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ORIGINAL ARTICLE

Histopathological comparison of incision methods in transconjunctival blepharoplasty: A rat model study

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Abstract

Objectives

The choice of incision method is critical in transconjunctival blepharoplasty, affecting both the wound healing process and aesthetic outcomes. This study aimed to compare the histopathological effects of four different incision methods: scalpel, electrocautery, radiocautery, and laser, on wound healing in an animal model.

Methods

A total of 54 female Sprague-Dawley rats were divided into nine groups, each subjected to different incision methods on their palpebral conjunctiva. Specimens were collected immediately after the incision and at 1- and 2-week intervals to evaluate wound width, depth, vascular proliferation, inflammation, and fibrosis.

Results

Analysis revealed that scalpel and laser incisions resulted in narrower and shallower defects immediately post-operation, while electrocautery and radiocautery produced the most pronounced tissue trauma. By the first week, electrocautery showed the least vascular proliferation, inflammation, and fibrosis, while radiocautery exhibited the most pronounced effects. At the second week, scalpel incisions showed the least inflammation and vascular proliferation, while fibrosis was least observed in radiocautery incisions. Interestingly, despite the initial trauma caused by electrocautery, this method showed less fibrosis over time, suggesting reduced long-term scarring compared to radiocautery. Laser incisions also showed favorable healing outcomes, but with more moderate results compared to the scalpel group. Overall, the study highlights the varying impacts of each incision method on the healing process, indicating that scalpel and laser offer advantages in the early stages of healing, while electrocautery, despite initial trauma, may result in less long-term scarring.

Conclusions

The results highlight the importance of selecting the appropriate incision method to minimize complications and optimize healing in transconjunctival blepharoplasty.

Keywords: Scalpel; electrocautery, laser, transconjunctival blepharoplasty, wound healing

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Introduction

Some incisions are described as exposing the infraorbital rim, orbital floor, or periocular region. The most used approaches are the subciliary, subtarsal, infraorbital, and transconjunctival approaches [1]. Surgeons are still searching for the best instrument that can achieve the optimal skin incision. This instrument should be easy to use, easy to incise with minimal pressure and tissue tension or minimal inclination, good hemostasis during the incision, less damage to adjacent tissues, less scarring, and rapid sensory recovery [2].

All incisions have advantages and disadvantages. The infraorbital incision is associated with the most complications, including scarring and edema [3]. The subciliary incision rarely leaves a noticeable scar but produces significant temporary lower eyelid retraction [4]. The subtarsal incision is made along the natural crease of the lower eyelid under the tarsal plate and is associated with scarring [1]. A concealed orbital incision and low rates of ectropion have made the transconjunctival approach popular [5-10]. The transconjunctival approach was first described by Bourget in 1924 with the removal of lower eyelid fat [11]. Some authors have suggested that the transconjunctival approach reduces the risk of postoperative eyelid retraction, ranging from scleral demonstration to permanent ectropion [6,12]. However, complications also occur with this approach. The most common complications are lower eyelid avulsion, lower eyelid malposition, lower eyelid retraction, ectropion, and acquired or cicatricial entropion due to adhesion [13-14]. For many years, research has focused on preventing postoperative adhesions. The most important measures to reduce the incidence of adhesions are atraumatic surgical procedure, careful hemostasis, and ischemia [15]. A wide variety of instruments are available for cutting mucosal surfaces, causing varying degrees of tissue trauma, bleeding, and ischemia. Lasers perform tissue cutting by vaporizing the tissue as a result of the absorption of optical energy and its conversion to thermal energy [16]. RF devices generate high energy flow around the electrode tip, which causes less damage to the normal tissue around the lesion [17].

Different devices will have different penetration and thermal effects in the conjunctival mucosa. The aim of this study was to evaluate the effects of incisions made in the palpebral conjunctiva with scalpels, electrocautery, laser, and radiofrequency cautery on wound healing in an animal model. The factors examined included the width and depth of the postoperative wound, vascular proliferation, inflammation, and fibrosis at the end of the first and second weeks. The clinical application of various devices in the palpebral conjunctiva may be better guided by the different effects on wound healing.

Methods

A total of 54 adult female Sprague-Dawley rats weighing between 200 and 250 grams were used as experimental animals in the study.

The rats were anesthetized by intraperitoneal Ketamine HCl 75 mg/kg and Xylazin 0.2 ml/kg. After monitoring the skeletal muscle tone, the subjects were laid on the workbench. The rats were fixed with 4-0 silk sutures so that their lower eyelid conjunctivas were exposed.

In our study, 15 scalpels, Sharplan 150 XJ SilkTouch CO2 laser, Covidien force FX Electrocautery, Covidien Radiofrequency were used.

In our study, 9 groups were formed and there were 6 experimental animals in each group.

Group 1: An incision was made on the right conjunctiva of the animals with a scalpel and the right sides of all animals were evaluated as the control group. An incision was made on the lower eyelid conjunctiva from the 3 mm inner part of the conjunctival rim with a number 15 scalpel, approximately 1.5 cm long and without reaching the septum. Immediately after the incision, the lower eyelid was completely excised for specimen collection. The right side was the control group, and the trauma zone created by the scalpel around the incision was pathologically evaluated. In this group, the left conjunctiva of the animals was incised with electrocautery. Specimens were taken in the same manner and the burn effect created by the electric current around the incision line (trauma-injury zone) was pathologically evaluated as the length. (Injury distance).

Group 2: The right conjunctiva of the animals was again the control group and incised with the scalpel in the same manner. Specimens were taken immediately for this purpose. Radiocautery was used in the left conjunctiva and the trauma zone was evaluated.

Group 3: The right conjunctiva of the animals was again the control group and incised with the scalpel in the same manner. Specimens were taken immediately for this purpose. Laser was used in the left conjunctiva and the trauma zone was evaluated.

Group 4: The procedures in Group 1 were repeated, but the specimens were taken 1 week later for the evaluation of acute inflammation. The acute inflammatory and vascular proliferation effects of electrocautery were investigated and compared with the control group.

Group 5: The procedures in Group 2 were repeated and the specimens were taken 1 week later to investigate the acute inflammatory and vascular proliferation effects of radio-cautery and compared with the control group and also with electro-cautery studies.

Group 6: The procedures in Group 3 were repeated and the specimens were taken 1 week later to investigate the acute inflammatory and vascular proliferation effects of laser and compared with the control group and also with electro-cautery and radio-cautery studies.

Group 7: The procedures in Group 1 were repeated and the specimens were taken 2 weeks later to evaluate inflammation and fibrosis and the effects of electro-cautery on chronic period healing in transconjunctival blepharoplasty were investigated.

Group 8: The procedures in Group 2 were repeated and the specimens were taken 2 weeks after the operation and the effects of radio-cautery on chronic period healing in transconjunctival blepharoplasty were investigated.

Group 9: The procedures in Group 3 were repeated and the specimens were taken 2 weeks after the operation and the effects of laser application on chronic period healing in transconjunctival blepharoplasty were investigated.

The specimen samples taken from the subjects were fixed in 10% buffered formalin solution. After being washed under running water for 1 day, they were passed through alcohol and xylene series and blocked in paraffin. The sections taken with a 5um thickness with a microtome (Leica RM2125RT) were stained with Hematoxylin Eosin for histopathological examination. The evaluation of the results was done with the help of a Nikon Eclipse E600W light microscope. Microscopic photographs were taken with a Nikon DS Camera Head DS-5M.

Statistical Analysis

The statistical analysis of the data was performed using the IBM SPSS 20 statistical package program. The differences between the groups were examined using the Kruskal-Wallis Test in non-parametric data. As a result of the statistical analysis, $p<0.05$ was considered statistically significant.

Results

4 different methods of incision were made on the eyelids of 54 subjects included in the study. These are (1) Incision with scalpel, (2) Incision with electrocautery, (3) Incision with radiocautery and (4) Incision with laser. Subjects were divided into 9 different groups and the incision methods described in each group were applied. Each subject had a scalpel incision on the right conjunctiva as a control group, 18 subjects were incised with electrocautery, 18 subjects were incised with radiocautery and 18 subjects were incised with laser.

In subjects who underwent surgical intervention; it was investigated whether there was a difference between the width of the defect created by surgery and its depth immediately after the intervention, whether there was a difference between the vascular proliferation, inflammation and fibrosis values after 1 week and whether there was a difference between the vascular proliferation, inflammation and fibrosis values after 2

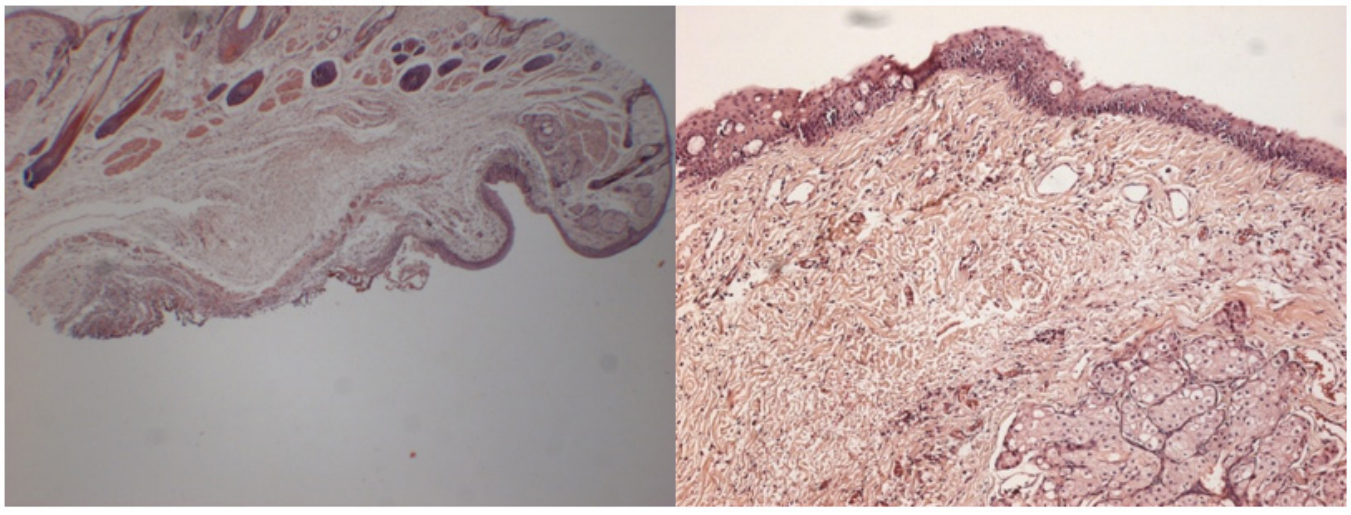

Figure 1. The figure illustrates the variation in tissue response, with differences in vascular proliferation, inflammation, and fibrosis levels after 2 weeks post-incision.

weeks (Figure 1).

In our study, on the day we started the experiment, it can be said that the defect widths in incisions made with scalpel and laser were less than in incisions assisted by radiocautery and electrocautery. In addition, on the same day, the defect depth was observed to be the least in incisions made with scalpel and the most in electrocautery and radiocautery. In the preparations we examined, it can be said that at the end of the first week, histologically, the least vascular proliferation, inflammation and fibrosis occurred in tissue preparations where electrocautery was used. On the contrary, at the end of the first week, the incision method that was detected the most among these histological parameters was radiocautery. In the examinations at the end of the second week, it was determined that the least vascular proliferation and inflammation belonged to the scalpel incision, and fibrosis was observed the least in tissues where radiocautery was used; on the contrary, it was determined that the incision in which these three histological parameters were observed the most belonged to electrocautery.

1-) It can be said with a 5% error that there is a difference in defect widths in the incisions made on day 0 (sig<0.05). In this context, it can be said that (1) Scalpel incision and (4) Laser incision create less defect width than the other two incision methods.

2-) It can be said with a 5% error that there is a difference in defect depths in the incisions made on day 0 (sig<0.05). In this context, it can be said that (1) Scalpel incision creates the least defect depth, and (4) Laser incision is in second place.

3-) It can be said with a 5% error that there is a difference in vascular proliferation, inflammation and fibrosis in the incisions made on week 1 and week 2 in terms of methods (sig<0.05). In this context, it can be said that (1) incision with scalpel causes the least vascular proliferation, and (4) incision with laser is in the second place.

4-) It can be said with a 5% error that there is a difference between vascular proliferation, inflammation and fibrosis in the incisions made in the 1st and 2nd weeks in terms of methods (sig<0.05). In this context, it can be said that (2) incision with electrocautery causes the least inflammation, and (1) incision with scalpel is in the second place.

5-) It can be said with a 5% error that there is a difference between vascular proliferation, inflammation and fibrosis in the incisions made in the 1st and 2nd weeks in terms of methods (sig<0.05). In this context, it can be said that (2) incision with electrocautery causes the least fibrosis, and (1) incision with scalpel is in the second place.

Kruskal-Wallis Test

As a result of the second Kruskal-Wallis test; 1-) In the incisions made in the 1st week, it can be said with a 5% error that there is a statistically significant difference in terms of vascular proliferation, inflammation and fibrosis formation in terms of incision methods (sig<0.05). In this context, it can be said that incisions made with electrocautery in the 1st week revealed the least vascular proliferation, inflammation and fibrosis.

As a result of the second Kruskal-Wallis test;

1-) In the incisions made in the 2nd week, it can be said with a 5% error that there is a statistically significant difference in terms of vascular proliferation in terms of incision methods (sig<0.05). In this context, it can be said that incisions made with scalpel in the 2nd week revealed the least vascular proliferation, and secondly, incision with Laser revealed the least vascular proliferation.

2-) In the incisions made in the 2nd week, it can be said with a 5% error that there is no statistically significant difference in terms of inflammation and fibrosis in terms of incision methods.

Discussion

On the day we started the experiment in our study, it can be said that the defect widths in the incisions made with scalpel and laser were less than in the incisions assisted by radiocautery and electrocautery. In addition, on the same day, the defect depth was observed to be the least in the incision made with scalpel and the most in the incisions made with electrocautery and radiocautery. In the preparations we examined, it can be said that at the end of the first week, histologically, the least vascular proliferation, inflammation and fibrosis occurred in the tissue preparations where electrocautery was used. On the contrary, at the end of the first week, the incision method that was detected the most among these histological parameters was the use of radiocautery. In the examinations at the end of the second week, it was determined that the least vascular proliferation and inflammation belonged to the scalpel

incision, and fibrosis was observed least in the tissues where radiocautery was used; conversely, the incision where these three histological parameters were observed the most was found to be electrocautery. This also suggests that long-term scarring will be greater in tissues where electrocautery was used. However, in the study conducted by Pruksapong et al., long-term scar results of Colorado needle-tip cautery and classical scalpel in upper eyelid blepharoplasty were compared, and it was observed that cautery did not have worse results [2]. In the article by Laurence et al., the use of CO2 laser, electrocautery and scalpel was compared specifically for blepharoplasty surgery, and no difference was found between the three incisions in terms of scar quality, color, size and structure [18]. Rokhsar et al. used CO2 laser and Colorado needle-tip cautery in upper and lower blepharoplasty and compared them in terms of scarring. Histological examination showed that CO2 laser caused more thermal damage; however, there was no difference in scar width on the 30th postoperative day [19]. Again, Carqueville and Chesnut, in their article comparing upper blepharoplasty incisions, found that heat artifacts, thermal damage and epidermal necrosis related to this were more in histological specimens of CO2 laser compared to microdissection cautery and classical scalpel [20]. In the study conducted by Liboon et al. by incising pig mucosa, it was stated that the least histological damage was in the tissues where scalpel was used [21]. Fisher et al. stated in their article that less scar tissue was formed and healing occurred faster in laser-created wounds compared to wounds opened with traditional scalpel [22]. In the experimental study conducted by Sinha et al. on the oral mucosa of guinea pigs, straight scalpel, ultrasonic scalpel, monopolar and bipolar were compared. At the end of 28 days, it was observed that the best tensile strength and the fastest re-epithelialization were in the incisions made with the classical and ultrasonic scalpels, and that complete resolution of inflammation was again in the classical and ultrasonic scalpels in 14 days [23]. Barbi et al. compared radiofrequency and scalpel incisions in upper blepharoplasty and observed no difference in scar vascularity, elasticity or pigmentation after a six-month follow-up [24].

Conclusion

This study highlights the varying effects of scalpel, electrocautery, radiocautery, and laser incisions on wound healing in transconjunctival blepharoplasty. Scalpel and laser incisions caused less tissue trauma and faster healing in the short term, while electrocautery and radiocautery produced more pronounced tissue damage initially but led to reduced inflammation and fibrosis over time. At one week, electrocautery showed the least vascular proliferation and fibrosis, whereas radiocautery caused the most tissue trauma early on. By the second week, scalpel incisions resulted in the least inflammation, and radiocautery had the least fibrosis. These findings suggest that while scalpel and laser may be preferable for short-term healing, electrocautery offers potential benefits in minimizing long-term scarring, underlining the importance of selecting the appropriate incision method based on both immediate and long-term outcomes.

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