Objective: To report the results of a multi-institutional experience with the minimally invasive video-assisted thyroidectomy, which was conceived in Europe and Asia and has only recently been embraced in the United States.

Design: Prospective, nonrandomized analysis.

Setting: Four academic thyroid surgical practices.

Patients: Consecutive series of 228 patients who required thyroid surgery and were deemed at surgeon discretion to be eligible for a minimal access surgery.

Interventions: Minimally invasive video-assisted thyroidectomy was performed in 216 patients.

Main Outcome Measures: The data, which were recorded prospectively, included age, sex, indication for surgery, incision length, and complications of surgery.

Results: Because conversion to an open approach was required in 12 of the 228 patients, the study group comprised 216 patients (25 men and 191 women; mean [SD] age, 44.5 [14.1] years). There were no hematomas and no cases of permanent hypoparathyroidism or permanent vocal cord paralysis. Nine patients had a transient vocal cord paresis (3.2% of nerves at risk); 5 patients experienced temporary hypocalcemia (8.1% of total thyroidectomies); 1 patient reported a change in voice pitch; and 1 patient required a scar revision.

Conclusions: Use of the minimally invasive video-assisted thyroidectomy technique has been adopted cautiously in the United States. The safety of the procedure represented by the data from this multi-institutional experience would support its expanded adoption by high-volume thyroid surgeons.


MINIMAL-ACCESS THYROID SURGERY was conceived primarily in Europe and Asia. A number of groups have made pioneering contributions to this field. While a variety of minimally invasive approaches have been endorsed, the technique most widely practiced in North America is the minimally invasive video-assisted thyroidectomy (MIVAT), as originally described by Miccoli et al. As with many new surgical techniques, adoption of MIVAT in the United States has been slow and somewhat deliberate. Increasingly, however, high-volume thyroid surgical centers have embraced this approach, and modest-sized case series have been published detailing their experiences.

To provide a more comprehensive reflection of the North American experience with MIVAT, we consolidated data that were compiled prospectively at 4 academic medical centers, paying specific attention to the safety and feasibility of this approach. The findings, as well as a proposal for more widespread adoption of this technique, are presented herein.

METHODS

Patients requiring thyroid surgery were carefully selected at the surgeon’s discretion to undergo MIVAT at 1 of 4 academic institutions (Medical College of Georgia, Augusta; Northwestern University, Chicago, Illinois; University of Cincinnati, Cincinnati, Ohio; and Loma Linda University, Loma Linda, California). Typical indications included nonobese individuals with nodules that were no larger than 3 cm and with no thyroiditis. Data, which were recorded prospectively, included age, sex, indication for surgery, incision length, and complications of surgery.

The patient information was deidentified and compiled into a single spreadsheet. The data were reported as mean (SD) where appropriate. In cases in which information was not available, the sample size was pro-
The surgical approach, which has been described previously, was uniform among the institutions (2 authors trained with Dr Miccoli and in turn trained the other 2 authors). Briefly, the procedure included a minimal-access incision followed by vertical separation of the strap muscles and thorough blunt dissection in the plane between the thyroid gland and the strap muscles and around the posterior surface of the gland. The superior pole was ligated with Harmonic shears (ACE23P, ACE14S, or CS14C; Ethicon Endo-Surgery, Cincinnati, Ohio), as were any other vessels of meaningful size. Endoscopic visualization (with a 5-mm, 30° laparoscope) was used primarily for management of the superior pole and for identification of the recurrent laryngeal nerve. Once the recurrent laryngeal nerve and the superior and inferior parathyroid glands were located and isolated from the thyroid gland, the isthmus and the ligament of Berry were transected and the thyroid lobe was removed. This procedure was repeated on the contralateral side if a total thyroidectomy was indicated.

Laryngeal nerve monitoring, which is used by 3 of the 4 authors, was done in most cases in this series. Drains were used selectively according to surgeon preference, and patients were either treated on an outpatient basis or kept in the hospital overnight. Postoperative laryngeal examinations were accomplished at varying intervals depending on the institution, but typically within 1 month after surgery.

### RESULTS

A total of 228 patients were identified as potentially eligible for a MIVAT. In 12 of the patients, conversion to an open procedure was necessary for 1 of the following reasons: in 8 patients, the nodules proved to be too large for the endoscopic technique; 2 patients had invasive cancers, necessitating wider exposure; 1 patient had previously undiagnosed thyroiditis, and 1 patient had a lithium goiter. The remaining 216 patients composed the treated group. There were 25 men and 191 women, with an overall mean (SD) age of 44.5 (14.1) years. The vast majority of these patients underwent surgery for presumed benign disease, and 44 of them (20.4%) turned out to have a malignant neoplasm.

<table>
<thead>
<tr>
<th>Type of Disease</th>
<th>Patients, No. (%)</th>
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<tbody>
<tr>
<td>Benign</td>
<td>172 (79.8)</td>
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<tr>
<td>Malignant</td>
<td>44 (20.2)</td>
</tr>
<tr>
<td>Papillary</td>
<td>32 (14.8)</td>
</tr>
<tr>
<td>Follicular</td>
<td>5 (2.3)</td>
</tr>
<tr>
<td>Hürthle cell tumor</td>
<td>3 (1.4)</td>
</tr>
<tr>
<td>Medullary</td>
<td>2 (0.9)</td>
</tr>
<tr>
<td>Renal metastasis</td>
<td>1 (0.5)</td>
</tr>
<tr>
<td>Lymphoma</td>
<td>1 (0.5)</td>
</tr>
<tr>
<td>Total</td>
<td>216 (100)</td>
</tr>
</tbody>
</table>

There were 154 hemithyroidectomies and 62 total thyroidectomies in the study group. The mean (SD) incision length (available in 182 of 216 patients) was 27.7 (6.6) mm. There were 16 complications (7.4%) (Table). The 9 temporary recurrent laryngeal nerve pareses (4.2% of patients) occurred among a total of 278 nerves at risk, representing a paresis rate of 3.2% of nerves at risk. These were distributed among the institutions, and there was no identifiable factor related to these cases of temporary nerve dysfunction. The 5 instances of temporary hypocalcemia (2.3% of patients) occurred among 62 patients who underwent total thyroidectomy (8.1%). No patients had permanent vocal cord paralysis or permanent hypoparathyroidism. Examples of the appearance of the postoperative cosmetic results are depicted in Figure 1 and Figure 2.

### COMMENT

Billroth’s and Kocher’s substantial contributions to the practice of thyroid surgery proved to be durable, resulting in a standard for thyroid surgery that lasted longer than 100 years. However, the recent advent of novel technologies and innovative surgical techniques has altered the typical approach to surgery for many surgeons. Miccoli et al., in particular, have developed a surgical approach that combines endoscopic visualization and Harmonic technology along with a series of departures from conventional steps in thyroidectomy to achieve a minimally invasive thyroidectomy that has been adopted by other surgeons worldwide. Some of the features of this innovative approach include the lack of neck extension classically advocated for thyroid surgery, the use of blunt elevators (normally associated with nasal and sinus surgery), and a sutureless skin closure (using cyanoacrylate). The advantages of the technique include reduced discomfort after surgery, improved cosmetic outcome, more rapid wound healing, and an opportunity to perform thyroidectomy without a drain and on an outpatient basis.

Physicians as a group, and surgeons in particular, are cautious in adopting and embracing new technologies and new surgical approaches. There is a certain amount of comfort in performing procedures that have been heavily validated; therefore, most individuals are fearful of change. Nevertheless, among the novel thyroid surgical approaches that have been described over the past decade, MIVAT has proved to be the most popular and the most widely applicable.
Because of the relatively narrow indications for endoscopic thyroidectomy,15 most of the published experience has been represented by relatively small case series, particularly in North America. We therefore sought to compile a robust experience in an effort to further validate this approach. Our data demonstrate the substantial feasibility of this procedure, as reflected by a low conversion rate to conventional surgery (5.3%). The safety of the procedure is now firmly established, with a permanent vocal cord paralysis rate of 0% and a permanent hypoparathyroidism rate of 0%, both of which serve to validate the findings of Miccoli and colleagues.1-3 The fact that 4 independent surgeons, from distinct regions of the country, were able to achieve similar success with MIVAT provides support for the wider applicability of this approach, at least in the practices of high-volume surgeons.

More than 20% of the patients in our surgical cohort proved to have a diagnosis of malignancy. While it is the practice at the 4 centers represented by this multiinstitutional experience to perform total thyroid lobectomies or total thyroidectomies as the 2 primary procedures for any thyroid disease, it is reasonable to question whether the completeness of the thyroid resection imparted by the endoscopic technique is comparable to that achieved with a conventional open approach. Although this question cannot be answered with the data available in the current study, the issue was addressed by Miccoli et al16 in a convincing prospective, randomized trial. Patients with papillary thyroid cancer were randomly assigned to undergo either MIVAT or conventional thyroid surgery. One month after surgery, thyroglobulin levels and uptakes on iodine 131 scans were nearly identical in the 2 groups.

Individuals who are considering embarking on a minimally invasive thyroid surgical program are encouraged to consider a number of factors. It is probably easier and safer to pursue a graduated approach to MIVAT. Marking incisions in the upright position before surgery, minimizing neck extension, and adopting Harmonic technology will enable gradually smaller incisions and improved cosmetic outcomes.17 Horizontal transection of the strap muscles in selected circumstances may also facilitate minimal-access approaches.18 Laryngeal nerve monitoring may add a measure of safety as the novice minimal-access surgeon makes the final step to endoscopic surgery, given that the smaller surgical aperture necessarily limits the exposure.19

Further validation of the MIVAT approach will be welcome, as an expanded experience may be persuasive to re-
lucent surgeons. However, we are confident that Miccoli and colleagues\textsuperscript{1-3,16} have made a sustainable contribution to the practice of thyroidectomy, particularly for those patients who are eligible for endoscopic thyroidectomy, but even for those who undergo conventional procedures. Finally, the introduction of certain novel technologies, in particular Harmonic energy, and probably laryngeal nerve monitoring in some cases, is likely also to prove durable.

In conclusion, MIVAT was introduced in Italy nearly a decade ago. This approach has been embraced by other centers in Europe and has now been validated by a robust North American experience. It is feasible and safe and provides meaningful advantages for selected patients at high-volume thyroid surgical centers.

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Author Contributions: Dr Terris had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Terris and Steward. Acquisition of data: Terris, Angelos, Steward, and Simental. Analysis and interpretation of data: Terris. Drafting of the manuscript: Terris. Critical revision of the manuscript for important intellectual content: Terris, Angelos, Steward, and Simental. Statistical analysis: Terris and Steward. Administrative, technical, and material support: Terris and Angelos. Study supervision: Terris.

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REFERENCES