Alopecia Following Bicoronal Incisions

Sameep Kadakia, MD; Arvind Badhey, MD; Sara Ashai; Thomas S. Lee, MD; Yadranko Ducic, MD

IMPORTANCE  Multiple techniques may be used to perform bicoronal incisions, and alopecia is a known postoperative complication of this procedure. To date, no large studies exist comparing alopecia outcomes among bicoronal incision techniques with and without the use of Raney clips.

OBJECTIVE  To determine (1) whether postoperative alopecia is more common when bicoronal incisions are performed with monopolar cautery, Colorado microdissection tip cautery, or traditional cold steel and (2) whether this outcome is affected by the use of Raney clips.

DESIGN, SETTING, AND PARTICIPANTS  This retrospective study of postoperative alopecia included 505 patients undergoing bicoronal incisions in a single head and neck surgery practice from 1997 to 2015 with a minimum follow-up of 1 year. Patients with preexisting baldness as well as patients not following up for the minimum period were excluded. All data analysis took place between 1997 and 2015.

MAIN OUTCOMES AND MEASURES  Maximum alopecia width was measured in the postoperative period and compared among the technique groups both with and without Raney clip use. Raney clip duration as a product of surgery length was also compared.

RESULTS  A total of 505 patients (301 male, 204 female) ranging in age from 3 to 97 years were included in the study (median age, 53.9 years). Of these, 236 underwent bicoronal incisions to approach the skull base, 78 to treat chronic frontal sinusitis unresponsive to endoscopic management or frontal sinus mucocele, 143 for trauma, and 48 for craniofacial surgery. For 173 patients, the cold steel technique was used for both skin and subcutaneous incision, 102 of whom needed Raney clips. For 161 patients, cold steel technique was used for skin incisions and monopolar cautery for subcutaneous incision; 81 of these patients required Raney clips. For 171 patients, Colorado tip microdissection cautery was used for both skin and subcutaneous incision, with Raney clips used in 66 of these patients. Incisions made with cold steel for both skin and subcutaneous tissue, regardless of Raney clip use, had lower postoperative alopecia than those made with cautery; for scalpel use for both skin and subcutaneous tissue, average alopecia width was 2.8 mm without Raney clip and 3.5 mm with Raney clip. For scalpel use with skin and monopolar cautery for subcutaneous tissue, average alopecia width was 3.8 mm without Raney clip and 4.3 mm with Raney clip. Colorado tip microdissection cautery used for skin and subcutaneous tissue was associated with the greatest alopecia width: Colorado tip for skin and subcutaneous tissue, average alopecia width, 4.9 mm; with Raney clip, 5.9 mm. Duration of Raney clip use was significantly associated with increased alopecia width: less than 3 hours, 4.1 mm; 3 hours or more, 5.2 mm (\( P < .001 \)).

CONCLUSIONS AND RELEVANCE  When performing bicoronal incisions, postoperative alopecia can be minimized by preferentially using a cold steel scalpel for skin and subcutaneous incisions. Raney clip use should be avoided when possible or used for only a short time during the procedure.

LEVEL OF EVIDENCE  3.

Published online January 5, 2017.

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The bicoronal flap, first introduced in 1907, has been used among multiple surgical disciplines in a wide array of procedural approaches. Popularized for its use in LeFort II/III osteotomies and a reliable aesthetic outcome, the bicoronal technique provides versatility, acceptable cosmetic outcomes, and maximum exposure when approaching the upper and middle craniofacial skeleton. The incision begins at the upper border of one helix moving transversely to the other while maintaining a gentle curvature posterior to the hairline. The depth of the incision traverses the skin, subcutaneous, galea aponeurotica, loose areolar, and peristomeum layers (SCALP). Special care is taken at the lateral anterior borders as the surgeon passes through the layers of the temporoparietal fascia where the frontal branch of the facial nerve can be found immediately deep to this fascia. The bilateral supratrochlear and supraorbital arteries provide a robust and reliable primary blood supply to the entire coronal flap. The bicoronal flap provides critical exposure of the supraorbital skeleton, providing for a single-incision approach to surgical management of craniofacial trauma, deformities, and neoplasms with an aesthetic outcome.

Complications or undesirable outcomes related to the bicoronal incision include hematoma, infection, scarring, and alopecia, among others. Long-term alopecia and scarring pose a large aesthetic concern and affect patient satisfaction postoperatively. Small cohort studies including fewer than 75 total patients have reported the incidence of alopecia to be near 7%, leaving a substantial number of patients to cope with long-term postoperative sequelae. Papay et al demonstrated that patients’ subjective observations were significantly changed based on the level of resultant alopecia and visible scarring. Through the growth and advancement of the various bicoronal incision techniques, multiple authors have advocated approaches that minimize alopecia.

Although electrocautery is essential in hemostatic surgery, its use for skin incisions lacks consensus. Specially manufactured instruments such as the Colorado microdissection tip have been introduced to abate common fears of delayed wound healing, postoperative wound infections, and alopecia. The needle-tip monopolar device has been in use for 20 years and has grown more popular over the last 5 years owing to concerns over cost. While some studies have examined postoperative alopecia as a result of specific surgical instrumentation, such as cautery or cold steel, our knowledge no studies have accounted for the effect of Raney clips, commonly used in scalp incisions for their superior hemostatic ability, on this postoperative complication.

The goal of the present study is to conduct a large-scale analysis of bicoronal incision techniques and use of Raney clips and their association with postoperative alopecia. To our knowledge, this study is the single largest study to date; it compares microdissection electrocautery, cold steel scalpel use, and monopolar cautery with Raney clips and duration of surgery. In addition, to our knowledge, this study is the first of such magnitude examining the influence of multiple variables on alopecia.

### Methods

Institutional review board approval was obtained from the John Peter Smith Hospital in Fort Worth, Texas, waiving written informed consent. However, written informed consent was obtained for all photographs.

This retrospective study sought to analyze differences in alopecia following bicoronal incisions; it compared the outcomes of several surgical techniques while also assessing the use of Raney clips for scalp hemostasis. A medical record review was performed for patients who underwent bicoronal incisions between August 1997 and May 2015. Patients were all treated by the senior author (Y.D.) at a public hospital in Fort Worth, Texas, and followed up for a minimum period of 12 months postoperatively.

Information regarding surgical technique used to perform the bicoronal incision, use of Raney clips for hemostasis, and duration of Raney clip use was documented. Prior to making incisions, the senior author would inject approximately 10 mL of lidocaine with epinephrine near the supraorbital and supratrochlear arteries, as well as along the planned incision line. Each patient’s age, sex, and reason for requiring surgery were also noted. During the postoperative period, maximum width of alopecia was measured for each patient. Excluded from the study were patients who did not meet the minimum follow-up requirement of 12 months follow-up and those who had incisions traversing preexisting areas of hair loss.

Once the information was collected, each technique with and without the use of Raney clips was compared using an unpaired t test, and a significance threshold of \( P < .005 \) was set (including a Bonferroni correction). As typically the significance threshold is set at \( P < .05 \), and given that 10 comparisons were made using the same data set with individual comparisons, a Bonferroni correction was computed by dividing the initial significant threshold \((a) .05\), by the number of tests, 10, to obtain the new significance threshold of .005. Durations of surgery as a marker of Raney clip application time were also compared to determine differences in postoperative alopecia.
Table 1. Postoperative Alopecia Outcomes With and Without Use of Raney Clips

<table>
<thead>
<tr>
<th>Surgical Technique</th>
<th>Patients, No.</th>
<th>Alopecia Width, Mean (Range), mm</th>
<th>P Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold steel scalpel for skin and subcutaneous tissue incision with sparing use of bipolar cauteru</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Raney clip</td>
<td>71</td>
<td>2.8 (0-4)</td>
<td>.0001</td>
</tr>
<tr>
<td>Raney clip</td>
<td>102</td>
<td>3.5 (1-5)</td>
<td></td>
</tr>
<tr>
<td>Cold steel scalpel for skin and monopolar cauteru for subcutaneous tissue incision</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Raney clip</td>
<td>80</td>
<td>3.8 (1-6)</td>
<td>.0121</td>
</tr>
<tr>
<td>Raney clip</td>
<td>81</td>
<td>4.3 (1-6)</td>
<td></td>
</tr>
<tr>
<td>Colorado tip monopolar cauteru for skin and subcutaneous tissue incision</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Raney clip</td>
<td>105</td>
<td>4.9 (1-7)</td>
<td>.0001</td>
</tr>
<tr>
<td>Raney clip</td>
<td>66</td>
<td>5.9 (2-9)</td>
<td></td>
</tr>
</tbody>
</table>

* Significance for t test, P value set at P < .005.

Results

After completing medical record review for patients undergoing bicoronal incisions, 505 patients were identified who satisfied the inclusion criteria. The patient population consisted of 301 male and 204 female patients, ranging in age from 3 to 97 years. The median age of the population was 53.9 years. A total of 236 patients required bicoronal access to approach the skull base, 78 for chronic frontal sinusitis unresponsive to endoscopic management or frontal sinus mucocele, 143 for trauma, and 48 for craniofacial surgery.

Following identification, patients were divided into groups based on the technique used to perform the bicoronal incision. During this stratification, patients were placed into subgroups depending on the use of Raney clips during the procedure. A total of 173 patients had a bicoronal incision performed with a scalpel to incise both the skin and subcutaneous tissue, using a bipolar cauteru sparingly for small bleeding vessels. In this group, there were 71 patients for whom no Raney clips were used and 102 for whom they were used. Patients without Raney clips use had an average alopecia width of 2.8 mm (range 0-4 mm). Patients with Raney clips use had an average alopecia width of 3.5 mm (range 1-5 mm) (Table 1).

In the second group, 161 patients had skin incisions made with cold steel, while the subcutaneous tissue was incised with monopolar cauteru. Eighty patients did not have Raney clips used, while 81 patients did have Raney clips used. Of the patients not having Raney clips, the average alopecia width was 3.8 mm, ranging from 1 to 6 mm. In the subset of patients requiring Raney clips, the average alopecia width was 4.3 mm, with a range from 1 to 6 mm (Table 1).

The final group of 171 patients had both skin and subcutaneous tissue incised with Colorado tip monopolar cauteru (blend, 1; cautery, 15). One hundred five patients in that group did not receive Raney clips, while 66 did. In the group without Raney clips, the average alopecia width was 4.9 mm, with a range from 1 to 7 mm. The subset that did require Raney clips had an average alopecia width of 5.9 mm with a range from 2 to 9 mm (Table 1 and Table 2).

Following acquisition of data stratified by technique and Raney clip use, average alopecia width was compared in patients requiring Raney clips arranged by duration of surgery. A total of 249 patients required Raney clips intraoperatively for hemostasis. Ninety-five patients had surgery lasting less than 3 hours, with an average alopecia width of 4.1 mm and ranging from 1 to 5 mm. One hundred fifty-four patients had surgery lasting 3 hours or more, with an average alopecia width of 5.2 mm, ranging from 3 to 9 mm (Tables 1 and 2).

To determine whether technique, Raney clip use, and duration of surgery were significant factors in influencing postoperative alopecia, several groups were compared using an unpaired t test with a significance threshold (α) of .005. Across the different techniques, both with and without Raney clip use, all P values were less than .05 (Tables 1 and 2), suggesting significant differences in the average alopecia width. Comparison of alopecia outcomes with and without Raney clips within each technique group also yielded P values less than .005 for each technique except for cold steel skin incisions followed by monopolar cautery for subcutaneous tissue (Tables 1 and 2). In this group, the difference was initially found to be significant at P = .0121, but following application of the Bonferroni correction, this value no longer held significant difference. Finally, comparison of surgery duration and alopecia yielded a P value of .0001 (Table 2). All group comparisons and associated P values are listed in Table 1 and 2.

Discussion

Initially described for frontal lobe access in 1907, the bicoronal flap was not applied to maxillofacial surgery until the 1970s, when it was found to provide superior access for LeFort 2 and LeFort 3 fractures. Known for its minimal morbidity and ease of performance, it has since been popularized for intraorbital access, skull base surgery, trauma, and frontal sinus procedures. The bicoronal approach provides clear exposure to the upper and middle third of the face while allowing facile instrumentation of the orbital walls, zygomatic arch, frontonasal complex, and temporal fossa.

Although bicoronal incisions are typically of low morbidity and acceptable cosmesis, alopecia is a well-known potential complication following the procedure and has been noted in several studies along the incision line. In a 2012 study,
Gabrielli et al\textsuperscript{19} examined 118 patients following bicoronal incision and found 18\% to have alopecia. Twenty-one of 24 patients had localized alopecia, with an average maximal width less than 1 cm, while the remaining 3 had alopecia extending the entire length of the incision. The authors reported that the alopecia might have been due to the use of Raney clips or cautery.\textsuperscript{19}

Following the development of cautery units in neurosurgery, the technique has become widely used in all surgical fields.\textsuperscript{10,20} Farnworth et al\textsuperscript{20} and Rappaport et al\textsuperscript{21} reported increased tissue necrosis and decreased wound tensile strength with the use of cautery units for tissue dissection. Cold steel, however, was not noted to cause tissue necrosis or adverse effects on tissue healing.\textsuperscript{22}

While, to our knowledge, no studies in the English language literature have examined the role of Raney clip use in the development of postoperative alopecia, studies have suggested an association with electrosurgical techniques. Papay et al\textsuperscript{10} sought to compare microdissection cautery (Colorado tip) and cold steel in the development of alopecia following bicornal incision for repair of craniosynostosis. Their study examined 12 patients requiring bicornal access, with half of the incision performed with cold steel and the other half performed with Colorado tip microdissection cautery. Following completion of the procedure, patients were followed up for 6 to 30 months. Not only did patients report a scar disparity on a verbal questionnaire, but the comparison of maximum alopecia width revealed significantly greater alopecia with use of the Colorado tip.\textsuperscript{10}

In another study of 117 patients with incisions through hair-bearing skin with microdissection cautery needles, all patients were noted to have alopecia along the incision line; however, the width of maximum alopecia was not reported.\textsuperscript{23} These studies suggest an increased incidence of postincisional alopecia with the use of thermal energy. However, no studies to our knowledge have examined the differences in postoperative alopecia in reference to both technique of incision and Raney clip use, which have also been suggested to cause tissue ischemia and lead to postoperative alopecia.\textsuperscript{18}

Our study represents the largest study in the English language literature to our knowledge examining postoperative alopecia in patients with bicoronal incisions, and the only study to our knowledge comparing multiple techniques with and without Raney clip use. To draw conclusions based on our data, multiple comparisons were made to determine significance in the difference of maximum alopecia. First, each technique was examined separately by comparing alopecia when Raney clips were and were not used, testing the hypothesis that Raney clip use may lead to increased postoperative alopecia. Regardless of technique (scalpel, monopolar cautery, Colorado tip cautery), all but the monopolar cautery group showed a significantly greater maximum alopecia width when Raney clips were used (Tables 1 and 2; \(P = .0001\), \(P = .0121\), \(P = .0001\)).

Next, to compare the multiple techniques while keeping Raney clip use constant, all of the techniques were first compared with Raney clip use and subsequently without. When comparing cold steel vs monopolar cautery, cold steel vs Colorado tip, and monopolar vs Colorado tip all without Raney clip use, it was noted that the differences in maximum alopecia among all combinations of technique were statistically significant (Tables 1 and 2; \(P = .0001\), \(P = .0001\), \(P = .0001\)). These findings suggest that without Raney clip use, the level of maximum alopecia is greatest with Colorado tip cautery used for skin and subcutaneous tissue and least with cold steel use for the entire depth of the incision.

<table>
<thead>
<tr>
<th>Comparison Groups</th>
<th>Patients, No.</th>
<th>Alopecia Width, Mean (Range), mm</th>
<th>(P) Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Without Raney Clips</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scalpel skin and subcutaneous tissue vs Scalpel skin and monopolar subcutaneous tissue</td>
<td>71</td>
<td>2.8 (0-4)</td>
<td>.0001</td>
</tr>
<tr>
<td>Scalpel skin and subcutaneous tissue vs Colorado tip</td>
<td>71</td>
<td>2.8 (0-4)</td>
<td>.0001</td>
</tr>
<tr>
<td>Scalpel skin and subcutaneous tissue vs Colorado tip monopolar cautery skin and subcutaneous tissue</td>
<td>105</td>
<td>4.9 (1-7)</td>
<td>.0001</td>
</tr>
<tr>
<td>Scalpel skin and monopolar subcutaneous tissue vs Colorado tip</td>
<td>80</td>
<td>3.8 (1-6)</td>
<td>.0001</td>
</tr>
<tr>
<td>Scalpel skin and monopolar subcutaneous tissue vs Colorado tip monopolar cautery skin and subcutaneous tissue</td>
<td>105</td>
<td>4.9 (1-7)</td>
<td>.0001</td>
</tr>
<tr>
<td><strong>With Raney Clips</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scalpel skin and subcutaneous tissue vs Scalpel skin and monopolar subcutaneous tissue</td>
<td>102</td>
<td>3.5 (1-5)</td>
<td>.0001</td>
</tr>
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</tr>
<tr>
<td>Scalpel skin and monopolar subcutaneous tissue vs Colorado tip monopolar cautery skin and subcutaneous tissue</td>
<td>66</td>
<td>5.9 (2-9)</td>
<td>.0001</td>
</tr>
<tr>
<td>Raney clip used in any surgical technique</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time of surgery &lt; 3 hours</td>
<td>95</td>
<td>4.1 (1.0-5.0)</td>
<td>.0001</td>
</tr>
<tr>
<td>Time of surgery ≥ 3 hours</td>
<td>154</td>
<td>5.2 (3.0-9.0)</td>
<td>.0001</td>
</tr>
</tbody>
</table>

*Significance for \(t\) test \(P\) value set at \(P < .005\).
A similar analysis was then carried out, examining techniques with concurrent use of Raney clips for hemostasis. Interestingly similar to the results of the previous group, the differences were again significant in all comparisons (Tables 1 and 2). Again, these findings suggest that despite the use of Raney clips, Colorado tip cautery for skin and subcutaneous incision was associated with the greatest degree of postoperative alopecia.

Finally, in an attempt to determine if the duration of Raney clip use affected postoperative alopecia, the operative times in patients with Raney clips was compared. Patients with surgery lasting less than 3 hours had significantly less alopecia than those with surgery 3 hours or more (P = .0001; Table 2), suggesting that the prolonged duration of Raney clip use can adversely affect outcomes.

The results of our data analysis strongly suggest increased postoperative alopecia when a Colorado tip monopolar technique was used to incise both skin and subcutaneous tissue compared with scalpel for skin incision and monopolar cautery used to incise just subcutaneous tissue and a cold steel scalpel used for both skin and subcutaneous tissue. Moreover, based on our results, Raney clip use also increased postoperative alopecia, especially in patients whose surgery lasted 3 hours or more. The lack of significance in alopecia width in the monopolar cautery group with and without Raney clip use suggests a possible outlier and may require a higher-power study to determine validity. The findings of this study suggest that cold steel in bicoronal incisions is to be preferred, and Raney clips should be avoided, unless absolutely necessary for hemostasis, to improve cosmesis and minimize the risk of postoperative alopecia.

Conclusions

In performing bicoronal incisions, using a Colorado tip may result in increased maximum width of postoperative alopecia; thus, cold steel may be a more aesthetically favorable option. Raney clip use, along with increased time of application, can also result in greater alopecia and should be avoided unless necessary for hemostasis.

REFERENCES

5. Rajmohan S, Badhey, Lee. Acquisition, analysis, or interpretation of data: Kadakia, Badhey, Lee. Drafting of the manuscript: Kadakia, Badhey, Lee. Critical revision of the manuscript for important intellectual content: Ashai, Lee, Ducic. Statistical analysis: Kadakia, Lee. Administrative, technical, or material support: Kadakia, Lee, Ducic. Study supervision: Lee, Ducic. Conflict of Interest Disclosures: None reported.