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Systematic Review

Sphenopalatine Artery Surgery for Refractory Idiopathic Epistaxis: Systematic Review and Meta-Analysis

Takahiro Kitamura, MD ©; Yukinori Takenaka, MD, PhD; Kazuya Takeda, MD; Ryohei Oya, MD; Naoki Ashida, MD; Kotaro Shimizu, MD; Kazuya Takemura, MD; Yoshifumi Yamamoto, MD; Atsuhiko Uno, MD, PhD

Objectives: Epistaxis, especially posterior epistaxis, is occasionally refractory to treatment. In these cases, sphenopalatine artery surgeries, including cauterization and ligation, are required. Previous reports have demonstrated treatment results for these procedures but failed to provide high-level evidence. The aim of this study was to quantify the rates of failure and perioperative complications of these procedures by using a meta-analysis technique.

Methods: We systematically searched electronic databases and identified articles regarding epistaxis, sphenopalatine artery ligation, or cauterization. Pooled rebleeding and complication rates were calculated by using a random effects model.

Results: A total of 896 cases of sphenopalatine ligation or cauterization for epistaxis were analyzed. Pooled rebleeding rates for the entire cohort, cauterization group, and ligation group were 13.4% (95% confidence interval [CI] 10.0–17.8, P < 0.001), 7.2% (95% CI 4.6–11.0, P < 0.001), and 15.1% (95% CI 9.8–22.5, P < 0.001), respectively. Pooled perioperative complication rates for the entire cohort, cauterization group, and ligation group were 8.7% (95% CI 4.9–15.1, P < 0.001), 10.2% (95% CI 3.8–24.5, P < 0.001), and 6.4% (95% CI 1.8–20.9, P < 0.001), respectively.

Conclusion: Overall, sphenopalatine surgery for refractory epistaxis is an effective method because of its low rates of failure and complications. Cauterization is more effective than ligation, whereas complications are comparable between the two procedures.

Key Words: Epistaxis, nasal bleeding, sphenopalatine artery, ligation, cauterization

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INTRODUCTION

Idiopathic epistaxis is a primary emergent disease in the field of otolaryngology. Many factors, such as seasonal variation, nasal allergy, environmental humidity, hypertension, and the use of anticoagulant drugs, are associated with epistaxis. Generally, anterior epistaxis does not require medical treatment; in cases where medical treatment is indicated, epistaxis can easily be controlled with a first-line treatment, including anterior nasal packing. In contrast, posterior epistaxis is often refractory and recurs despite treatment. Nasal packing is often used because it is easily performed and is less invasive. However, in some instances, packing is not effective for severe posterior epistaxis. Thus, more invasive procedures, such as surgery or embolization, are essential in such cases. Surgical procedures include ligation and cauterization of the sphenopalatine, internal maxillary, external carotid, and/or anterior ethmoid arteries.2–4 Previously, external carotid or internal maxillary artery surgeries were performed in cases of refractory epistaxis. However, the external carotid artery requires neck surgery and often sacrifices other important vessels, such as the facial or lingual arteries.5,6 Internal maxillary artery surgery may require Caldwell-Luc surgery, which often results in cheek pain; alternatively, such surgery could be performed via an endoscopic transmaxillary approach.5 Embolization is used to control bleeding in various body sites, including in cases of epistaxis. However, it requires the application of elaborate techniques by an expert interventional radiologist. Further, it may involve serious complications, such as necrosis of soft palate tissue, facial paresis, and blindness.7 Systemic complications also may occur, including inhalation hypoxia, hypovolemia, angina, and myocardial infarction.8 Sphenopalatine surgery was once an extremely difficult method. Endoscopic surgery has made progress with the improvement of instruments available for surgery. Therefore, an increasing number of surgeons perform endoscopic
sphenopalatine surgery, and it has become an important method to control severe epistaxis. However, previously reported cases of sphenopalatine surgery enrolled a small number of patients and did not generate an appropriate level of evidence. Further, there is no consensus regarding which procedures should be employed, sphenopalatine artery ligation or cauterization.

Here, we conducted a meta-analysis of the efficacy of sphenopalatine artery surgery for severe or recurrent epistaxis. Further, we compared two commonly used types of sphenopalatine surgery, ligation and cauterization.

**METHODS**

**Study Selection**

This study was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. We performed a literature search regarding sphenopalatine artery surgery (ligation and cauterization) for epistaxis for articles published until December 31, 2017; we used the PubMed database (www.ncbi.nlm.nih.gov/pubmed) and Scopus (https://www.scopus.com/). Search terms included “nasal bleeding,” “epistaxis,” “sphenopalatine artery,” “ligation,” “cauterization,” and “diathermy.” Furthermore, the references in the retrieved articles were manually searched for associated studies. Two of the authors (T.K. and Y.T.) independently evaluated the electronically searched titles for inclusion. All potentially relevant publications were retrieved in full text. Interreviewer agreement was assessed by using Cohen’s kappa. Cohen’s kappa measures the agreement between two raters. Kappa over 0.75 is considered excellent; 0.40 to 0.75 is fair to good; and below 0.40 is poor. Disagreement was resolved by consensus.

Inclusion criteria were as follows: 1) studies involving adult epistaxis; 2) treatment procedure included sphenopalatine surgery; 3) study type was either randomized controlled trial, cohort study, or case series. Included case series comprised a minimum of five patients. Exclusion criteria were as follows: 1) studies regarding artery embolization techniques, 2) nonhuman studies, and 3) no English full text available. A risk of bias for each study was assessed using methodological index for nonrandomized studies (MINORS) score.

**Data Extraction**

Number, age, sex, surgical method, total rebleeding rate, and treatment rebleeding rate (for some treatments, such as reoperation, nasal packing or embolization) were extracted.

**Statistical Analysis**

The included studies exhibited considerably different characteristics. Therefore, meta-analyses were conducted with a random effects model using version 2 of Comprehensive Meta-Analysis (Biostat, Englewood, NJ). Meta-analysis was conducted for rates of rebleeding and complications. Publication bias was assessed by using the funnel plot and tested with Egger's regression intercept test. Heterogeneity was assessed by using the Cochran Q test and I² statistics. All statistical tests were two-sided, and statistical significance was defined by a P value of <0.05.

**RESULTS**

**Literature Search Results**

A flow diagram illustrating the article selection procedure is shown in Figure 1. Electronic database searches retrieved 434 records. We excluded articles that did not meet our criteria. Furthermore, additional three papers were obtained by hand-searching. Finally, 33 full papers were included in the present study. These data are shown in Table I. Cohen’s kappa for inter-reviewer agreement was 0.45. From 33 papers, 896 cases of sphenopalatine ligation and cauterization for epistaxis were analyzed. The years of publication for these articles ranged from 1,955 to 2,017. Among 33 studies, only three articles were prospective. Nine studies showed the treatment result of ligation; 17 studies showed the results of cauterization; and four studies showed the results of ligation and cauterization. MINORS score ranged from 3 to 19, which indicated that the quality of included studies varied widely among studies.

**Rebleeding Rate**

Figure 2 shows the results of total rebleeding rate analysis. The total rebleeding rate ranged up to 48%. The pooled total rebleeding rate for sphenopalatine surgery was 13.4% (95% confidence interval [CI], 10.0%–17.8%).

Next, we investigated the rebleeding events that required some type of treatment. The rebleeding rate for selected treatments in included studies ranged from 0% to 30%.
TABLE 1  
Summary of studies (SPA surgery for idiopathic epistaxis).  

<table>
<thead>
<tr>
<th>Year of public</th>
<th>First author</th>
<th>Country</th>
<th>Study Design</th>
<th>No. of patients</th>
<th>Age</th>
<th>Vessel</th>
<th>Method</th>
<th>Anticoagulant drug</th>
<th>HT</th>
<th>MINORS score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1955</td>
<td>Sihelblatt</td>
<td>USA</td>
<td>Retrospective</td>
<td>10</td>
<td>48</td>
<td>SPA</td>
<td>Ligation</td>
<td>0%</td>
<td>20</td>
<td>7</td>
</tr>
<tr>
<td>1987</td>
<td>Sulsenti</td>
<td>Italy</td>
<td>Retrospective</td>
<td>17</td>
<td>60</td>
<td>SPA</td>
<td>Ligation</td>
<td>47%</td>
<td>23</td>
<td>3</td>
</tr>
<tr>
<td>1997</td>
<td>Sharp</td>
<td>UK</td>
<td>Retrospective</td>
<td>10</td>
<td>54</td>
<td>SPA</td>
<td>Ligation</td>
<td>3%</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>1997</td>
<td>Snyderman</td>
<td>USA</td>
<td>Retrospective</td>
<td>38</td>
<td>SPA</td>
<td>SPA</td>
<td>Ligation</td>
<td>8%</td>
<td>50</td>
<td>7</td>
</tr>
<tr>
<td>2000</td>
<td>Bhaskar</td>
<td>UK</td>
<td>Retrospective</td>
<td>6</td>
<td>60</td>
<td>SPA</td>
<td>Ligation</td>
<td>7</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>2000</td>
<td>Flynn</td>
<td>US</td>
<td>Retrospective</td>
<td>12</td>
<td>65</td>
<td>SPA</td>
<td>Ligation</td>
<td>5%</td>
<td>50</td>
<td>7</td>
</tr>
<tr>
<td>2000</td>
<td>Srnrivasan</td>
<td>UK</td>
<td>Retrospective</td>
<td>10</td>
<td>62</td>
<td>SPA</td>
<td>Ligation</td>
<td>15%</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>2000</td>
<td>Wormald</td>
<td>Australia</td>
<td>Retrospective</td>
<td>13</td>
<td>56</td>
<td>SPA</td>
<td>Ligation</td>
<td>61%</td>
<td>61</td>
<td>10</td>
</tr>
<tr>
<td>2001</td>
<td>Louis</td>
<td>Brazil</td>
<td>Retrospective</td>
<td>11</td>
<td>43</td>
<td>SPA</td>
<td>Ligation</td>
<td>36%</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>2002</td>
<td>Klotz</td>
<td>USA</td>
<td>Retrospective</td>
<td>9</td>
<td>SPA</td>
<td>SPA</td>
<td>Ligation</td>
<td>15%</td>
<td>15</td>
<td>7</td>
</tr>
<tr>
<td>2002</td>
<td>Rocked</td>
<td>UK</td>
<td>Retrospective</td>
<td>10</td>
<td>67</td>
<td>SPA</td>
<td>Ligation</td>
<td>78%</td>
<td>10</td>
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</tr>
<tr>
<td>2003</td>
<td>Holzmann</td>
<td>Switzerland</td>
<td>Retrospective</td>
<td>95</td>
<td>62</td>
<td>SPA</td>
<td>Cauterization</td>
<td>17%</td>
<td>17</td>
<td>7</td>
</tr>
<tr>
<td>2005</td>
<td>Umapathy</td>
<td>UK</td>
<td>Retrospective</td>
<td>41</td>
<td>61</td>
<td>SPA</td>
<td>Ligation</td>
<td>22%</td>
<td>17</td>
<td>19</td>
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<tr>
<td>2007</td>
<td>Ardelkader</td>
<td>UK</td>
<td>Prospective</td>
<td>43</td>
<td>69</td>
<td>SPA</td>
<td>Ligation</td>
<td>30%</td>
<td>12</td>
<td>11</td>
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<tr>
<td>2007</td>
<td>Nouraei</td>
<td>UK</td>
<td>Retrospective</td>
<td>67</td>
<td>56</td>
<td>SPA</td>
<td>Ligation</td>
<td>30%</td>
<td>30</td>
<td>11</td>
</tr>
<tr>
<td>2008</td>
<td>Harvinder</td>
<td>Malaysia</td>
<td>Retrospective</td>
<td>8</td>
<td>52</td>
<td>SPA</td>
<td>Ligation</td>
<td>50%</td>
<td>7</td>
<td>7</td>
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<tr>
<td>2009</td>
<td>Asanau</td>
<td>France</td>
<td>Retrospective</td>
<td>45</td>
<td>71</td>
<td>SPA</td>
<td>Ligation</td>
<td>76%</td>
<td>60</td>
<td>18</td>
</tr>
<tr>
<td>2009</td>
<td>Seno</td>
<td>Japan</td>
<td>Retrospective</td>
<td>11</td>
<td>SPA</td>
<td>SPA</td>
<td>Ligation</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>2010</td>
<td>Minni</td>
<td>Italy</td>
<td>Retrospective</td>
<td>42</td>
<td>59</td>
<td>SPA</td>
<td>Cauterization</td>
<td>43%</td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>2011</td>
<td>Beatrix</td>
<td>Spain</td>
<td>Retrospective</td>
<td>50</td>
<td>61</td>
<td>SPA</td>
<td>Ligation</td>
<td>60%</td>
<td>56</td>
<td>7</td>
</tr>
<tr>
<td>2011</td>
<td>Eladi</td>
<td>Egypt</td>
<td>Prospective</td>
<td>42</td>
<td>51</td>
<td>SPA</td>
<td>Ligation</td>
<td>67%</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>2012</td>
<td>Geroge</td>
<td>UK</td>
<td>Retrospective</td>
<td>22</td>
<td>64</td>
<td>SPA</td>
<td>Ligation</td>
<td>10</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>2013</td>
<td>Gandomi</td>
<td>Iran</td>
<td>Prospective</td>
<td>27</td>
<td>45</td>
<td>SPA</td>
<td>Ligation</td>
<td>12</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>2013</td>
<td>Gede</td>
<td>Denmark</td>
<td>Retrospective</td>
<td>42</td>
<td>61</td>
<td>SPA</td>
<td>Ligation</td>
<td>13%</td>
<td>25</td>
<td>10</td>
</tr>
<tr>
<td>2013</td>
<td>Lakhar</td>
<td>UK</td>
<td>Retrospective</td>
<td>27</td>
<td>60</td>
<td>SPA</td>
<td>Ligation</td>
<td>17%</td>
<td>17</td>
<td>7</td>
</tr>
<tr>
<td>2013</td>
<td>Mohammad</td>
<td>Iran</td>
<td>Retrospective</td>
<td>11</td>
<td>SPA</td>
<td>SPA</td>
<td>Ligation</td>
<td>19</td>
<td>19</td>
<td>19</td>
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<tr>
<td>2014</td>
<td>Shrestha</td>
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<td>Retrospective</td>
<td>12</td>
<td>36</td>
<td>SPA</td>
<td>Cauterization</td>
<td>3</td>
<td>3</td>
<td>3</td>
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<tr>
<td>2015</td>
<td>Millidli</td>
<td>Turkey</td>
<td>Retrospective</td>
<td>37</td>
<td>42</td>
<td>SPA</td>
<td>Cauterization</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>2015</td>
<td>Yung</td>
<td>UK</td>
<td>Retrospective</td>
<td>21</td>
<td>71</td>
<td>SPA</td>
<td>Ligation</td>
<td>48.5%</td>
<td>48</td>
<td>15</td>
</tr>
<tr>
<td>2016</td>
<td>Mcdermot</td>
<td>Ireland</td>
<td>Retrospective</td>
<td>45</td>
<td>62</td>
<td>SPA</td>
<td>Ligation</td>
<td>40%</td>
<td>40</td>
<td>3</td>
</tr>
<tr>
<td>2016</td>
<td>Odat</td>
<td>Jordan</td>
<td>Retrospective</td>
<td>15</td>
<td>45</td>
<td>SPA</td>
<td>Ligation</td>
<td>20%</td>
<td>40</td>
<td>9</td>
</tr>
<tr>
<td>2017</td>
<td>Dutta</td>
<td>India</td>
<td>Retrospective</td>
<td>38</td>
<td>SPA</td>
<td>SPA</td>
<td>Ligation</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
</tbody>
</table>

Abbreviations: SPA, sphenopalatine artery. AEA, anterior ethmoid artery; MINORS, methodological index for non-randomized studies.

TABLE 2  
Comparison between cauterization and ligation groups.  

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>No. of studies</th>
<th>No. of patients</th>
<th>Event Rate (95% CI)</th>
<th>p -value for event rate</th>
<th>Q-value</th>
<th>p -value (heterogeneity)</th>
<th>I² (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total rebleeding</td>
<td>5.66</td>
<td>0.017</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cauterization</td>
<td>0.072</td>
<td>0.046-0.110</td>
<td>3.35</td>
<td>0.910</td>
<td>0.004</td>
<td>54.4</td>
<td></td>
</tr>
<tr>
<td>Ligation</td>
<td>0.151</td>
<td>0.098-0.225</td>
<td>3.50</td>
<td>0.899</td>
<td>0.059</td>
<td>53.0</td>
<td></td>
</tr>
<tr>
<td>Rebleeding rate for treatment</td>
<td>2.54</td>
<td>0.111</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cauterization</td>
<td>0.068</td>
<td>0.043-0.106</td>
<td>3.50</td>
<td>0.899</td>
<td>0.059</td>
<td>53.0</td>
<td></td>
</tr>
<tr>
<td>Ligation</td>
<td>0.107</td>
<td>0.077-0.146</td>
<td>8.79</td>
<td>0.888</td>
<td>0.059</td>
<td>53.0</td>
<td></td>
</tr>
<tr>
<td>Complication rate</td>
<td>0.32</td>
<td>0.567</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cauterization</td>
<td>0.102</td>
<td>0.038-0.245</td>
<td>10.00</td>
<td>0.040</td>
<td>60.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ligation</td>
<td>0.064</td>
<td>0.018-0.209</td>
<td>10.65</td>
<td>0.059</td>
<td>53.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abbreviation: CI, confidence interval.
Perioperative Complication Rate

Among the 31 enrolled studies, 14 studies reported complication rates, which ranged from 0% to 27%. The pooled perioperative complication rate was 8.7% (95% CI, 4.9–15.1). The most frequent complication was nasal crusting, which occurred in either 21%10 or 8%.9 The second most frequent complication was acute sinusitis and nasal dryness: acute sinusitis occurred in 10%9 and severe nasal dryness occurred in 10%.32 Complications and surgical procedures were not systematically related.

Comparison Between Cauterization and Ligation Groups

Sphenopalatine artery surgery is mainly divided into cauterization and ligation methods. These were compared by using a subgroup analysis (Table II) (Supporting Fig. S1). The pooled total rebleeding rates in cauterization and ligation groups were 7.2% (95% CI, 4.6–11.0) and 15.1% (95% CI, 9.8–22.5), respectively. There was a significant difference between the groups ($P = 0.017$). Next, we investigated the difference in rebleeding rates for selected treatments. The pooled rebleeding rates for

![Fig. 2. Forest plots showing total rebleeding rate. The squares represent event rates for each study. The sizes of squares and the horizontal lines crossing the squares represent the weight of the study in the meta-analysis and the 95% CIs, respectively. CI = confidence interval.](image1)

![Fig. 3. Funnel plot of total rebleeding rate.](image2)
selected treatments in cauterization and ligation groups were 6.8% (95% CI, 4.3–10.6) and 10.7% (95% CI, 7.7–14.6), respectively. There was not a significant difference between the groups (P = 0.111). The pooled complication rate in the cauterization group was 10.2% (95% CI, 3.8–21.4), whereas the rate in the ligation group was 6.4% (95% CI, 1.8–20.9). There was no significant difference between the groups (P = 0.567).

Publication Bias

Figure 3 shows funnel plots for total rebleeding rate. The funnel plot shows an apparent asymmetry, which indicates that small studies reporting high rebleeding rates were fewer than expected, thus representing publication bias. Egger’s test of the intercept for total rebleeding and rebleeding for selected treatments yielded P values <0.001. Supporting Figure S2 shows the sensitivity analysis for the total rebleeding rate and rebleeding for selected treatments. No single study affected the overall results.

DISCUSSION

In some cases of posterior epistaxis for which the source of bleeding is not visible, the bleeding point cannot be cauterized. In those cases, ligation or cauterization of the sphenopalatine artery is an alternative option. Furthermore, these surgical procedures are effective for controlling epistaxis because of the high success rate and low complication rate. Although endoscopic sinus surgery can cause orbital or intracranial complications, endoscopic intranasal sphenopalatine ligation rarely does.

In the present study, we evaluated surgical failure rate among sphenopalatine ligation versus cauterization for epistaxis. The pooled total rebleeding rate of cauterization was 7.2% (95% CI 4.6–11). Conversely, the rate in ligation procedures was 15.1% (95% CI, 9.8–22.5). These data suggest that cauterization may be more favorable than ligation. No previous study showed superiority of either procedure; thus, the choice of ligation or cauterization has been largely based on the operator’s preference. Surgical artery ligation enables preservation of the artery by using a clip, which can risk dislocation of the clip over time; this could cause rebleeding after surgery. The details of ligation procedures were not clearly stated in all the included studies. Most of the included studies performed ligation or cauterization, Nouraei et al.14 and Ardelkader et al.31 performed ligation after cauterization of the artery. This method is listed as ligation and cauterization in Table I.

Another cause of failure after surgery is anatomical variation. Most sphenopalatine arteries exhibit a single branch; in some patients, there are two or more branches.38 If SPA surgery is performed in only one branch, nasal bleeding occasionally arises from other branches in patients who exhibit several SPA branches. This anatomical variation may lead to treatment failure. Variations and patterns of SPA were as follows: single branch, 36%–83%; double branch, 17%–44%; three or more branches, 0%–20%.2,9,21,24

Alternative methods of arterial surgical intervention comprise ligation of the external carotid or maxillary arteries.5 External carotid artery ligation requires neck incision and can damage the hypoglossal or vagus nerves. Transantral maxillary arterial surgery requires canine tooth fossa incision and may cause cheek pain or discomfort. Occasionally, it may cause oroantral fistula. More importantly, both methods have poor success rates. Embolization is an effective method for treating refractory epistaxis, which requires the involvement of an expert interventional radiologist. It may cause major complications, such as blindness and soft tissue ischemia.39 There is a risk of systemic complications, including inhalation hypoxia, hypovolemia, angina, and myocardial infarction.8 However, recent advances in techniques and surgical devices have led to fewer complications, as well as enhanced success rates (71%–94%).7,39,40 An advantage of embolization is the detection of variations in vascular anatomy; further, multiple arteries can be occluded. Notably, embolization can be performed under local anesthesia.

There were several limitations in our study. Some studies included data of other hemostatic methods, such as embolization or surgery of the anterior ethmoid or internal maxillary arteries. We excluded these cases; thus, the number of patients was reduced, resulting in lowered statistical power. We searched and analyzed failure or success rates in this study. Furthermore, our primary intention was to search and analyze comorbidities (e.g., hypertension, chronic heart disease, liver disease, or blood disorder), as well as hospital stay duration, cost-effectiveness, and rates of transfusion. However, because of the limited number of studies that included these data, we were not able to analyze them.

CONCLUSION

Both cauterization and ligation of the sphenopalatine artery are effective methods for treatment of recurrent or refractory epistaxis because they involve low rates of failure and complications. When the two methods were compared, cauterization showed a significantly lower failure rate than ligation. Thus, cauterization of the sphenopalatine artery is regarded as a more favorable method for treating refractory epistaxis, compared with ligation. Further research regarding the effectiveness of embolization, as well as cost-effectiveness of ligation or cauterization of the sphenopalatine artery (preferably within a randomized controlled trial), is required.

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