Utilization and Dissection for Endoscopic Sinus Surgery Training in the Residency Program

Baran Acar, MD,* Emre Gunbey, MD, * Mehmet Ali Babademez, MD, * Hayriye Karabulut, MD, * Hediye Pinar Gunbey, MD, † and Riza Murat Karasen, MD*

Objective: To develop an animal cadaver model that would allow residents to learn functional endoscopic sinus surgery as a complementary model.

Study Design: Prospective experimental study.

Patients and Methods: Two of our first-year residents were included in the study, and each operated on 5 sheep noses. All the routine steps of endoscopic sinus surgery were performed, except for sphenoidotomy, and their success and complication scores were recorded. The residents’ performance for maxillary antrostomy, ethmoidectomy, and frontal sinusotomy in sheep cadaver noses were evaluated by the authors. Predissection and postdissection computer tomography assessed the completeness of dissection. Images were analyzed for maxillary antrostomy, frontal sinusotomy, residual ethmoid cells and partitions, and residual frontal recess cells. The first and last 5 sides of residents were analyzed together as the first 10 sides (group 1) and last 10 sides (group 2).

Results: Group 2 had significantly better outcomes for frontal sinusotomy and ethmoidectomy (P = 0.011 and P = 0.003, respectively). The mean duration of procedures for group 1 was 15.7 minutes and that for group 2 was 10.3 minutes (P = 0.000). The difference was not significant between the 2 groups when comparing the success rates of maxillary antrostomy and the complication rates (P > 0.05).

Conclusions: The nasal cavity of the sheep is anatomically similar to the human nasal cavity, and the model using sheep cadaver for endoscopic sinus surgery training is a cost-effective and useful model for the first step of the learning curve.

Key Words: Endoscopic sinus surgery, sheep nasal cavity, residency

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Fig. 1A). A cannula was placed, and methylene blue was then connected to run intracranially. Should the skull base be injured, it may be noted through the methylene blue leak (Fig. 1B). All these steps were observed by the authors, and complications, if any, were recorded. After each operation, the possible causes for complications were discussed. Ten cadaver heads were used for the study. Twenty cadaver sides were dissected and were included for analysis. The training period was divided into 2 steps: the first 10 and the second 10 sides for the residents. Two training periods were compared with preoperative and postoperative CT scans, success, and complication rates.

When the residents completed their dissections, the following parameters were determined by the authors: (1) site of the nose (right vs left), (2) duration of the procedure and duration of each step, and (3) complications when opening the frontal recess (cerebrospinal fluid [CSF] leak vs no complication).

Computed tomographic scans were then obtained for the second time and were designated as postoperative CT scans. All images were assessed by a radiologist blinded to the participant’s subjective ESS practice level and years in practice. The comparison between preoperative and postoperative scans was made for the evidence of surgical maxillary antrostomy and frontal sinusotomy. These were designated as opened or unopened. The number of residual ethmoid and frontal recess cells and the presence of conchal osteitis were also recorded on the database.

Statistical analysis was performed using SPSS 15.0. The χ² test was used to compare the procedure’s success and complication rates. The Mann-Whitney U test was used to compare other numerical parameters. P < 0.05 was considered significant.

RESULTS

Each of the 2 first-year residents performed ESS on 10 sides. For all the parameters, both residents had similar outcomes; therefore, the first and last 5 sides of residents were analyzed together as the first 10 sides (group 1) and the last 10 sides (group 2). There was no significant difference between the right and left sides (P > 0.005). The mean duration of the procedures for group 1 was 15.7 minutes, and for group 2, it was 10.3 minutes (P < 0.005). The mean duration of frontal sinusotomy and ethmoidectomy was significantly shorter for group 2. This significant difference was not present for the duration of maxillary antrostomy (P > 0.005). Cerebrospinal fluid leak occurred in 3 cases (30%) during frontal sinusotomy in group 1, whereas no CSF leak occurred in group 2. When comparing the success rates of maxillary antrostomy, ethmoidectomy, and frontal sinusotomy, the success rate was higher in group 2. In group 1, the success rate for maxillary antrostomy was 60%, and in group 2, it was 80%. The success rates for frontal sinusotomy were 40% and 100% for groups 1 and 2, respectively. There was a significant difference between 2 groups with regard to residual ethmoidal cells (P = 0.003). The mean number of unopened ethmoid cells was 1.3 for group 1 versus 0.1 for group 2. There was no significant difference for unopened frontal recess cells. The mean number of unopened frontal recess cells was 1 for group 1 versus 0.8 for group 2 (P > 0.005). The rate of iatrogenic injury to middle concha was 80% for group 1 and 50% for group 2. These data are presented in Table 1.

DISCUSSION

Endoscopic sinus surgery is a standard surgical intervention used to treat nasal and paranasal pathologies such as chronic sinusitis and nasal polyposis. It is commonly used in many surgical pathologies of the orbit and skull base. Complications of ESS include major complications such as injury of the orbit, optic nerve, internal carotid artery, CSF leak, meningitis, diplopia, blindness, major bleeding, and death, and minor complications such as infection, hemorrhage, synchia, ostial stenosis, loss of sense of smell, numb lips and teeth, and recurrence.2 Endoscopic sinus surgery is a challenging surgical procedure technically because of the complex anatomic structure of the paranasal sinuses, a neighborhood with important structures, and frequency of variations, and success of surgery requires experience.3 Mosher4 described intranasal ethmoidectomy as “one of the easiest operations with which one can kill a patient” at the beginning of 20th century. Since then, many technological developments have been recorded in this field, mainly by the routine use of CT and image-guided surgery. Despite these developments, the complication rates have been reported to range between 2% and 17% in different publications.5,6 The main factor affecting the complication rate is the experience of the surgeon. Every surgeon who learns ESS poses a certain inclination for complications.3 Stankiewicz et al8 reported that the complication rate of a surgeon performing ESS is 5% in the first 90 cases and 0.7% in the next 90 cases. Performing endoscopic surgery, different from open surgery, requires the use of both hands and being oriented to relations of surgical equipment and anatomic structures while using plain and angled endoscopes. In their study on participants of a cadaver dissection course, Zuckerman et al9 assessed the effect of cadaver dissections and experience on increasing the success of surgery and reducing the complications of ESS. They found that experience was effective especially in frontal and sphenoid sinusotomy and complete ethmoidectomy. In the same study, it was reported that

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<th>Group 2</th>
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<tr>
<td>Maxillary antrostomy, %</td>
<td>60</td>
<td>80</td>
<td>0.628</td>
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<tr>
<td>Frontal sinusotomy, %</td>
<td>80</td>
<td>100</td>
<td>0.011</td>
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<td>1.3</td>
<td>0.1</td>
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<td>Retained frontal recess cells, mean</td>
<td>1</td>
<td>0.8</td>
<td>0.529</td>
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<td>Maxillary antrostomy duration, min</td>
<td>5.7</td>
<td>4.4</td>
<td>0.339</td>
</tr>
<tr>
<td>Ethmoidectomy duration, min</td>
<td>4.9</td>
<td>2.7</td>
<td>0.001</td>
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<tr>
<td>Frontal sinusotomy duration, min</td>
<td>5.1</td>
<td>3.2</td>
<td>0.002</td>
</tr>
<tr>
<td>Duration of total procedure, min</td>
<td>15.7</td>
<td>10.3</td>
<td>0.000</td>
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<tr>
<td>CSF leak, %</td>
<td>30</td>
<td>0</td>
<td>0.211</td>
</tr>
<tr>
<td>Middle turbinate injury, %</td>
<td>80</td>
<td>50</td>
<td>0.350</td>
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postoperative CT investigations had a positive effect on the success of consequent surgical interventions. In our study, after each procedure, postoperative CT investigations were assessed by the residents under the supervision of the authors.

Training during ESS, which has many vital complications, causes an increase in complication rates and is ethically inconvenient.\textsuperscript{5,9}

Resident training programs provide the opportunity for gaining surgery experience in a less stressful medium and less bloody surgical field. Resident training programs in ESS are focused on human cadaver dissections and endoscopic surgical simulations that provide the possibility of working in a bloodless field with real sinal pull.\textsuperscript{7,10} Although human cadaver is the most convenient model for ESS training, many residents cannot perform this because of difficulties in finding cadavers and high costs. The cost of human cadaver head training per resident has been reported to be $1520.\textsuperscript{11} Another training model for ESS is the use of sheep cadaver model. Resident training programs on many topics have been implemented on cadaver sheep heads and reported to be beneficial.\textsuperscript{8} The reasons for preferring cadaver sheep head have been the low cost ($5), easy availability, resemblance of sheep’s nasal cavity to that of human’s, and easier manipulation as it is larger than human’s.

The sheep proved to be the most useful nasal and paranasal sinus model for the eligibility to treat ESS. Before the study, the authors examined sheep’s anatomy and explained the method and steps of surgery to the residents by performing ESS in sheep. The nasal cavity of the sheep was seen to be very similar in appearance, although somewhat wider, and the main sinuses lie at approximately the same orientation as they do in humans (Fig. 2). To minimize this disadvantage, the anterior part was shortened before the procedure. Maxillary antrostomy was more difficult because the middle concha was closer to the lateral wall and uncinate process than that of human’s, and the procedure was more difficult because of its spiral and bullous structure. In some procedures, it was necessary to perform partial resection on the middle concha. Therefore, the rate of complication of concha injury was higher both in the first and in the last 10 sides. Working in a bloodless field was an advantage for training, as it has been the case in all cadaver models, and it significantly shortened the operation time. The orbit was at the lateral side of the sheep, its medial wall was not adjacent to the lateral nasal wall, and these diminished the risk of orbital complication. The lack of a significant difference between the first and the second 10 sides for maxillary antrostomy supported this information. Owing to the lack of a sphenoid sinus, the sphenoidotomy procedure has no value. The head of the horse is a good model for the human sphenoid sinus. Obtaining horse heads is more difficult with respect to cost and

![Figure 2](image2.png)

**FIGURE 2.** Endoscopic view of the maxillary antrostomy (A) and frontal sinusotomy (B) being performed on the model. fs, indicates frontal sinus; it, inferior turbinate; mo, maxillary ostium; mt, middle turbinate; u, uncinate process.

![Figure 3](image3.png)

**FIGURE 3.** Participant ESS sheep cadaver dissection CT scans: before (A) and after (B) surgery. Maxillary antrostomy with uncinectomy (white arrow), frontal sinusotomy (green arrow), and ethmoidectomy were successfully performed on the postoperative cadaver specimen. The specimen has no middle turbinate injury (red arrow).

**CONCLUSIONS**

There was a significant difference between the first 10 sides and the second 10 sides in terms of frontal sinusotomy, residual frontal recess cells, and operation time in ESS that was performed...
by first-year residents in sheep cadavers. It was found to be beneficial to use the sheep cadaver model, an inexpensive and easily available material for teaching residents the basic steps of ESS and the orientation in working with plain and angled endoscopes.

REFERENCES

5. Mosher HP. The applied anatomy and the intra-nasal surgery of the ethmoid labyrinth. Trans Am Laryngol Assoc 1912;94:25–39
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