Comparing Hematoma Incidence between Hemostatic Devices in Total Thyroidectomy: A Systematic Review and Meta-analysis

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Abstract

Objective. Alternative energy devices have become a popular alternative to conventional hemostasis in thyroid surgery. These devices have been shown to reduce operative time and thermal nerve injury. As hemostasis is paramount in thyroid surgery, we sought to examine the relative efficacy of 2 alternate energy devices compared to conventional hemostasis in preventing postoperative hematoma following total thyroidectomy.

Data Sources. Ovid MEDLINE, EMBASE, PubMed, and Cochrane Central Register of Controlled Trials.

Review Methods. A systematic literature search was performed for all relevant English-language studies published between 1946 and July 2018. Two authors independently extracted data and analyzed articles for quality using the National Institute of Health Quality Assessment Scale. Our primary outcome of interest was hematoma requiring reoperation.

Results. A total of 348 studies were screened, with 23 meeting the inclusion criteria. We found no significant difference in postoperative hematoma rates using alternate energy devices compared to conventional hemostasis (P = .370, .317). Network meta-analysis echoed the results of conventional meta-analysis, demonstrating no significant difference in hematoma rates.

Conclusions. We found no significant difference in postoperative hematoma rates following total thyroidectomy for any indication with the use of alternate energy devices compared to conventional hemostatic techniques. This suggests that hematoma occurrence does not necessarily need to be considered when choosing between these hemostatic devices. This information may help guide surgeons’ decisions regarding choice of hemostatic technique during thyroid surgery.

Keywords

total thyroidectomy, thyroid surgery, hematoma, hemostasis, harmonic scalpel, LigaSure, conventional hemostasis, ultrasonic scalpel

Hematoma is a relatively uncommon but feared complication of total thyroidectomy. The thyroid gland is highly vascularized, and postoperative bleeding leading to neck hematoma can result in rapid airway compression or obstruction, which may be life-threatening. Effective intraoperative hemostasis is therefore paramount and an important goal of thyroid surgery.

Many options are available for intraoperative hemostasis. Conventional hemostatic techniques include the use of conventional bipolar and monopolar cautery, “clamp-and-tie” or vascular ligations, and the use of hemostatic clips. These conventional techniques are often considered the gold standards for intraoperative hemostasis. More recently developed hemostatic techniques that have demonstrated high efficacy are the use of “alternative energy devices” such as radiofrequency or ultrasound. Radiofrequency and ultrasonic vessel sealing devices have been shown to reduce operative time and a variety of postoperative complications, such as thermal nerve injury during thyroidectomy.

The primary objective of our study was to determine if the rates of postoperative hematoma following total thyroidectomy differ with the use of conventional hemostasis compared to alternative energy devices.

Methods

A systematic review of the literature based on the Cochrane Handbook and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines was performed.

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Eligibility Criteria and Study Selection

Study inclusion and exclusion criteria were defined using the Population, Intervention, Comparison, Outcome (PICO) guidelines. All English-language studies published in peer-reviewed journals from 1946 to July 2018 were considered for inclusion. To be included, studies must have been randomized control trials (RCTs) that compared hematoma rates in at least 2 of the following: conventional hemostatic technique (CH), Harmonic Scalpel (HS; Ethicon, Somerville, New Jersey), or LigaSure (LS; Covidien, Mansfield, Massachusetts) following total thyroidectomy for any indication. Studies were excluded if the population included hemi, partial, or subtotal thyroidectomy or if concomitant central or lateral compartment lymph node dissection was performed. Case reports, cohort studies, and case-control studies were also excluded.

Information Sources and Search Strategy

A literature search was conducted using the following electronic databases: Ovid MEDLINE, EMBASE, PubMed, and the Cochrane Central Register of Controlled Trials. Our electronic search was augmented by a hand search of references from all systematic reviews and meta-analyses yielded from the initial literature search. Our detailed search strategy can be found in Appendix 1 in the online version of the article.

Data Collection and Extraction

Two reviewers (N.H., A.E.Q.) independently reviewed titles and abstracts to assess for initial relevance. Abstracts deemed relevant based on our predefined inclusion and exclusion criteria were selected for full-text review. Full-text articles were independently obtained and reviewed by both reviewers to determine if they met eligibility criteria; those that met criteria were included in our study. Disagreements regarding article selection were resolved by consensus meetings among all 3 authors (N.H., A.E.Q., S.J.-O.). Data extraction was completed in duplicate by 2 reviewers (N.H., A.E.Q.). Extracted data included baseline clinical variables as well as exposure and outcome measures. Disagreements with regard to data extraction and resolved by consensus among all 3 authors.

Outcome Measures and Data Items

The primary outcome measure was incidence of postoperative hematoma, defined as postoperative bleeding requiring reoperation. Studies that only reported on hematomas resolving spontaneously or by conservative (nonoperative) treatment were excluded from our analysis. If the definition of hematoma was not explicitly stated, the study was included in our analysis on the assumption that these were significant events requiring reoperation.

Baseline variables collected included study design, indication for surgery, hemostatic method used (LS, HS, CH), method of CH used if applicable (eg, electrocautery, vessel ligation, clips, or a combination of these), and whether or not drains were used.

Risk of Bias in Individual Studies

Because our primary outcome of interest was dichotomous in nature (ie, did hematoma requiring reintervention occur, yes or no), there was minimal risk of reporting bias in our included studies. In addition, we had strict inclusion criteria in which the definition of hematoma required return to the operating room in order to limit heterogeneity in the severity of hematoma.

The quality of included studies was assessed using the National Institutes of Health (NIH) Quality assessment tool for controlled intervention studies (Supplemental Tables S1-S3, available in the online version of the article).11

Statistical Analysis

Both traditional pairwise meta-analysis and network meta-analysis were performed to compare hematoma rates between interventions. A random-effects model was used for pairwise meta-analysis. Statistical heterogeneity was estimated using the inconsistency index ($I^2$) and $Q$ statistics. The relative risk (RR) was chosen as our pooled outcome measure. Network meta-analysis was performed using the methods described by White et al12 and Higgins et al.13 The assumption of consistency in network meta-analysis was formally tested using a fixed-effects test. A $P$ value of less than .05 was set as the cutoff for statistical significance. All statistics were performed using STATA software, version 15 (StataCorp, College Station, Texas).

Risk of Bias across Studies

The possibility of publication and selective reporting biases were assessed using funnel plots and Egger’s tests of asymmetry. Significance was determined using a 1-tailed $P$ value. If the intercept differed significantly from 0, it was deemed that significant publication bias was detected.

Results

Study Selection

A total of 348 studies were screened based on title and abstract, and 133 articles met eligibility for full-text review based on initial screen by inclusion and exclusion criteria. A hand search resulted in an additional 6 articles for full-text review. After full-text review, 23 articles met all inclusion/exclusion criteria and were eligible for inclusion in the final analysis (see Figure 1).

Study Characteristics

The total number of patients who underwent total thyroidectomy in our 23 included studies was 5408. Of these, 2445 were operated on with HS, 942 with LS, and 2021 with CH. Indications for operation included malignancy and benign conditions such as multinodular goiter, but no patient underwent concomitant central or lateral compartment lymph node dissection. A summary of study characteristics and collected baseline patient variables can be found in Tables 1 and 2, respectively.6,8,9,14-33
Quality Assessment

Study quality was considered to be “moderate” overall based on the NIH quality assessment tool for RCTs. The major source of bias was inadequate reporting of blinding of outcomes. For example, 87% of RCTs did not report whether or not investigators were blind to hemostatic technique when assessing outcomes. Other biases included lack of reporting of whether intention-to-treat analysis was performed, with only 13% of RCTs reporting this information. There was no evidence of selective reporting in any of our included studies. All studies had complete data on our outcome of interest (postoperative hematoma). See Supplemental Tables S1 to S3 (available in the online version of the article) for details on quality assessment.

Conventional Meta-analysis

Thirteen studies directly compared hematoma outcomes between CH and HS. Pairwise meta-analysis using a random-effects model revealed no significant difference in the incidence of postoperative hematoma between CH and HS (pooled RR = 0.607; 95% confidence interval [CI], 0.269-1.370; \( P = .370 \)). The \( I^2 \) statistic demonstrated that there was no significant heterogeneity among included studies (\( I^2 = 0.0\% \); \( Q = 3.13 \), \( P = .926 \)) (see Figure 2).

Three studies directly compared hematoma outcomes between CH and LS. Pair-wise meta-analysis using a random effects model revealed no significant difference in the incidence of postoperative hematoma between CH and LS (pooled RR = 2.642, 95% CI [0.394 - 17.710], \( P = .317 \)). The \( I^2 \) statistic demonstrated that there was no significant heterogeneity among included studies (\( I^2 = 0.0\% \); \( Q = 0.14 \), \( P = .704 \)) (see Figure 3).

Five studies directly compared hematoma outcomes between HS and LS. Pairwise meta-analysis using a random-effects model revealed no significant difference in the incidence of postoperative hematoma between HS and LS (pooled RR = 1.664; 95% CI, 0.206-13.419; \( P = .633 \)). The \( I^2 \) statistic demonstrated that there was no significant heterogeneity among included studies (\( I^2 = 0.0\% \); \( Q = 0.23 \), \( P = .632 \)) (see Figure 4).

Network Meta-analysis

Network meta-analysis was conducted on all 23 included studies. There were 2 studies directly comparing all 3 hemostatic techniques, 13 studies comparing HS to CH, 5 studies comparing HS to LS, and 3 studies comparing LS to CH. The results from the multivariable network meta-analysis echoed those from the conventional pairwise meta-analysis. That is, there was no significant difference in hematoma rates when comparing HS and CH (RR = 0.657; 95% CI, 0.322-1.341; \( P = .249 \)), LS and CH (RR = 0.890; 95% CI, 0.289-2.742; \( P = .840 \)), and HS and LS groups (RR = 0.738; 95% CI, 0.245-2.225; \( P = .590 \)). A test for consistency using a fixed-effect test revealed that there was no significant evidence of inconsistency (\( P = .2823 \)) (see Figure 5).
devices.8,9

demonstrated similar safety and efficacy between the 2
been directly compared in a variety of studies, which have
variety of postoperative complications.34 However, few sys-
tmetic reviews and meta-analyses have compared hema-
toma outcomes across the 3 modalities.

Discussion

Postoperative hematoma is a potentially life-threatening
complication of thyroidectomy and can be mitigated by
meticulous intraoperative hemostasis. Alternative energy
devices have recently gained popularity for use during thyr-
roidectomy, with promise to reduce operative time and a
magnificent intraoperative hemostasis. Alternative energy
devices have recently gained popularity for use during thyr-

doctrine hemostasis. We have performed both pairwise
meta-analysis and network meta-analysis of 23 total studies,
both of which demonstrate no difference in hematoma rates
across the 3 studied techniques. Quality assessment of indi-

tic reviews and meta-analyses have compared hema-
toma outcomes across the 3 modalities.

Risk of Bias in Individual Studies

Our primary outcome measure was dichotomous (ie, “Did
postoperative bleeding requiring intervention occur, yes or no?”), minimizing the risk of reporting bias and information bias in our included studies. Seven studies (30%) did not specify a definition for hematoma or postoperative hemorrhage; however, in 4 of these, no hematoma occurred.

Table 1. Included Study Baseline Variables.6,8,9,14,33

<table>
<thead>
<tr>
<th>Study Name</th>
<th>Year</th>
<th>Total No.</th>
<th>HS, No.</th>
<th>LS, No.</th>
<th>CH, No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arslan et al14</td>
<td>2018</td>
<td>206</td>
<td>101</td>
<td>0</td>
<td>105</td>
</tr>
<tr>
<td>Askar et al15</td>
<td>2011</td>
<td>130</td>
<td>65</td>
<td>0</td>
<td>65</td>
</tr>
<tr>
<td>Bircan et al16</td>
<td>2014</td>
<td>54</td>
<td>0</td>
<td>32</td>
<td>22</td>
</tr>
<tr>
<td>Ciftci et al17</td>
<td>2016</td>
<td>201</td>
<td>97</td>
<td>104</td>
<td>0</td>
</tr>
<tr>
<td>Coiro et al18</td>
<td>2015</td>
<td>190</td>
<td>0</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td>Dioni et al19</td>
<td>2012</td>
<td>182</td>
<td>92</td>
<td>90</td>
<td>0</td>
</tr>
<tr>
<td>Docimo et al20</td>
<td>2012</td>
<td>200</td>
<td>100</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Duan et al21</td>
<td>2013</td>
<td>778</td>
<td>389</td>
<td>0</td>
<td>389</td>
</tr>
<tr>
<td>Gentileschi et al22</td>
<td>2017</td>
<td>81</td>
<td>43</td>
<td>0</td>
<td>38</td>
</tr>
<tr>
<td>Karaca13</td>
<td>2015</td>
<td>929</td>
<td>468</td>
<td>0</td>
<td>461</td>
</tr>
<tr>
<td>Konturek et al24</td>
<td>2012</td>
<td>82</td>
<td>41</td>
<td>0</td>
<td>41</td>
</tr>
<tr>
<td>Lombardi et al25</td>
<td>2008</td>
<td>200</td>
<td>100</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Materazzi et al26</td>
<td>2013</td>
<td>268</td>
<td>141</td>
<td>0</td>
<td>127</td>
</tr>
<tr>
<td>Minni et al27</td>
<td>2016</td>
<td>361</td>
<td>174</td>
<td>0</td>
<td>187</td>
</tr>
<tr>
<td>Mourad et al28</td>
<td>2011</td>
<td>68</td>
<td>34</td>
<td>0</td>
<td>34</td>
</tr>
<tr>
<td>Papavramidis et al29</td>
<td>2010</td>
<td>90</td>
<td>45</td>
<td>0</td>
<td>45</td>
</tr>
<tr>
<td>Pons et al9</td>
<td>2009</td>
<td>60</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Ruggiero et al8</td>
<td>2014</td>
<td>400</td>
<td>200</td>
<td>200</td>
<td>0</td>
</tr>
<tr>
<td>Ruggiero et al6</td>
<td>2018</td>
<td>250</td>
<td>125</td>
<td>125</td>
<td>0</td>
</tr>
<tr>
<td>Saint Marc et al20</td>
<td>2007</td>
<td>200</td>
<td>0</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Sartori et al31</td>
<td>2008</td>
<td>150</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Teksoz et al32</td>
<td>2013</td>
<td>245</td>
<td>119</td>
<td>126</td>
<td>0</td>
</tr>
<tr>
<td>Zanghi et al33</td>
<td>2014</td>
<td>83</td>
<td>41</td>
<td>0</td>
<td>42</td>
</tr>
</tbody>
</table>

Abbreviations: CH, conventional hemostasis; HS, Harmonic Scalpel; LS = Ligasure.

The results of our study demonstrate that, among patients undergoing total thyroidectomy for any indication, there is no difference in the incidence of postoperative hematoma when using alternative energy techniques compared to conventional hemostasis. We have performed both pairwise meta-analysis and network meta-analysis of 23 total studies, both of which demonstrate no difference in hematoma rates across the 3 studied techniques. Quality assessment of individual articles included in our analysis demonstrated moderate overall quality.

In 2017, Luo et al4 performed the first systematic review and meta-analysis comparing outcomes after thyroidectomy using these energy devices. Their study’s primary outcome of interest was operative time, assessed across 47 studies. Hematoma was assessed as a secondary outcome of interest (among others) in 14 RCTs. The authors found no significant difference in hematoma occurrence among the 3 techniques, using pairwise meta-analysis.8 Another recent study by Contin et al35 also used pairwise meta-analysis of 16 total studies assessing hematoma as a secondary outcome. They also found no significant differences in rates of hematoma formation among the 3 hemostatic techniques.

Our study is the first to examine hematoma rates following thyroidectomy with the use of CH, HS, and LS devices as the primary outcome of interest. It augments the results of prior studies by Luo et al8 and Contin et al35 by combining the results of a greater number of studies through the use of both pairwise and network meta-analysis. In the present study, we have restricted our analysis to total thyroidectomy procedures only, compared to prior studies that pooled hematoma rates following both total and hemithyroidectomies.4,35 In doing so, we have reduced heterogeneity across interventions, thus improving the internal validity of our results. Our results have been consistent with the findings of previous studies, thereby adding strength to the body of literature citing that there is no difference in hematoma rates between CH, HS, and LS techniques.

Our study had several limitations. First, we imposed a clear definition of hematoma as “postoperative bleeding requiring intervention/return to the operating room.” We therefore did not include studies that reported on “hematomas resolved spontaneously/by conservative management.” As such, our analysis may be underestimating the rates of all “hematoma” overall across groups. Second, 7 (30%) included studies did not specify a description of hematoma, so were assumed to meet our study definition of requiring reoperation. However, 4 of these 7 studies (57%) found zero incidence of hematoma across all groups, thereby minimizing the magnitude of potential overestimation through inclusion of these studies. Third, our inclusion was limited to English-language studies. Fourth, our study population was heterogeneous with regard to thyroid pathologies undergoing operation, and therefore we cannot delineate based on the present study whether certain pathologies were associated with increased hematoma using certain devices. However, a previous systematic review and meta-analysis completed by our group demonstrated Graves’ disease to be
### Table 2. Included Patient Baseline Characteristics.\(^{6,8,9,14-33}\)

<table>
<thead>
<tr>
<th>Study Name</th>
<th>All</th>
<th>HS</th>
<th>LS</th>
<th>CH</th>
<th>Age (%)</th>
<th>% Malignant</th>
<th>Surgery Indication</th>
<th>CH Method (if Applicable)</th>
<th>Drains (Y/N)</th>
<th>Abbreviations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arslan et al(^{14})</td>
<td>45 (23-78)</td>
<td>43 (23-78)</td>
<td>—</td>
<td>47 (21-75)</td>
<td>17.5</td>
<td>19.8</td>
<td>15.5</td>
<td>B and M</td>
<td>Y (23% HS, 14% CH)</td>
<td>B, benign; CH, conventional hemostasis; HS, Harmonic Scalpel; LS = LigaSure; M, malignant; NA, not applicable; N, no; Y, yes; —, no information provided.</td>
</tr>
<tr>
<td>Askar et al(^{15})</td>
<td>38.53 ± 12.13 (12-79)</td>
<td>41.81 ± 13.4 (16-79)</td>
<td>—</td>
<td>36.24 ± 12.62 (12-72)</td>
<td>20.8</td>
<td>16.9</td>
<td>24.6</td>
<td>B Knot tying, electrocautery</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Bircan et al(^{16})</td>
<td>—</td>
<td>—</td>
<td>52.5 ± 14.03</td>
<td>56.23 ± 17.34</td>
<td>—</td>
<td>15.6</td>
<td>36.4</td>
<td>B Electrocautery</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Ciftci et al(^{17})</td>
<td>—</td>
<td>—</td>
<td>44.33 ± 18.06</td>
<td>46.24 ± 12.4</td>
<td>16.5</td>
<td>24</td>
<td>—</td>
<td>B NA</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Cointo et al(^{18})</td>
<td>—</td>
<td>—</td>
<td>48.42 ± 10.81</td>
<td>49.27 ± 10.99</td>
<td>16.8</td>
<td>16.8</td>
<td>16.8</td>
<td>B Clamp and tie</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Dionigi et al(^{19})</td>
<td>—</td>
<td>—</td>
<td>40.8 (20-79)</td>
<td>41 (20-83)</td>
<td>20.3</td>
<td>18.5</td>
<td>22.2</td>
<td>B NA</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Doccino et al(^{20})</td>
<td>46 (16-70)</td>
<td>47</td>
<td>—</td>
<td>—</td>
<td>35</td>
<td>30</td>
<td>40</td>
<td>B and M</td>
<td>Clamp and tie</td>
<td>Y</td>
</tr>
<tr>
<td>Duan et al(^{21})</td>
<td>—</td>
<td>—</td>
<td>50.1 ± 19.3</td>
<td>48.5 ± 21.8</td>
<td>15.8</td>
<td>17</td>
<td>14.7</td>
<td>B and M</td>
<td>Suture ligation</td>
<td>Y</td>
</tr>
<tr>
<td>Gentilecchi et al(^{22})</td>
<td>—</td>
<td>49 ± 13</td>
<td>—</td>
<td>48 ± 15</td>
<td>16</td>
<td>20.9</td>
<td>10.5</td>
<td>B and M</td>
<td>Suture ligation</td>
<td>Y</td>
</tr>
<tr>
<td>Karaca(^{23})</td>
<td>—</td>
<td>Mean 47.61 ± 13.68</td>
<td>—</td>
<td>48.41 ± 12.98</td>
<td>12.4</td>
<td>—</td>
<td>—</td>
<td>B Clamp and tie, monopolar cautery</td>
<td>Y (if necessary)</td>
<td></td>
</tr>
<tr>
<td>Konturek et al(^{24})</td>
<td>—</td>
<td>41.1 ± 7.5</td>
<td>—</td>
<td>42 ± 7.5</td>
<td>18.3</td>
<td>17.1</td>
<td>19.5</td>
<td>B Clips, ligation, bipolar cautery</td>
<td>N</td>
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</tr>
<tr>
<td>Lombardi et al(^{25})</td>
<td>—</td>
<td>49.5 ± 14.2 (20-72)</td>
<td>—</td>
<td>52.5 ± 23.4 (25-74)</td>
<td>23.5</td>
<td>25</td>
<td>22</td>
<td>B and M</td>
<td>Suture ligation, electrocautery</td>
<td>Y (98%)</td>
</tr>
<tr>
<td>Materazzi et al(^{26})</td>
<td>—</td>
<td>51.68 ± 12.2</td>
<td>—</td>
<td>53.97 ± 12.5</td>
<td>23.9</td>
<td>20.6</td>
<td>27.6</td>
<td>B Clamp and tie</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Minni et al(^{27})</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>42.1 ± 42</td>
<td>42.2</td>
<td>—</td>
<td>—</td>
<td>B Suture, clips, electrocautery</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Mourad et al(^{28})</td>
<td>—</td>
<td>50 ± 15 (35-65)</td>
<td>—</td>
<td>47 ± 12 (35-69)</td>
<td>23.5</td>
<td>23.5</td>
<td>23.5</td>
<td>B Suture ligation, clips, electrocautery</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Papavramidis et al(^{29})</td>
<td>—</td>
<td>48.78 ± 14.7</td>
<td>—</td>
<td>49.39 ± 11.59</td>
<td>14.4</td>
<td>15.6</td>
<td>13.3</td>
<td>B and M</td>
<td>Clamp and tie</td>
<td>Y</td>
</tr>
<tr>
<td>Pons et al(^{30})</td>
<td>55 ± 11</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>20</td>
<td>—</td>
<td>—</td>
<td>B Clamp and tie, bipolar cautery</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Ruggiero et al(^{31})</td>
<td>46 (16-70)</td>
<td>44</td>
<td>47</td>
<td>—</td>
<td>35</td>
<td>40</td>
<td>30</td>
<td>B and M</td>
<td>NA</td>
<td>Y</td>
</tr>
<tr>
<td>Ruggiero et al(^{32})</td>
<td>48 (16-70)</td>
<td>45</td>
<td>47</td>
<td>—</td>
<td>32</td>
<td>28</td>
<td>36</td>
<td>B and M</td>
<td>NA</td>
<td>Y</td>
</tr>
<tr>
<td>Saint Marc et al(^{33})</td>
<td>—</td>
<td>—</td>
<td>49.5 ± 11.3 (24-76)</td>
<td>54.08 ± 13.2 (18-80)</td>
<td>18</td>
<td>10</td>
<td>26</td>
<td>B Clamp and tie</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>Santori et al(^{34})</td>
<td>—</td>
<td>—</td>
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<td>—</td>
<td>B and M</td>
<td>Suture ligation</td>
<td>Y</td>
</tr>
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<td>Telksiz et al(^{35})</td>
<td>—</td>
<td>48.77 ± 14.21</td>
<td>49.99 ± 12.73</td>
<td>—</td>
<td>22</td>
<td>25.2</td>
<td>19</td>
<td>B and M</td>
<td>NA</td>
<td>Y</td>
</tr>
<tr>
<td>Zangh et al(^{36})</td>
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<td>—</td>
<td>—</td>
<td>B Suture ligation, clips, electrocautery</td>
<td>Y</td>
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</table>
the only thyroid condition to be associated with increased hematoma formation—not malignancy or multinodular goiter. In the present study, 8 of the RCTs included in our analysis included patients with Graves’ disease, but the incidence of Graves’ disease was balanced across intervention groups in each case. We therefore do not have reason to believe that there is evidence for confounding based on indication for thyroidectomy. Similarly, we would anticipate that the potential for confounding by other factors such as bleeding disorders or use of anticoagulation
medications would be negligible due to the randomized nature of studies included herein. Only 4 of 23 included studies explicitly addressed patient coagulation status prior to surgery, and each of these 4 excluded patients with a history of coagulation disorders or who were on anticoagulant medications prior to surgery; however, no study explicitly demonstrated that randomization had succeeded in balancing these potentially confounding variables across intervention groups. A final potential confounder of our findings is that of differing surgeon experience. Of studies included in our analysis, 3 (13%) were single-surgeon studies, 14 (61%) were multisurgeon, and 6 (26%) did not comment on the number of surgeons involved in the study. Only 3 studies (13%) specified the surgeons’ technical experience, either in terms of years of experience (minimum 6 years, maximum >10 years) or total number of surgeries performed (1 study reported >1000 thyroidectomies performed). It is therefore conceivably possible that variations in hematoma rates observed across the 3 devices may be due at least in part to surgeon experience; however, we believe that the robust nature of our data (5408 total thyroidectomies across 23 RCTs) lends strength to the overall external generalizability of our results.

Finally, given the lack of significance of our findings, a post hoc power calculation was conducted to assess our ability to detect true differences in hematoma rates with use of each of the 3 hemostatic methods, if such differences exist. Based on mean hematoma rates in our study cohort of 2.6%, 0.4%, and 1.0% for HS, LS, and CH, respectively, to achieve 80% power to detect a difference in hematoma rates, if one exists, we would require 2166 patients to detect a difference between HS and CH, 6060 patients to detect a difference between LS and CH, and 958 to detect a difference between HS and LS. Therefore, our current study may be slightly underpowered to detect a true difference in hematoma rates between LigaSure and conventional hemostasis, if one exists. Given that we have systematically reviewed the literature to identify all RCTs that compare hematoma rates among these 3 hemostatic devices, further randomized trials and meta-analysis would be required to achieve such a sample size to ensure adequate power.

Based on our findings, postoperative hematoma rates following total thyroidectomy appear to be similar regardless of the hemostatic method used. A surgeon’s choice of
hemostatic technique should therefore be weighted more heavily on other important metrics such as operative time, intraoperative bleeding, postoperative pain, and other postoperative complications such as hypocalcemia or recurrent laryngeal nerve palsy. Surgeon preference and comfort should also be prioritized in choosing a technique, as is supported in the literature.\(^3\)\(^9\)

**Conclusion**

Our study adds to the current body of literature demonstrating that there is no significant difference in postthyroidectomy hematoma rates with the use of alternative energy devices compared to conventional hemostasis. This information suggests that hematoma outcomes do not need to be considered when selecting a hemostatic technique in thyroid surgery.

**Author Contributions**

Nadia Hua, article selection, data extraction, quality assessment, manuscript writing; Alexandra Elizabeth Quimby, article selection, data extraction, quality assessment, statistical analysis, manuscript writing; Stephanie Johnson-Obaseki, design, article selection, manuscript writing.

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**Supplemental Material**

Additional supporting information is available in the online version of the article.

**References**


