

Scalpel Versus Electrocautery Dissections: The Effect on Wound Complications and Pro-Inflammatory Cytokine Levels in Wound Fluid

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Aim: Electrocautery has been postulated as a risk factor for wound complications. This study was conducted to evaluate the effects of electrocautery and scalpel dissections on wound complications and local cytokine levels.

Materials and Methods: Patients undergoing modified radical mastectomy were assigned to flap dissection with either electrocautery (n = 18) or scalpel (n = 20). Blood loss, drain volume and duration, seroma formation and wound complications were recorded. Tumor necrosis factor-alpha (TNF- α) and interleukin (IL)-6 levels were measured in drain fluids at postoperative 24 hours.

Results: The electrocautery group had significantly reduced blood loss and total drain volume, but increased seroma formation rate. Significantly elevated levels of TNF- α were measured in drain fluids of patients with electrocautery dissection.

Conclusions: The use of electrocautery causes less bleeding and total drain output with an increased rate of seroma formation. Electrocautery dissection increases pro-inflammatory cytokine response in wound fluid, which may reflect an aggravated inflammation and increased potential for tissue damage.

Key Words: Electrocautery, sharp dissection, seroma, wound complication, tumor necrosis factor-alpha, interleukin-6

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Mastektomide Keskin Diseksiyon ve Koter Diseksiyonu Tekniklerinin Postoperatif Yara Komplikasyonları ve Yara Sıvısındaki Sitokin Düzeyleri Üzerine Etkileri

Amaç: Elektrokoter kullanımın yara iyileşmesi açısından bir risk faktörü olduğu bildirilmiştir. Bu çalışma elektrokoter ve keskin diseksiyon kullanımının yara komplikasyonları ve lokal sitokin düzeyleri üzerine etkilerini karşılaştırmak amacıyla düzenlenmiştir.

Yöntem ve Gereç: Modifiye radikal mastektomi yapılan hastalar flep diseksiyonu için elektrokoter (n = 18) ve bistüri (n = 20) kullanılanlar şeklinde iki gruba ayrıldı. Tüm hastaların peroperatif kan kayıpları, drenaj süreleri ve miktarları, seroma oluşumu ve diğer komplikasyonları kaydedildi. Tüm hastaların postoperatif 24. saatte dren sıvılarından alınan örneklerde. Tumor necrosis factor-alpha ve interleukin-6 düzeyleri ölçüldü.

Bulgular: Elektrokoter kullanılan grupta kan kaybı ve toplam drenaj miktarları açısından anlamlı düşüklük saptanırken seroma oluşumu ve dren sıvılarında ölçülen Tumor necrosis factor-alpha açısından anlamlı artış tespit edildi.

Sonuç: Flep diseksiyonunda elektrokoter kullanımı kanama ve toplam drenaj miktarında azalmaya neden olurken seroma oluşumunu arttırmaktadır. Bununla birlikte yara sıvısındaki proinflatuvar sitokin cevabının da artmış olması elektrokoter kullanımının inflamasyonda artışa neden olduğunu ve doku hasarında artış yarattığını düşündürmektedir.

Anahtar Sözcükler: Elektrokoter, keskin diseksiyon, seroma, yara komplikasyonu, tumor necrosis factor-alpha, interleukin-6

Received: August 13, 2007
Accepted: February 28, 2008

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Introduction

Modified radical mastectomy (MRM) is still the most commonly performed operation for breast cancer, despite the trends towards breast-conserving treatment (1). Since the 1970s, electrocautery has been a widespread surgical tool to raise flaps and excise the breast specimen in order to perform a bloodless mastectomy (2). Both experimental and clinical deleterious effects of electrocautery on wound healing and infection have been frequently reported (3-6). Wound seroma is the most common wound-related postoperative complication following MRM (7). There are abundant amounts of evidence about the role of electrocautery in wound complications, especially on seroma formation, in mastectomy wounds (6,8-10).

Seroma is defined as the serous fluid collection under the skin flaps or in the axillary dead space. Seroma can eventually result in flap necrosis, wound dehiscence, delay in recovery, and adjuvant treatment, and usually necessitates repeated needle aspirations. Seroma fluid contains immunoglobulin, granulocytes and leukocytes, yet few lymphocytes, suggesting that it is a wound exudate rather than lymphatic fluid (11). This makes the mastectomy an ideal model for human wound fluid studies.

Pro-inflammatory cytokines are known to increase in wounds after trauma (12,13). However, there have been few studies investigating the accumulation of cytokines in human wounds (14) and wound fluids (15-17). To our knowledge, there is no study in the English literature about the association of electrocautery with wound fluid levels of pro-inflammatory cytokines. This prospective non-randomized study was carried out to compare the electrocautery and sharp scalpel dissection techniques and their effects on seroma formation, wound complications and pro-inflammatory cytokine levels in wound fluid.

Materials and Methods

The study protocol was approved by the Institutional Committee of Ethics of Ankara Oncology Training and Research Hospital. Thirty-eight consecutive patients with operable breast cancer were enrolled in the study after obtaining an informed consent. The patients were assigned to cutaneous flap dissection and excision of the breast with pectoralis fascia with either electrocautery or

scalpel. Patients who underwent adjuvant chemotherapy, breast conservation therapy or immediate breast reconstruction were not included in the study.

Surgical Techniques

Skin flap dissection and the excision of breast and pectoralis fascia were performed with scalpel or cutting current electrocautery (Olympus – UES 10, Kyoritsu Co, Japan) in alternate patients. Control of small bleeding vessels with coagulation current was allowed for both groups. A standard level III axillary lymph node dissection was performed using scissors, cautery and ligation in all patients. At the end of the procedure, a hemovac drain (Bicakcilar Co, Turkey) was placed in the axilla, and a second one under the skin flaps in all patients. Ipsilateral arm exercise was allowed 48 hours after surgery. The drains were removed when the output was less than 30 ml in 24 hours.

Seroma was defined as any clinically apparent fluid collection under the skin flaps or in the axilla. Cellulitis, wound infection requiring drainage of pus, and full or partial thickness skin necrosis were all defined as wound-related complication.

The medical records of the patients were reviewed for age, body mass index (BMI), volume of the specimen, total lymph nodes removed, and number of positive nodes. The clinical outcome was measured in terms of operating time, intraoperative blood loss (estimated by sponge count and weight), total drain volume, duration of drains, seroma formation, total volume of seroma aspirations, and wound complications.

Tumor Necrosis Factor-alpha (TNF- α) and Interleukin-6 (IL-6) Measurements

Samples were collected from drain fluid at postoperative 24 hours. TNF- α and IL-6 were measured in wound fluid by quantitative ELISA analysis using human TNF- α (hTNF- α) and IL-6 (hIL-6) kits (Biosource International, Inc., USA). Monoclonal antibodies specific for hTNF- α and hIL-6 had been coated onto the wells of the microtiter strips provided. Samples, including standards of known hTNF- α content, control specimens, and unknowns were pipetted into these wells. During the first incubation, antigens bind to the immobilized (capture) antibody on one site. After washing, biotinylated monoclonal antibodies were added. During the second incubation, antibodies bind to the immobilized hTNF- α and hIL-6 captured during the first incubation.

After removal of excess second antibody, streptavidin-peroxidase enzyme was added. This binds to the biotinylated antibody to complete the four-member sandwich. After a third incubation and washing to remove all the unbound enzyme, a substrate solution was added, which is acted upon by the bound enzyme to produce color. The intensity of this colored product is directly proportional to the concentrations of hTNF- α and hIL-6 present in the original specimen. The results had the dimensions of pg/ml.

Statistical Analysis

All numerical data were expressed as mean \pm SEM. The adverse outcomes in the groups were compared by using the chi-square test. Evaluation of the mean values of continuous variables to assess the statistical significance of inter-group differences was performed by Mann-Whitney *U* test. $P < 0.05$ was considered as statistically significant.

Results

There were 20 patients in the scalpel dissection group, and 18 patients in the electrocautery group. The two groups were comparable regarding the age and BMI of the patients, specimen volume, and the numbers of the total and positive nodes removed (Table 1).

The clinical outcome measures are shown in Table 2. No difference between groups was observed in operating time, duration of drains, total volume of seroma aspiration, or rate of wound complications, which included cellulitis ($n = 4$), wound infection requiring drainage of pus ($n = 3$), and full or partial thickness skin necrosis ($n = 7$). The use of electrocautery for dissection was found to be significantly associated with reduced estimated blood loss and total drain volume. The electrocautery group had significantly increased rate of seroma formation when compared to the scalpel dissection group.

Table 1. Characteristics of patients in scalpel and electrocautery groups.

	Scalpel (n = 20)	Electrocautery (n = 18)	P value
Age	50.1 \pm 2.32	50.2 \pm 3.43	NS
Body mass index (kg/m ²)	27.4 \pm 0.98	26.11 \pm 0.86	NS
Specimen volume (cm ³)	3189 \pm 403	3721 \pm 381	NS
Total nodes	22 \pm 1.7	21.5 \pm 1.8	NS
Positive nodes	1.35 \pm 0.5	5.85 \pm 2.46	NS

NS: Non-significant.

Table 2. Relationship of dissection technique with operation- and drain-related outcomes.

	Scalpel (n = 20)	Electrocautery (n = 18)	P value
P value Operating time (min)	186.5 \pm 5.7	178.1 \pm 8.7	NS
Estimated blood loss (ml)	228 \pm 13	140 \pm 9	0.003
Total drain output (ml)	921 \pm 107	575 \pm 77	0.032
Duration of drains (day)	6.40 \pm 0.60	6.10 \pm 0.4	NS
Seroma formation	7	13	0.028
Total volume of seroma aspiration (ml)	118.9 \pm 50.72	160.2 \pm 34.60	NS
Wound complication	8	6	NS

NS: Non-significant.

Significantly elevated levels of TNF- α were measured in drain fluids of patients with electrocautery dissection at 24 hours when compared to those with scalpel dissection ($P < 0.05$) (Figure 1). There was no statistically significant difference in IL-6 levels between groups (Figure 2).

Discussion

The findings of the present study indicate that both electrocautery and scalpel dissections have similar operation characteristics and complication rates. Electrocautery dissection is associated with less blood loss and total drain volume, though with increased seroma formation rate and aggravated pro-inflammatory cytokine response in wound fluid.

It has been known that electrocautery has adverse effects on experimental wound healing in the skin, such as reduction in early tensile strength and impairment in histological evidence of wound healing and re-epithelialization (3,4,6). There have been few human studies of skin incisions made with electrocautery. Groot et al. (18) did not find a significant difference in wound infection rates in abdominal or thoracic incisions created

by electrocautery when compared with cold scalpel. A recent study showed that scalpel and electrocautery were similar in terms of early and late wound complications when used to perform midline abdominal incisions (19). Furthermore, in their prospective randomized trial, Kearns et al. (20) found that use of electrocautery in midline incisions significantly reduced blood loss, postoperative pain and analgesia requirements.

Similar discrepancies exist among cutaneous flap studies. Kakos and James (2) detected no histological difference in canine flaps made by a cold knife versus those made by electrocautery. However, Gelman et al. (21) found that scalpel-created canine skin flaps had better bursting strength, more collagen and fibroblasts, fewer leukocytes, and less wound drainage than flaps made with electrocautery. A recent rat study also demonstrated significantly more flap complications in the electrocautery group compared with the sharp dissection group (5).

Electrocautery dissection was found to be associated with surgical morbidity in MRM patients (22). Previous retrospective studies suggested that wound complications including cellulitis, infections, flap necrosis, and seroma formation were increased with the use of electrocautery

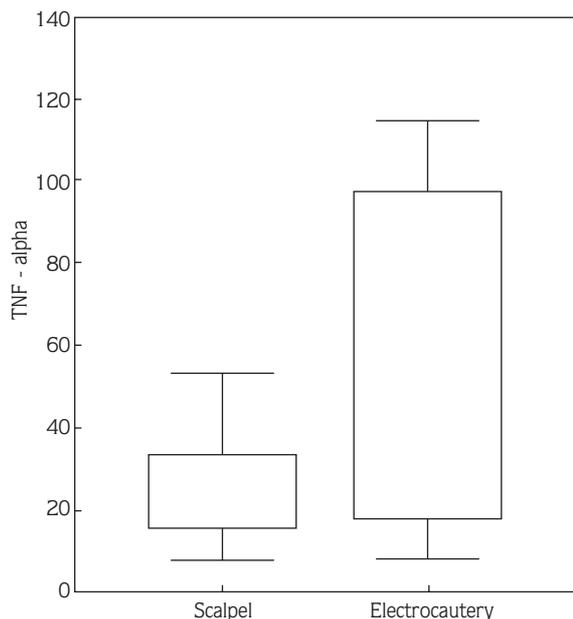


Figure 1. TNF- α (pg/ml) in drain fluids of scalpel and electrocautery groups ($P = 0.037$).

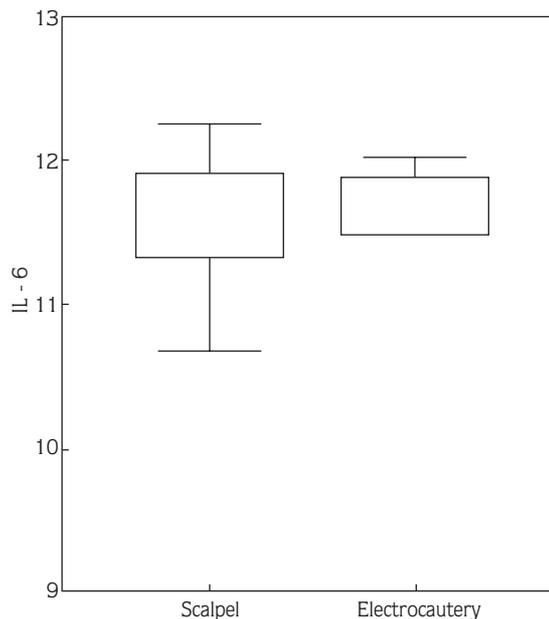


Figure 2. IL-6 (pg/ml) in drain fluids of scalpel and electrocautery groups ($P = 0.450$).

(9,10). Porter et al. (8) prospectively randomized MRM patients to flap dissection with either scalpel or electrocautery. They found electrocautery to be associated with reduced blood loss but increased rate of seroma formation. No significant difference in total days of drain duration or total drain output was observed in their study. Although previous evidences have indicated the role of electrocautery, MRM, independent of the dissection technique, was found to be the only factor in seroma formation in a recent study (7). Another study comparing electrocautery with scalpel found no difference in seroma between groups (23). The overall seroma rate of 52.6% (20/38) in the present study was similar to rates of previous reports (7,8). No difference was found in operating time, duration of drains, and rate of wound complications. The use of electrocautery for flap dissection versus sharp dissection was associated with decreased amount of operative blood loss and total drain volume, but with increased seroma formation rate. The lower blood loss in the electrocautery group might suggest adequate arterial and venous vascular control during flap dissection (8).

Experimental trauma is known to increase local cytokine levels in wound fluid (12). Quantification of pro-inflammatory cytokine levels in human skin wounds created with sharp incisions (14) and in skin graft donor site wound fluid (15) showed increased levels. Wound fluid obtained from patients undergoing reduction mammoplasty demonstrated the presence of cytokines at levels several times higher than in plasma (16). During normal wound healing, TNF- α and IL-6 are released and their levels peak within the first day of wounding, stimulating multiple inflammatory processes and modulating wound regeneration (13). For this reason, we

measured wound fluid levels of these cytokines at 24 hours after MRM.

The use of electrocautery in experimental skin flaps in rats increases the cellular inflammatory response and correlates with the production of acute phase reactants in the wound (24). The detrimental effect of electrocautery was linked to the relative ischemia of the flaps caused by the increased thrombosis of the subdermal vessels (9) and to the thermal effects on subcutaneous fat (8). Chow et al. (17) reported a recent study on the cytokine dynamics in wound fluid after mastectomy performed with electrocautery. They did not make a comparison between electrocautery and sharp dissections in that study. They showed that IL-6 levels were elevated during the initial phase, but in the later phase the IL-6 levels dropped with a corresponding rise in TNF- α level. They suggested that the early changes in wound fluid cytokine levels reflect the inflammatory responses, while the changes measured on day 5 reflect their roles in wound healing. The present study could not demonstrate an increase in IL-6 levels in the electrocautery over the scalpel group on day 1. On the other hand, wound fluid level of TNF- α was increased with electrocautery compared with sharp dissection, a finding that should reflect an aggravated inflammatory reaction to electrocautery dissection.

In conclusion, dissection technique is an important factor affecting the postmastectomy period. Electrocautery dissection reduces operative blood loss and postoperative drain output, but increases seroma formation rate. Increased proinflammatory cytokine response in wound fluid is an indicator of an increased potential for tissue damage with electrocautery dissection.

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