REVIEW ARTICLE

Prospective Clinical Trials of Thyroidectomy With LigaSure vs Conventional Vessel Ligation

A Systematic Review and Meta-analysis

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Objective: To evaluate the hemostatic effects and safety of thyroidectomy performed using the LigaSure vessel-sealing device (Valleylab, Boulder, Colorado) or the conventional vessel ligation.

Data Sources: The MEDLINE, EMBASE, Elsevier, SpringerLink, Ovid, and Cochrane Library electronic databases as well as the LigaSure manufacturer's Web site were searched for studies published between 1996 and 2008. No language restrictions were applied.

Study Selection: Prospective, controlled clinical trials, both randomized and nonrandomized, comparing the hemostatic effects and safety of thyroidectomy using LigaSure and conventional vessel ligation were selected.

Data Extraction: Data regarding operative parameters, duration of the operation, amount of intraoperative blood loss, length of hospital stay, and any postoperative complications were entered and analyzed using dedicated software from the Cochrane Collaboration.

Data Synthesis: Four randomized and 5 nonrandomized trials that met selection criteria reported data from 927 patients, of whom 467 (50.4%) underwent LigaSure and 460 (49.6%) underwent conventional thyroidectomy. Operative duration (weighted mean difference [WMD], –11.97 minutes; 95% confidence interval [CI], –16.42 to –7.53 minutes) was significantly reduced with LigaSure thyroidectomy ($P < .001$). When LigaSure was used, operative time reductions of 20.32 minutes (95% CI, –33.86 to –6.79 minutes) for total thyroidectomy ($P = .003$) and 21.74 minutes (–38.32 to –5.16 minutes) for subtotal thyroidectomy ($P = .01$) were also confirmed with subgroup analysis. However, differences in the amount of intraoperative blood loss (WMD, –25.13 mL; 95% CI, –68.45 to 18.18 mL; $P = .26$), length of hospital stay (WMD, –0.08 days; 95% CI, –0.23 to 0.08 days; $P = .31$), and postoperative complication rates (odds ratio, 0.91; 95% CI, 0.61-1.04; $P = .65$) were not statistically significant for LigaSure vs conventional thyroidectomy.

Conclusions: The LigaSure technique may provide a safe, effective, and fast alternative to conventional vessel ligation in thyroidectomy and may result in a significant reduction in operative duration. However, it may not confer any advantage over conventional thyroidectomy in terms of the amount of intraoperative blood loss, length of hospital stay, and postoperative complication rates.

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THYROIDECTOMY IS ONE OF the most frequently performed operations in general surgery. It involves meticulous devascularization of the thyroid gland, which has one of the richest blood supplies among the organs,

See Invited Critique at end of article

with numerous blood vessels and plexuses entering its parenchyma. Hemostasis is of paramount importance for controlling and dividing various vessels before excision of the gland.[1]

In the late 19th century, thyroidectomy was associated with massive blood loss and a mortality of 50%.[2] Theodor Kocher revolutionized thyroid operations with the introduction of suture ligation of the major arteries, which reduced mortality rates considerably.[2,3] Since that time, several alternative methods, such as electrocautery, the harmonic scalpel, and laser techniques, have been tested and used during thyroid procedures with encouraging results.[4-8] However, suture ligation with bipolar or monopolar electrocoagulation for smaller vessels remains the gold standard for intraoperative hemostasis in thyroid procedures.

The use of electrocoagulation to control bleeding carries a risk of damage to the surrounding structures because of the lateral heat dispersion.[9] The LigaSure vessel-sealing system (Valleylab, Boulder, Colorado) is a new hemostatic device pri-

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marily designed for abdominal operations. A bipolar, electrosurgical device, it seals vessels as large as 7 mm in diameter by denaturing collagen and elastin within the vessel walls and the surrounding connective tissue. When compared with unipolar cautery, LigaSure has a reduced energy spread profile (<2 mm) and a potentially decreased risk of injury to adjacent structures.[10] LigaSure has been used to secure hemostasis in various open and laparoscopic procedures. The risk of bleeding does not appear to increase with use of LigaSure, and some studies have even shown reduced operative blood loss as well as operating time in hemorrhoidectomy and laparoscopic gynecologic oncologic procedures.[11,12] Apart from its hemostatic efficiency and safety, LigaSure might minimize the risk of damage to parathyroid glands and recurrent laryngeal nerves because it disperses less heat to the surrounding tissue than classic bipolar or monopolar electrocoagulation methods. Because results from several studies assessing the efficacy of LigaSure in thyroidectomy have now been reported, a systematic review and meta-analysis of clinical trials seems appropriate to evaluate operative and postoperative parameters as well as adverse outcomes among patients undergoing LigaSure vs conventional thyroidectomy.

METHODS

SEARCH STRATEGY

The MEDLINE, EMBASE, Elsevier, SpringerLink, Ovid, and Cochrane Library electronic databases as well as the LigaSure manufacturer's Web site (http://www.ligasure.com/pages/articallist.htm) were searched for articles published from 1996 (when use of LigaSure was first reported) to 2008 to identify all clinical trials comparing LigaSure with conventional thyroidectomy. Search terms were "LigaSure" or "bipolar vessel sealing system" and "thyroid surgery" or "thyroidectomy." The "related articles" function was used to broaden the search, and all retrieved abstracts, studies, and citations were reviewed. Reference lists of the articles acquired were also searched by hand. The search was not limited by language or publication status. The latest date of this search was July 31, 2008.

SELECTION CRITERIA

The primary outcomes were operative duration and amount of intraoperative blood loss. The secondary outcomes were length of hospital stay and any postoperative complications, including hypocalcemia and recurrent nerve lesions. Stricter criteria were required for inclusion of meta-analyses: (1) the study must have a prospective, controlled design (both randomized and nonrandomized); (2) the study evaluated the LigaSure vessel sealing system vs conventional vessel ligation in thyroidectomy; (3) four counts (a, b, c, and d) of a standard 2×2 contingency table could be extracted or calculated for postoperative complication rates; and (4) it was possible to extract or calculate the appropriate data from the published results. The 4 counts were defined as follows: a, the number of patients who underwent operations using LigaSure and experienced the complication; b, the number of patients who underwent conventional vessel ligation and experienced the complication; c, the number of patients who underwent LigaSure thyroidectomy and did not experience the complication; d, the number of patients who underwent conventional vessel ligation and did not experience the complication.

STUDY SELECTION

Two of us (H.S.Y. and W.J.W.) independently assessed the titles and abstracts of all the identified studies. The individually recorded decisions were compared, and any disagreements were resolved by a third reviewer (C.P.R.). Following that, 2 reviewers (H.S.Y. and W.J.W.) evaluated each of the eligible studies and decided whether to include or exclude them according to the aforementioned criteria. For trials yielding multiple publications, we included only the most complete report for each outcome.

DATA EXTRACTION

Two of us (H.S.Y. and W.J.W.) independently extracted details from the selected studies. The outcome measures considered were based on end points provided in the studies, including operative duration, amount of intraoperative blood loss, length of hospital stay, and any postoperative complications such as hypocalcemia and recurrent nerve lesions. Continuous outcomes, summary estimates per group (means and medians) with measures of variability (standard deviation) or precision (standard error and confidence interval [CI]) were recorded, as available. Authors were contacted when case information provided in the articles was ill-defined. The third reviewer (C.P.R.) resolved discrepancies between the first 2 reviewers. All discrepancies were minor and were resolved with discussion until agreement was met.

QUALITY ASSESSMENT

The first 2 reviewers (H.S.Y. and W.J.W.) independently assessed the methodological quality of the full-text studies using an assessment tool that draws on the schema suggested by the National Health Service Centre for Reviews and Dissemination,[13] Verhagen et al,[14] Downs and Black,[15] and the generic appraisal tool for epidemiological studies. Judgments of quality were based on the qualitative assessment of the number and type of criteria met by individual studies.

QUANTITATIVE DATA ANALYSIS

For operative duration, amount of intraoperative blood loss, and length of hospital stay, standardized differences in means were used as treatment effect measures. When necessary, standard deviations were estimated from the range values provided. For the outcome measure complication incidence, odds ratio was chosen as the treatment effect measure. Quantitative data were analyzed using Review Manager meta-analysis software,[16] as previously reported.[17] Statistical heterogeneity was tested using χ^2 and I^2 tests. If heterogeneity was high ($I^2 > 50\%$), we used the random-effects model; otherwise, the fixed-effects model was considered appropriate.[18,19] Potential publication bias in the meta-analysis was assessed by Begg funnel plot and Egger regression test.[20,21] Statistical significance was set at $P < .05$.

RESULTS

IDENTIFICATION AND CHARACTERISTICS OF STUDIES

Of 27 citations identified from electronic databases and by hand searching, 9 prospective clinical trials, 4 randomized and 5 nonrandomized, published between 2004 and 2008 with a total of 927 patients matched the predefined inclusion criteria (**Table 1**).[22-30] The 9 trials were all single-center studies. The largest study included data from 200

Table 1. Characteristics of the 9 Clinical Trials Comparing LT and CT

Source	Design	No. of Patients		Age, Mean (SD), y		No. of Men		Type of Thyroidectomy: Total		Type of Thyroidectomy: Subtotal		Type of Thyroidectomy: Lobectomy		Pathological Diagnosis of Lesions, B/M	
		LT	CT	LT	CT	LT	CT	LT	CT	LT	CT	LT	CT	LT	CT
Kiriakopoulos et al,[22] 2004	Non-RCT	40	40	48.2 (7.8)	46.4 (8.2)[a]	7	9[a]	NM	NM	NM	NM	0	0	33/7	34/6[a]
Kirdak et al,[23] 2005	Non-RCT	30	28	48 (13.9)	46 (12.9)[a]	6	7[a]	8	9[a]	14	9[a]	8	10[a]	28/2	25/3[a]
Manouras et al,[24] 2005	RCT	94	90	51.8 (11.6)	54 (13.3)[b]	20	10[a]	94	90[a]	0	0	0	0	70/24	68/22[a]
Barbaros et al,[25] 2006	Non-RCT	50	50	47 (11)	49 (13)[a]	7	8[a]	NM	NM	NM	NM	0	0	NM	NM
Kilic et al,[26] 2007	RCT	20	20	45.1 (14.3)	41.4 (12.5)[a]	3	7[a]	0	0	20	20[a]	0	0	20/0	20/0[a]
Marrazzo et al,[27] 2007	RCT	25	25	NM	NM	NM	NM	25	25[a]	0	0	0	0	NM	NM
Saint Marc et al,[28] 2007	RCT	100	100	49.5 (11.3)	54.1 (13.2)[b]	10	26[b]	100	100[a]	0	0	0	0	82/18	90/10[a]
Cipolla et al,[29] 2008	Non-RCT	53	52	50.1 (11.4)	50.5 (14.3)[a]	10	9[a]	53	52[a]	0	0	0	0	48/5	46/6[a]
Youssef et al,[30] 2008	Non-RCT	55	55	44 (11.4)	43.8 (10.7)[a]	12	14[a]	15	15[a]	30	29[a]	10	11[a]	51/4	52/3[a]

Abbreviations: B, benign; CT, conventional thyroidectomy; LT, LigaSure (Valleylab, Boulder, CO) thyroidectomy; M, malignant; NM, not mentioned; RCT, randomized controlled trial.

[a] No significant difference between patients undergoing LT vs CT.

[b] Significant difference between patients undergoing LT vs CT ($P<.05$).

patients,[28] and the smallest had 40 patients.[26] Agreement among authors about study inclusion was 100%.

PATIENT CHARACTERISTICS

Four studies[24,27-29] involved 539 patients who underwent total thyroidectomy, 1 study[26] involved 40 patients who underwent subtotal thyroidectomy, 2 studies[22,25] involved 180 patients who underwent total or subtotal thyroidectomy, and 2 studies[23,30] involved 168 patients who underwent thyroidectomy without special restrictions on what types of thyroid procedure were performed. One study[27] did not provide the age and sex of the included patients, whereas the others, except for Saint Marc et al,[28] had insignificant differences in mean age and male to female ratio between the LigaSure and conventional thyroidectomy groups. The percentage of men varied from 10% to 22% in the LigaSure group[28,30] and from 11% to 35% in the conventional group.[24,26] The postoperative pathological findings for the LigaSure vs conventional groups were not statistically different in 7 studies; Barbaros et al[25] and Marrazzo et al[27] did not provide pathological data. The percentage of malignant tumors varied from 0% to 26% in the LigaSure group and from 0% to 24% in the conventional group[24,26] (Table 1).

THYROIDECTOMY PROCEDURES

All patients received general anesthesia. After the low-collar Kocher incision, the subcutaneous tissue and the platysma were divided, and skin flaps were constructed with monopolar electrocautery. The strap muscles were divided in the midline and retracted laterally. Regardless of vessel diameter, the inferior, middle, and superior thyroid vessels were ligated with knot tying in the conventional group and were sealed with LigaSure in the LigaSure group in all included studies, except for Saint Marc et al,[28] in which LigaSure was the main device used except when vessels were larger than 4 mm in diameter. In addition to sealing of the thyroid vessels, Kirdak et al[23] and Manouras et al[24] maintained that LigaSure was also more suitable for dissection and homeostasis of the thyroid gland during hemithyroidectomy because it separates tissue more easily than conventional dissection and ligation. The recurrent laryngeal nerves and parathyroid glands were identified and protected in most studies. In all studies, use of LigaSure was not recommended when the handpiece was very close to the recurrent laryngeal nerves or parathyroid glands. Closure of the surgical wound followed conventional procedure in both groups. Thyroid bed drainage was used and was removed on the first postoperative day in all studies except for Saint Marc et al,[28] which did not use drainage after LigaSure thyroidectomy.

OPERATIVE AND POSTOPERATIVE PARAMETERS

Operative duration was available for 8 trials, with a total sample size of 817 patients.[22-29] In 6 studies,[23-28] a shorter operative duration was noted for LigaSure thyroidectomy (mean decrease, 6.4-32.4 minutes[27,28]) (**Table 2**). Quantitative meta-analysis of these 8 trials confirmed that LigaSure thyroidectomy was a mean of 11.97 minutes shorter than conventional thyroidectomy (95% CI, –16.42 to –7.53 minutes; $P<.001$) (**Figure 1** and **Table 3**). Similarly, subgroup meta-analysis of 586 participants undergoing total thyroidectomy in 6 studies[23,24,27-30] and 122 participants undergoing subtotal thyroidectomy in 3 studies[23,26,30] also revealed mean operative duration reduction of 20.32 minutes (95% CI, –33.86 to –6.79 minutes; $P=.003$) and 21.74 minutes (–38.32 to –5.16 minutes; $P=.01$), respectively, for LigaSure thyroidectomy (Figure 1 and Table 3).

A Begg funnel plot of the 8 trials is shown in **Figure 2**. This is a scatterplot of the treatment effects estimated from individual studies plotted on the horizontal axis (weighted mean difference [WMD]) against the standard error of the estimate shown on the vertical axis. Only 1 study[27] obviously exceeded the 95% CIs, and exclusion of this study did not change the results of the meta-analysis. The potential publication bias was significant, as confirmed by Begg analysis ($P=.02$) and the Egger regression test ($P=.004$). To investigate the source of heterogeneity, we performed a meta-regression using covariates containing age, sex, and pathological character. None of the variables was signifi-

Table 2. Operative and Postoperative Parameters of the 9 Clinical Trials Comparing LT and CT

Source	Operative Duration, Mean (SD), min		Operative Blood Loss, Mean (SD), mL		Length of Hospital Stay, Mean (SD), d		Postoperative Complications, No. of Patients							
							Hypocalcemia				Nerve Lesions			
							Transient		Permanent		Transient		Permanent	
	LT	CT	LT	CT	LT	CT	LT	CT	LT	CT	LT	CT	LT	CT
Kiriakopoulos et al,[22] 2004	84 (6)	89 (7)[a]	30 (5)	35 (8)[a]	NM	NM	1	2[a]	0	0[a]	1	0[a]	0	0[a]
Kirdak et al,[23] 2005	96.2 (22.2)	115.4 (19.1)[b]	NM	NM	1.4 (1.2)	1.3 (0.7)[a]	5	3[a]	0	0	1	3[a]	0	0
Manouras et al,[24] 2005	87.3 (21.3)	101.6 (34.2)[b]	NM	NM	2.1 (1.5)	1.8 (0.9)[a]	0	0	0	0	0	0	0	0
Barbaros et al,[25] 2006	58 (21)	75 (23)[b]	NM	NM	1.4 (0.1)	1.6 (0.2)[b]	2	3[a]	0	0	0	0	0	0
Kilic et al,[26] 2007	55.7 (12.7)	68.3 (19.9)[b]	NM	NM	1 (NM)	1 (NM)[a]	0	1[a]	0	0	0	0	0	0
Marrazzo et al,[27] 2007	60 (14.8)	92.4 (27.5)[b]	NM	NM	1.9 (0.4)	2.2 (0.4)[b]	3	5[a]	0	0	1	1[a]	0	1
Saint Marc et al,[28] 2007	42.5 (11.2)	48.9 (6.8)[b]	NM	NM	1.1 (0.3)	1.1 (0.2)[a]	21	18[a]	1	2[a]	12	10[a]	1	1[a]
Cipolla et al,[29] 2008	104 (12.7)	110 (15.6)[c]	58 (38.2)	61 (37.5)[c]	NM	NM	4	4[a]	0	0	1	1[a]	0	0
Youssef et al,[30] 2008	NM	NM	65.6 (14.8)	132.7 (28.4)[b]	2 (NM)	2 (NM)[a]	2	3[a]	0	0[a]	2	2[a]	0	1[a]

Abbreviations: CT, conventional thyroidectomy; LT, LigaSure (Valleylab, Boulder, CO) thyroidectomy; NM, not mentioned.
[a] No significant difference between patients undergoing LT vs CT.
[b] Significant difference between patients undergoing LT vs CT ($P<.05$).

cantly related to the WMD of operative duration. However, the proportion of male patients was significantly associated with extending operative time ($P<.001$).

Mean amount of intraoperative blood loss, as calculated using a small suction device and by weighing the sponges at the end of the procedure, was reported quantitatively in 185 participants with standard deviation in the studies by Kiriakopoulos et al,[22] Youssef et al,[30] and Cipolla et al.[29] Youssef et al noted that significantly less bleeding occurred during LigaSure thyroidectomy (mean difference, 67.1 mL), whereas Kiriakopoulos et al and Cipolla et al did not find significant differences (Table 2). Meta-analysis showed that the amount of intraoperative blood loss during LigaSure thyroidectomy was not significantly different compared with conventional thyroidectomy (WMD, –25.13 mL; 95% CI, –68.45 to 18.18 mL; $P=.26$) (Table 3 and **Figure 3**).

Two studies reported data regarding postoperative pain and analgesic use.[26,30] The postoperative pain score, assessed on a visual analog scale, and analgesia intake in the first 48 hours postoperatively were significantly reduced among patients after LigaSure thyroidectomy compared with conventional thyroidectomy. Patients who underwent LigaSure thyroidectomy had earlier pain-free return to normal activity and to work.[30] In another recent study by Kilic et al,[26] a single dose of first-generation cephalosporin prophylaxis was given preoperatively to both patient groups, and postoperative analgesia was provided with a single dose of intramuscular nonsteroidal anti-inflammatory drugs. Pain scoring was conducted by recording the need for additional analgesic doses, ie, the pain score was 1+ for 1 additional dose and 2+ for 2 additional doses. Kilic et al[26] found that only 3 of 20 patients in the LigaSure group had a pain score of 2+ compared with 7 of 20 patients in the conventional group.

Seven of 9 studies compared the length of hospital stay for LigaSure thyroidectomy vs conventional thyroidectomy.[23-28,30] Patients were discharged on the first postoperative day in the study by Kilic et al[26] and on the second postoperative day in the study by Youssef et al[30]; Barbaros et al[25] and Marrazzo et al[27] reported significant shorter hospitalization of 0.2 and 0.3 days, respectively, after LigaSure thyroidectomy. The remaining 3 studies[23,24,28] did not find a significant difference (Table 2). No significant difference was found with quantitative meta-analysis between LigaSure and conventional thyroidectomy with respect to length of hospitalization in the 5 studies using a random-effects model ($I^2=83.5\%$) (WMD, –0.08 days; 95% CI, –0.23 to 0.08 days; $P=.31$) (Table 3 and Figure 3).

POSTOPERATIVE COMPLICATIONS

The 9 studies reported postoperative complications in 467 patients undergoing LigaSure thyroidectomy and 460 patients undergoing conventional thyroidectomy.[22-30] A total of 63 patients (13.5%) experienced postoperative complications after LigaSure thyroidectomy, including 38 patients with transient hypocalcemia, 18 with transient nerve lesions, 3 with hematomas, 2 with incision infections, 1 with permanent hypocalcemia, and 1 with permanent nerve lesions. After conventional thyroidectomy, 67 patients (14.6%) experienced postoperative complications, including 39 patients with transient hypocalcemia, 17 with transient nerve lesions, 2 with hematoma, 4 with incision infection, 2 with permanent hypocalcemia, and 3 with permanent nerve lesions. No deaths were reported. No significant difference was found between LigaSure thyroidectomy and conventional thyroidectomy for overall incidence of postoperative complications (odds ratio, 0.91; 95% CI, 0.61-1.36; $P=.65$) or for rates of the following individual postoperative complications: transient postoperative complications (0.97; 0.65-1.45; $P=.87$), transient hypocalcemia (0.96; 0.59-1.55; $P=.87$), transient nerve lesions (1.05; 0.53-2.08; $P=.88$), and permanent postoperative complications (0.49; 0.12-2.00; $P=.32$) (Table 3).

COMMENT

This study suggests that LigaSure thyroidectomy is a safe, effective, and fast alternative to the conventional

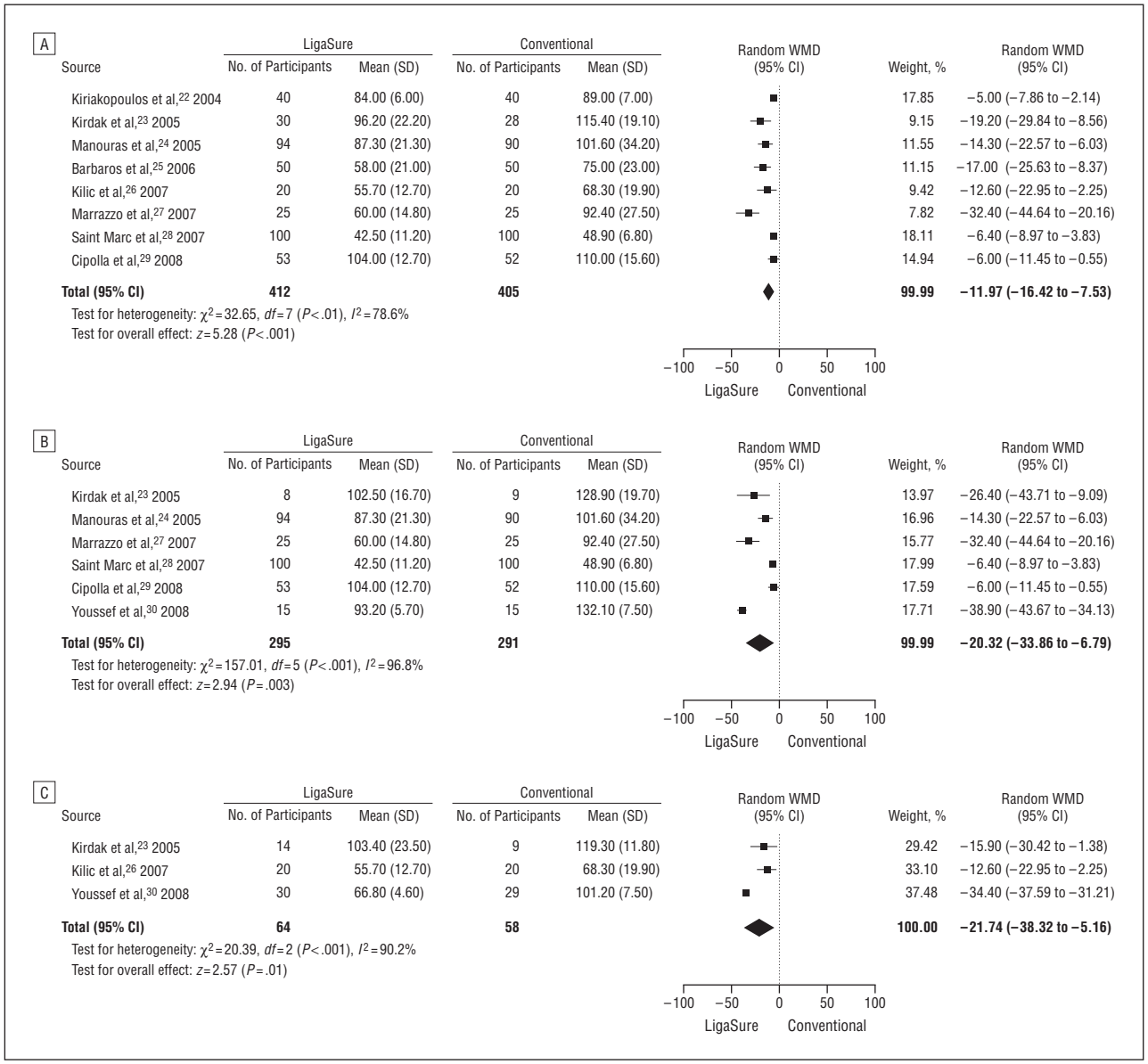

Figure 1. Forest plots for operative duration of unspecified thyroidectomy (A), total thyroidectomy (B), and subtotal thyroidectomy (C). Squares indicate the point estimates of the treatment effect (weighted mean difference [WMD]) with 95% confidence intervals (CIs) indicated by horizontal bars. Diamonds represent the summary estimate from the pooled studies with 95% CIs. LigaSure is a vessel-sealing device manufactured by Valleylab, Boulder, CO.

operation. Our meta-analysis of data from the largest available global sample finds that LigaSure thyroidectomy took significantly less time to complete (mean, –11.97 minutes) compared with conventional thyroidectomy. The reduced operative duration associated with LigaSure is likely related to better intraoperative hemostatic control and not needing to ligate the vessels. Further subgroup analysis of 586 participants undergoing total thyroidectomy in 6 clinical trials and 122 participants undergoing subtotal thyroidectomy in 3 clinical trials also revealed a greater operative time reduction (–20.32 and –21.74 minutes, respectively) for LigaSure thyroidectomy compared with conventional vessel ligation. However, this did not lead to any significant reduction in the amount of intraoperative blood loss or length of hospital stay in our quantitative meta-analysis.

In 2004, Petrakis et al[31] first reported results from LigaSure thyroidectomy in a retrospective case-control study. Since that time, an important clinical issue concerning the use of LigaSure in thyroidectomy has been the postoperative complication rates, especially for complications related to the extent of lateral thermal spread and associated tissue injury. After conventional thyroidectomy, it was reported that as many as 15% of patients had postoperative transient hypoparathyroidism when judged on clinical symptoms, and as many as 80% of patients would be diagnosed as having postoperative transient hypoparathyroidism when laboratory criteria were used.[32,33] In the study by Delbridge et al,[34] as many as 32% of patients who underwent total thyroidectomy required calcium supplementation 3 to 6 weeks postoperatively. Transient recurrent nerve paralysis has been observed in 8.7% to 39.0% of

Table 3. Quantitative Meta-analysis Results Based on the 9 Clinical Trials Comparing LT and CT[a]

Outcome	No. of Trials (N=9)	No. of Participants Included in the Meta-analysis		I^2, %	Pooling Model	Effect Size (95% CI)	*P* Value
		LT	CT				
Operative duration							
Thyroidectomy	8	412	405	78.6	WMD (rand)	–11.97 (–16.42 to –7.53)	<.001
Total thyroidectomy	6	295	291	96.8	WMD (rand)	–20.32 (–33.86 to –6.79)	.003
Subtotal thyroidectomy	3	64	58	90.2	WMD (rand)	–21.74 (–38.32 to –5.16)	.01
Intraoperative blood loss	3	148	147	98.9	WMD (rand)	–25.13 (–68.45 to 18.18)	.26
Length of hospital stay	5	299	293	83.5	WMD (rand)	–0.08 (–0.23 to 0.08)	.31
Postoperative complications	9	63/467[a]	67/460[a]	0	OR (fixed)	0.91 (0.61 to 1.36)	.65
Transient complications	9	61/467[a]	62/460[a]	0	OR (fixed)	0.97 (0.65 to 1.45)	.87
Transient hypocalcemia	9	38/467[a]	39/460[a]	0	OR (fixed)	0.96 (0.59 to 1.55)	.87
Transient nerve lesions	8	18/467[a]	17/460[a]	0	OR (fixed)	1.05 (0.53 to 2.08)	.88
Permanent complications	9	2/467[a]	5/460[a]	0	OR (fixed)	0.49 (0.12 to 2.00)	.32

Abbreviations: CI, confidence interval; CT, conventional thyroidectomy; LT, LigaSure (a vessel-sealing device; Valleylab, Boulder, CO) thyroidectomy; OR (fixed), odds ratio (fixed effects model); WMD (rand), weighted mean difference (randomized effects model).

[a] Data are given as the number of patients with the complication/total sample size.

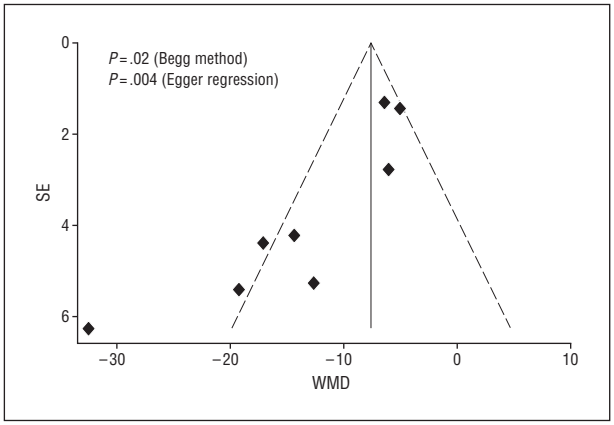

Figure 2. Funnel plot of studies included in the meta-analysis of operative duration. CI indicates confidence interval (dashed lines); SE, standard error; and WMD, weighted mean difference.

patients[35,36] and is not completely avoidable even with systematic laryngeal nerve identification.[36,37] After total thyroidectomy, the complication rate for permanent damage to the parathyroid glands or laryngeal nerves usually ranges from 1% to 4.5%, depending on the surgeon's experience, thyroid gland weight, and underlying thyroid disease. After subtotal thyroidectomy for benign thyroid disease, permanent damage to the parathyroid glands and recurrent nerves is likely in about 1% of patients.[34,38-41] However, in the 9 included studies, there was no significant difference in the rates of overall and individual postoperative complications for patients undergoing conventional vs LigaSure thyroidectomy. Moreover, because it is used solely during the entire procedure for vascular ligation of all thyroid vessels, no suture ligations are necessary. No foreign bodies (ie, ligations or clips) are left behind; therefore, the risk of knot slipping and clip dislodgment is nearly eliminated.

Even so, some authors believe that LigaSure is not suitable for the precise surgical maneuvers required for operations in the vicinity of extremely delicate structures such as the recurrent laryngeal nerves and parathyroid glands,[22,29] and conventional vessel knot-tying ligation still remains important when the handpiece of LigaSure is very close to the recurrent laryngeal nerves or the parathyroid glands. Furthermore, the recent studies have enabled clarification that, after LigaSure thyroidectomy, the postoperative pain treatment and analgesic requirements were significantly reduced, and patients returned pain-free to normal work or social activity significantly earlier.[26,30] Patients with hemorrhoids had significantly lower postoperative pain scores and required less postoperative analgesia after LigaSure hemorrhoidectomy vs conventional hemorrhoidectomy.[42] These results may be owing to the minimal intraoperative tissue dissection and postoperative tissue reaction, because the energy spread profile is greatly reduced with LigaSure.

It is important to mention the heterogeneity among studies when interpreting the meta-analysis results. Despite assessing outcomes only among patients undergoing thyroid operations, some differences existed in methodologies that might explain the heterogeneity. The inclusion of patient samples with different male to female ratios might also have affected the operative duration for thyroidectomy reported in the present study.

CONCLUSIONS

The results of this meta-analysis show that LigaSure thyroidectomy can be a safe, useful, and fast alternative to conventional thyroidectomy. The main advantage of this device is that it simplifies the procedure and eliminates the need for clips and suture ligations while also achieving efficient hemostasis. It significantly reduced operative duration without increases in the amount of intraoperative blood loss, morbidity rates, and length of hospital stay compared with the conventional technique. The LigaSure device appears to be safe for use in thyroid operations because there

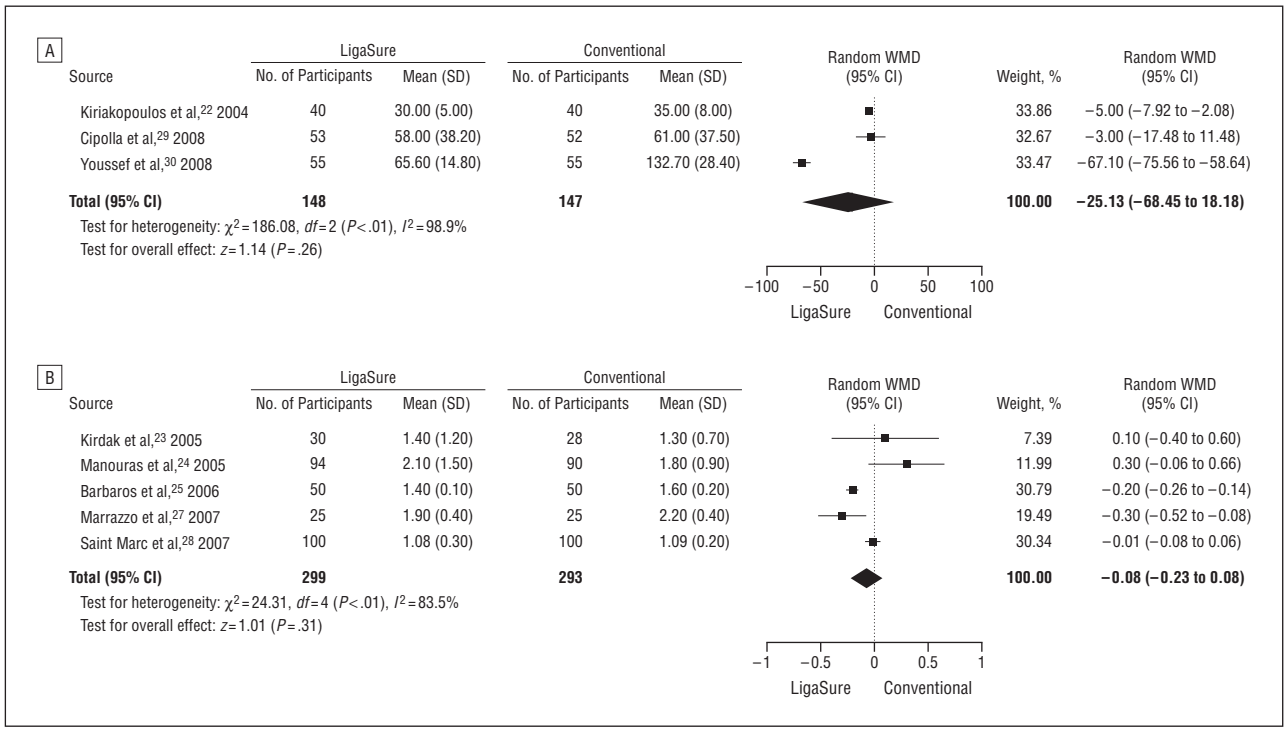

Figure 3. Forest plots for the amount of intraoperative blood loss (A) and length of hospital stay (B). Squares indicate the point estimates of the treatment effect (weighted mean difference [WMD]) with 95% confidence intervals (CIs) indicated by horizontal bars. Diamonds represent the summary estimate from the pooled studies with 95% CIs. LigaSure is a vessel-sealing device manufactured by Valleylab, Boulder, CO.

was no increase in postoperative complications, particularly recurrent laryngeal nerve or parathyroid injuries. Further prospective randomized, controlled trials still are required for assessment of routine use of this technology during thyroidectomy.

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INVITED CRITIQUE

Sutureless Thyroidectomy—Technological Advance or Toy?

In this meta-analysis of the use of LigaSure during thyroidectomy, the authors conclude that sutureless thyroid operations are safe, effective, and reduce operative duration. So what? Other than the arguable cost-effectiveness of reduced operating time, there is no difference between LigaSure thyroidectomy and standard open techniques. So is sutureless thyroidectomy really a significant advance, or just another expensive technological toy? Are we to abandon our surgical heritage and training and stop tying knots during thyroidectomy just for the sake of a few minutes saved in operating time? Well, I believe the answer to that question is an unequivocal yes. Sutureless techniques have been an invaluable advance for laparoscopic operations, and we are now entering a new sutureless era in open surgical procedures. It is fitting that this meta-analysis of sutureless thyroidectomy is now being published because thyroidectomy is one of the hallmark surgical procedures—the first Nobel Prize ever to be awarded to a surgeon was given to Theodor Kocher in 1909 for his pioneering work in relation to thyroidectomy and its follow-up.[1] The ability to offer thyroid procedures with an acceptable mortality rate was the cornerstone upon which many of the major surgical clinics in the United States established their reputations. It remains one of the most commonly performed surgical procedures worldwide and is considered fundamental to surgical training. Of interest, surgical techniques for thyroidectomy have, until recently, changed little from those used by Kocher in Switzerland; Dunhill in Melbourne, Australia; and the Mayo brothers in Minnesota early last century. Sutureless thyroidectomy represents the next major advance, but not just for thyroid procedures. Because the new generation of sutureless devices fit neatly into the surgeon's hand, acting as a virtual extension of the fingers but also capable of dissecting and vessel sealing, I have no doubt that, in a short