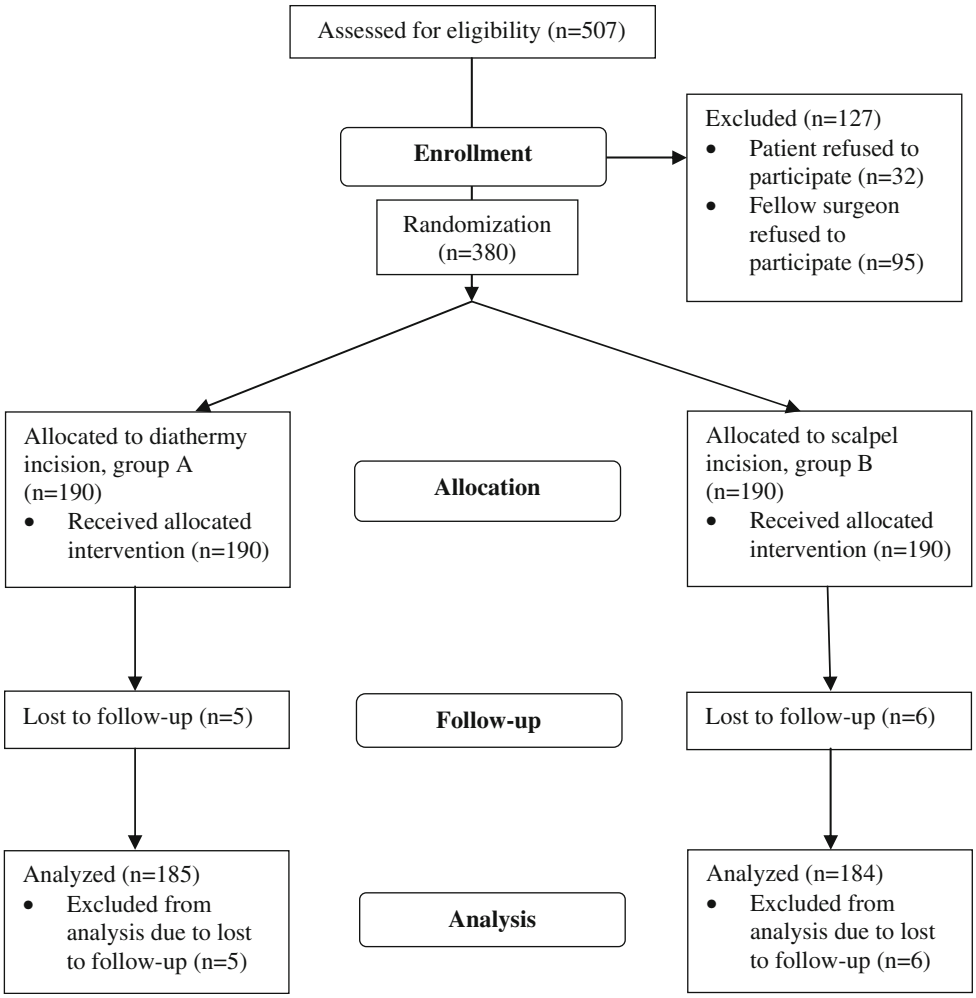

Fig. 1 Flow diagram of double-blind, randomized, controlled trial of diathermy versus scalpel incision in general surgery

heart disease (IHD) $n = 1$; chronic obstructive pulmonary disease (COPD) $n = 2$; hepatitis C $n = 2$; and history of previous surgery $n = 5$. In group B, 26 patients had associated comorbidity: diabetes mellitus $n = 4$; hypertension $n = 4$; IHD $n = 5$; COPD $n = 3$; hepatitis C $n = 3$; and history of previous surgery $n = 7$. In the diathermy group, 113 patients underwent elective operations and 72 emergency surgeries. In the scalpel group, 119 patients underwent elective operations and 65 emergency surgeries. Operations for each group are shown in Table 1; the indications and nature of the surgery did not differ significantly between the two groups.

The incision time and incisional blood loss were significantly higher in patients in group B (Table 2). Severity of pain VRS score also was significantly higher in this group on days 1 and 2 but did not differ markedly on day 3 (Table 2). Duration of operation and mean hospital stay was marginally higher in group B, whereas wound healing was slightly delayed in group A (Table 2). Wound postoperative complications (by wound classification) were significantly higher in group B (Table 3). The post hoc power analysis showed Power (1-β err prob) of 1.000000, calculated from mean of incisional blood loss (primary variable) with effect size 0.7651825 and α err prob 0.05.

Discussion

Diathermy is used increasingly for hemostasis and tissue dissection. Despite this, few surgeons use diathermy to incise skin; this reluctance is partly attributable to the belief that electrosurgical instruments increase devitalized tissue within the wound, which consequently leads to increased wound infection, increased scar formation, and delayed wound healing. However, these concerns have not been substantiated by recent studies of skin incision, which have shown faster operating times, reduced blood loss, reduced early postoperative pain, and lower analgesia requirements with diathermy compared with scalpel incision [6]. In an experimental study on rats, fascia incisions with cold scalpel were found to gain tensile strength faster than with harmonic scalpel or diathermy [8]. Another study

Table 1 Nature of operations performed in both groups

Nature of operation (diagnosis)	Diathermy group		Scalpel group	
	Frequency	Percent	Frequency	Percent
Appendicectomy (acute appendicitis)	51	27.6	53	28.8
Open cholecystectomy (cholelithiasis)	30	16.2	31	16.8
Hernioplasty (inguinal/incisional hernia)	26	14.1	27	14.7
Excision biopsy (lipoma, sebaceous cyst, lymph nodes, fibroadenoma)	23	12.4	25	13.6
Incision and drainage (abscess)	13	7	4	2.2
Herniorrhaphy (paraumbilical/epigastric hernia)	10	5.4	8	4.3
Open prostatectomy (benign prostatic hypertrophy)	4	2.2	4	2.2
Hemorrhoidectomy (hemorrhoids)	4	2.2	6	3.3
Lateral sphincterotomy (anal fissure)	3	1.6		
Repair and omental patch (perforated duodenal ulcer)	3	1.6	2	1.1
Gastrojejunostomy (gastric carcinoma)	2	1.1	3	1.6
Laparoscopic cholecystectomy (cholelithiasis)	2	1.1	4	2.2
Thyroidectomy (multinodular goiter)	2	1.1	1	0.5
Pyelolithotomy (staghorn calculus)	2	1.1	2	1.1
Orchidectomy (testicular torsion)	2	1.1	1	0.5
Cystolithotomy (vesicle calculus)	1	0.5	0	0
Foreign body removal (gossypiboma)	1	0.5	0	0
Primary repair (enteric perforation)	1	0.5	1	0.5
Ileostomy (enteric perforation)	1	0.5	1	0.5
Fistulectomy (anal fistula)	1	0.5	1	0.5
Excision (carbuncle)	1	0.5	1	0.5
Jaboulay's operation (hydrocele)	1	0.5	1	0.5
Mastectomy (breast carcinoma)	1	0.5	1	0.5
Myomectomy (uterine fibroids)	0	0	1	0.5
Salpingo-oophorectomy (ectopic pregnancy)	0	0	3	1.6
Suprapubic catheterization (urethral injury)	0	0	1	0.5
Total	185	100	184	100

on rats concluded healing of abdominal wall after dieresis with cold scalpel or electrocautery are equivalent and do not differ [9]. It has been suggested that local tissue heating increases subcutaneous oxygen tension, thus enhancing the resistance of the surgical wounds to infection [5].

In this study, diathermy incision for all types of general surgery was associated with a shorter incision time and reduced incisional blood loss, largely due to the intrinsic hemostatic effect of diathermy; differences were more marked than predicted during study design. Kearns et al. [6] found that laparotomy incisions using diathermy were significantly quicker than scalpel incisions (mean 6.1 ± 0.4 vs. 7.5 ± 0.5 s/cm^2; $p < 0.04$); there was significantly less blood loss in the diathermy group compared with the scalpel group (0.8 ± 0.1 vs. 1.7 ± 0.3 ml/cm^2; $p = 0.002$). Kearns also found that postoperative pain scores were significantly lower in the diathermy group for the first 48 hours after operation ($p < 0.05$) [6]. Similar pain scores were found in this study. The lower visual analogue pain scores during the first 48 hours postoperatively can be explained by the fact that cell vaporization caused by application of pure sinusoidal current leads to immediate tissue and nerve necrosis without significantly affecting nearby structures; consequently, there is total destruction or minimal injury to cutaneous nerves in the area of surgical wound [5]. There was no difference in duration of operation and healing time, supporting previous studies [5, 6]. Duxbury et al. [10] found similar results and advocated the use of diathermy needle rather than scalpel blade when undertaking excision of pilonidal disease in both acute and chronic patients. Sheikh [11] in 177 skin incisions for neurosurgical procedures using the microneedle electrocautery scalpel and steel scalpel found that time taken and blood loss during skin opening were significantly less using electrocautery scalpel, with only one wound dehiscence. Pearlman et al. [12], comparing carbon dioxide laser, scalpel, or electrosurgical incisions, found that the incision time and incisional blood loss was less

Table 2 Comparative analysis of incision wound characteristics, operative time, postoperative pain, hospital stay, and wound healing

Variable	Type of incision	*N*	Mean	Standard deviation	Standard error of the mean	Difference (95% CI)		*p* value
						Lower	Upper	
Wound area (cm^2)	Scalpel	184	27.0840	27.37201	2.01789	−9.08	2.08	0.218
	Diathermy	185	30.5841	27.16767	1.99741			
Incision time (s)	Scalpel	184	104.31	46.367	3.418	7.48	26.1	0.001*
	Diathermy	185	87.52	52.932	3.892			
Incision time (s/cm^2)	Scalpel	184	9.4691	11.40967	0.84113	1.62	5.78	0.001*
	Diathermy	185	6.2453	6.97198	0.51259			
Blood loss in incision (ml)	Scalpel	184	1.75	0.907	0.067	0.55	0.96	0.000*
	Diathermy	185	0.99	1.066	0.078			
Operative time (min)	Scalpel	184	37.7500	16.52329	1.21811	−1.26	5.72	0.210
	Diathermy	185	35.5189	17.56543	1.29144			
Pain VRS score, day 1	Scalpel	184	5.00	1.799	0.133	1.45	2.14	0.000*
	Diathermy	185	3.21	1.568	0.115			
Pain VRS score, day 2	Scalpel	184	1.99	1.291	0.095	.66	1.16	0.000*
	Diathermy	185	1.08	1.142	0.084			
Pain VRS score, day 3	Scalpel	184	0.66	1.480	0.109	−0.015	0.55	0.063
	Diathermy	185	0.39	1.282	0.094			
Hospital stay (days)	Scalpel	184	3.37	2.043	0.158	−0.09	0.70	0.129
	Diathermy	185	3.06	1.631	0.125			
Wound healing (days)	Scalpel	184	11.40	5.161	0.380	−0.86	1.30	0.683
	Diathermy	185	11.18	5.373	0.395			

p value and confidence interval (CI) calculated from independent sample Student's *t* test

* $P < 0.05$

Table 3 Comparative analysis of wound complications by wound classification

Incision mode	Wound classification	Postoperative wound complications						*p* value
		Infection (G1–G2)	Infection (G3–G4)	Wound dehiscence	Hematoma	None	Total	
Diathermy	Clean, with implant	0	0	0	2	23	25	0.002*
	Clean, without implant	1	0	0	0	39	40	
	Clean-contaminated	1	2	0	0	38	41	
	Contaminated	2	7	1	0	44	54	
	Dirty	2	6	1	0	16	25	
	Total	6	15	2	2	160	185	
Scalpel	Clean, with implant	1	0	0	4	20	25	0.000*
	Clean, without implant	1	0	0	0	38	39	
	Clean-contaminated	4	2	0	0	42	48	
	Contaminated	7	4	1	0	48	60	
	Dirty	2	3	0	0	7	12	
	Total	15	9	1	4	155	184	

*$P < 0.05$ (calculated from Pearson's χ^2 test)

with electrosurgery than with the carbon dioxide laser or scalpel; postoperative pain and wound healing, however, were the same for all three techniques.

In this study, no significant difference was found in postoperative wound complication rates between the two groups, as noted by Kearns et al. [6]. Chrysos et al. [5] found no change in wound complication rates or postoperative pain with the use of electrocautery, declaring it as safe as the scalpel in terms of wound healing with reduction in postoperative analgesics requirements. Stolz et al. [13] found that scalpel and electrosurgical thoracotomy incision in elective surgery were similar in terms of early and late

wound complications. Franchi et al. [14] in gynecologic oncologic surgery patients found a higher incidence of severe wound complications in the scalpel group than in the electrocautery group (8/531 vs. 1/433; $p < 0.05$). Groot and Chappell [15] found wound infections in 38 of 250 scalpel patients (15%) and in 30 of 242 cautery patients (12%); there were no differences in age grouping, use of steroids, incidence of diabetes, number of days preoperative, operative time, use of preoperative antibiotic prophylaxis, use of drains, number of obese patients, or gender ratio, as in this study. Dixon comparing skin incision by scalpel with electrosurgical needle incision had shown the later technique to be highly effective, consistently quicker, and to give better cosmetic results with minimal complications [3]. It is a convenient technique and well tolerated by the patients with no added discomfort. Skin diathermy burns and wound hematomas were only seen after scalpel incision [3]. Miller et al. [7] in a study of 49 mastectomies found that cautery patients had significantly less operative blood loss compared with scalpel patients.

The electrosurgical incision is not a cutting incision but one that causes molecular dissolution along the path of the electrode. The surgeon using electrosurgery must be properly trained and thoroughly familiar with electrosurgical techniques; he also must be familiar with the effects of the local wound environment on healing [16]. While using electrosurgical incisions, care should be taken to see that the patient is adequately grounded with a dispersive electrode to prevent cutaneous burns; cutting of the tissue should be brisk and with the smallest electrode and power setting possible [4].

Furthermore, the recent increase in bloodborne diseases, such as hepatitis C and human immunodeficiency virus infection, makes exclusion of the scalpel from the operative field an attractive option [6]. Scalpel blade injury had been reported to transmit human immunodeficiency virus, tuberculosis, and hepatitis C to surgeons [17–20].

Conclusions

Diathermy incision in both elective and emergency general surgery has significant advantages compared with the scalpel because of reduced incision time, less blood loss, and decreased early postoperative pain.

References

1. Johnson CD, Serpell JW (1990) Wound infection after abdominal incision with scalpel or diathermy. Br J Surg 77:626–627
2. Ji GW, Wu YZ, Wang X, Pan HX, Li P, Du WY, Qi Z, Huang A, Zhang LW, Zhang L, Chen W, Liu GH, Xu H, Li Q, Yuan AH, He XP, Mei GH (2006) Experimental and clinical study of influence of high-frequency electric surgical knives on healing of abdominal incision. World J Gastroenterol 12:4082–4085
3. Dixon AR, Watkin DF (1990) Electrosurgical skin incision versus conventional scalpel: a prospective trial. J R Coll Surg Edinb 35:299–301
4. Sebben JE (1988) Electrosurgery principles: cutting current and cutaneous surgery–part I. J Dermatol Surg Oncol 14:29–31
5. Chrysos E, Athanasakis E, Antonakakis S, Xynos E, Zoras O (2005) A prospective study comparing diathermy and scalpel incisions in tension-free inguinal hernioplasty. Am Surg 71:326–329
6. Kearns SR, Connolly EM, McNally S, McNamara DA, Deasy J (2001) Randomized clinical trial of diathermy versus scalpel incision in elective midline laparotomy. Br J Surg 88:41–44
7. Miller E, Paull DE, Morrissey K, Cortese A, Nowak E (1988) Scalpel versus electrocautery in modified radical mastectomy. Am Surg 54:284–286
8. Ozgun H, Tuncyurek P, Boylu S, Erpek H, Yenisey C, Kose H, Culhaci N (2007) The right method for midline laparotomy: what is the best choice for wound healing? Acta Chir Belg 107:682–686
9. Garcia A, Nascimento JE, Darold EM, Pimentel RE, Curvo EA, Daud FO (2007) Healing of abdominal wall aponeurosis of rats after incision with either cold scalpel or electrocautery. Acta Cir Bras 22(Suppl 1):12–15
10. Duxbury MS, Blake SM, Dashfield A, Lambert AW (2003) A randomised trial of knife versus diathermy in pilonidal disease. Ann R Coll Surg Engl 85:405–407
11. Sheikh B (2004) Safety and efficacy of electrocautery scalpel utilization for skin opening in neurosurgery. Br J Neurosurg 18:268–272
12. Pearlman NW, Stiegmann GV, Vance V, Norton LW, Bell RC, Staerkel R, Van-Way CW, Bartle EJ (1991) A prospective study of incisional time, blood loss, pain, and healing with carbon dioxide laser, scalpel, and electrosurgery. Arch Surg 126:1018–1020
13. Stolz AJ, Schutzner J, Lischke R, Simonek J, Pafko P (2004) Is a scalpel required to perform a thoracotomy? Rozhl Chir 83:185–188
14. Franchi M, Ghezzi F, Benedetti-Panici PL, Melpignano M, Fallo L, Tateo S, Maggi R, Scambia G, Mangili G, Buttarelli M (2001) A multicentre collaborative study on the use of cold scalpel and electrocautery for midline abdominal incision. Am J Surg 181:128–132
15. Groot G, Chappell EW (1994) Electrocautery used to create incisions does not increase wound infection rates. Am J Surg 167:601–603
16. Peterson A (1982) The use of electrosurgery in reconstructive and cosmetic maxillofacial surgery. Dent Clin North Am 26:799–823
17. Kaspar TA, Wagner RF Jr (1991) Percutaneous injury during dermatologic surgery. J Am Acad Dermatol 24:756–759
18. Ippolito G, Italiano-Rischio O (1996) Scalpel injury and HIV infection in a surgeon. Lancet 347(9007):1042
19. Tapias L, Tapias-Vargas LF, Tapias-Vargas L (2008) Primary cutaneous inoculation tuberculosis in a healthcare worker as a result of a surgical accident. Int J Dermatol 47:833–835
20. Tsude K, Fujiyama S, Sato S, Kawano S, Taura Y, Yoshida K, Sato T (1992) Two cases of accidental transmission of hepatitis C to medical staff. Hepatogastroenterology 39:73–75