Stretch of the Minimally Invasive Incision during Thyroid and Parathyroid Surgery

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Abstract
Objective. Identify and quantify changes in length of the skin incision following minimally invasive thyroid and parathyroid surgery and determine whether these changes persist postoperatively.

Study Design. Cohort study.

Setting. Tertiary care teaching hospital.

Subjects and Methods. Between July 2012 and June 2013, a prospective, nonrandomized study was performed on 44 consecutive patients undergoing open cervical minimally invasive thyroidectomy (incision approximately 6 cm or less) or minimally invasive parathyroidectomy (incision approximately 3 cm or less). Incision length was measured following initial incision, immediately after wound closure, and on postoperative follow-up at 2-week and 14-week visits.

Results. Thirty-one patients underwent minimally invasive thyroidectomy or parathyroidectomy with initial incision lengths ranging from 20 mm to 60 mm. Seven patients (21%) underwent total thyroidectomy with a length of 45 ± 8 mm, 15 patients (44%) underwent unilateral thyroid lobectomy with a mean length of 37 ± 5 mm, and 9 patients (26%) underwent parathyroidectomy with a mean length of 28 ± 2 mm. On average, the skin incision lengthened by 3.0 ± 0.9 mm during surgery representing an intraoperative stretch of 8.0% (P < .0001). Incision lengths decreased by an average of 0.3 mm at 2-week postoperative follow-up (ns) and 6.3 mm at 14-week postoperative follow-up (P < .0001).

Conclusion. Significant intraoperative incision stretch is likely to occur during minimally invasive thyroid and parathyroid surgery. Postoperative follow-up data suggest that the increase in incision length is not permanent and resolves upon postoperative follow-up.

Keywords
thyroidectomy, parathyroidectomy, minimally invasive, incision, stretch, cosmesis

Introduction
Minimally invasive surgical techniques have become increasingly utilized as greater emphasis is placed on health care costs, adverse outcomes, and patient satisfaction. With recent advances in surgical technology, several minimally invasive techniques have emerged for thyroid and parathyroid surgery. These include the use of the open cervical minimally invasive thyroidectomy (MIT), the minimally invasive video-assisted thyroidectomy (MIVAT), and extracervical approaches via the axilla, anterior chest, and facelift incision.¹⁻⁶ Numerous studies have addressed the safety, feasibility, and oncological effectiveness of such minimally invasive techniques. When compared to conventional surgical techniques, minimally invasive thyroidectomy (MIT) and minimally invasive parathyroidectomy (MIP) via an open cervical approach have been demonstrated to be safe and oncologically sound in the treatment of malignancy.⁶⁻¹¹ Further, minimally invasive approaches have been shown to be associated with reduced postoperative pain, decreased hospital length of stay, and improved cosmetic outcomes.⁴⁻⁶,¹⁰,¹²⁻¹⁴ The minimization of the wound length has become a major point of emphasis for non-endoscopic, minimally invasive thyroid and parathyroid surgery.¹² Although a smaller incision is generally regarded as improving wound appearance, the operative field is often limited by the size of lesion requiring removal. Significant intraoperative retraction is required to provide adequate access to target tissues. Potential trauma from external retraction may lead to inadvertent incision lengthening or stretch. Undoubtedly, head and neck surgeons have empirically recognized wound length changes that occur over time with surgical incisions made in the head and neck region. Given the present emphasis of limited incision length for the thyroid and parathyroid surgeries, it was felt that these case types

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would be suitable for the study of the wound changes that occur over time after the use of a minimal surgical incision. The objective of this study was to identify and quantify the change in incision lengths secondary to intraoperative retraction and to determine whether any resultant incision lengthening persisted postoperatively following wound contraction.

Methods

The Health Sciences Institutional Review Board at the University of Missouri approved this study for investigation. Forty-four consecutive patients undergoing either MIT or MIP between July 2012 and June 2013 were enrolled in the study. Patients with previous cervical operations, incisions >6 cm, concomitant lateral cervical lymphadenectomy, or tracheostomy were excluded from the study. Informed consent was obtained from all study participants. Surgical interventions were performed by 1 of 2 surgeons (RPZ or JBJ) and were assisted by residents. All procedures were performed under general anesthesia. The length of the skin incision was measured after incision, immediately following wound closure, and on subsequent follow-up 2- and 14-week visits.

Thyroidectomy Surgical Technique

A transverse midcervical incision approximately 2 cm above the superior clavicular plane was utilized. The strap muscles were divided at the midline and elevated from the underlying thyroid gland. The terminal branches of the middle thyroid vein were ligated at the level of the thyroid capsule, allowing the lobe to be retracted medially. The recurrent laryngeal nerve was then identified using a lateral approach and was traced to the point of the cricothyroid articulation. The parathyroid glands were identified whenever possible and preservation of their vascular supply by distal division of the inferior thyroid arterial branches was always attempted. The superior thyroid pedicle was divided at the level of the thyroid capsule as well. The lobe was delivered through the surgical incision and the thyroid isthmus was divided. The contralateral lobe was removed in a similar fashion when indicated. Following re-approximation of the strap muscles, the skin was closed via subcuticular running suture (RPZ) or vertical mattress suture (JBJ).

Parathyroidectomy Surgical Technique

A transverse mid-cervical incision approximately 2 cm above the sternal notch was utilized. The strap muscles were divided at the midline and elevated sharply from the underlying thyroid gland. The thyroid lobe was retracted medially. The parathyroid adenoma was then located, dissected, and removed. The skin was closed via subcuticular running suture (RPZ) or vertical mattress suture (JBJ).

Results

A priori power analysis indicated 30 patients were required for study inclusion in order to reach a statistical power of 90%. Forty-four patients were enrolled in this study to compensate for potential dropout. Data from 31 patients were available. Seventeen patients (56%) underwent total thyroidectomy, 15 patients (44%) underwent unilateral lobectomy, and 9 patients (26%) underwent parathyroidectomy. Breakdown of thyroid and parathyroid pathology was as follows: total thyroidectomy, multinodular goiter (4) and malignancy (3); thyroid lobectomy, benign nodule (12) and multinodular goiter (3); and parathyroidectomy, focused exploration (7) and unilateral exploration (2). Initial incision lengths ranged from 20 to 60 mm. Mean length of the incision was 45 ± 8 mm for total thyroidectomy, 37 ± 5 mm for unilateral thyroid lobectomy, and 28 ± 2 mm for parathyroidectomy.

On average, the skin incision lengthened by 3.0 ± 0.9 mm during surgery, representing an intraoperative stretch of approximately 8% (P < .0001). Incision lengths decreased by an average of 0.3 mm (95% CI, –2.4 to 1.9 mm) at 2-week postoperative follow-up. The incision length reduction at 2 weeks was not statistically significant (P > .05). Sixteen of the 31 patients returned for 14-week postoperative follow-up. At 14 weeks, the length of the incision decreased by an average of 6.3 mm compared to initial incision length at wound closure (95% CI, –9.5 to –3.2 mm, P < .0001; Figure 1).

No significant adverse events were described intraoperatively or postoperatively for total thyroidectomy, thyroid lobectomy, or parathyroidectomy surgical patients enrolled in the study.

Subgroup Analysis

Total Thyroidectomy

Seven patients (21%) underwent total thyroidectomy, 15 patients (44%) underwent unilateral lobectomy, and 9 patients (26%) underwent parathyroidectomy. Breakdown of thyroid and parathyroid pathology was as follows: total thyroidectomy, multinodular goiter (4) and malignancy (3); thyroid lobectomy, benign nodule (12) and multinodular goiter (3); and parathyroidectomy, focused exploration (7) and unilateral exploration (2). Initial incision lengths ranged from 20 to 60 mm. Mean length of the incision was 45 ± 8 mm for total thyroidectomy, 37 ± 5 mm for unilateral thyroid lobectomy, and 28 ± 2 mm for parathyroidectomy.

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**Thyroid Lobectomy**

Fifteen patients underwent minimally invasive thyroid lobectomy, with a mean length of incision of 37 ± 5 mm. On average, the skin incision lengthened by 3.5 mm during surgery (95% CI, 1.4-5.0 mm, \( P < .0001 \)), representing an intraoperative stretch of approximately 11%. At 2-week follow-up, the length of the incision increased by an average of 1.6 mm (95% CI, 0.9 to 2.3 mm), which was not statistically significant. Six of the 15 patients returned for 14-week postoperative follow-up. The length of the incision decreased by an average of 6.8 mm since wound closure (95% CI, –10.2 to –3.5 mm, \( P = .05 \)).

**Parathyroidectomy**

Nine patients underwent MIP, with an initial mean length of incision of 28 ± 2 mm. On average, the skin incision lengthened by 3.2 mm during surgery (95% CI, 1.4-5.0 mm, \( P < .0001 \)), representing an intraoperative stretch of approximately 11%. At 2-week follow-up, the length of the incision increased by an average of 1.6 mm (95% CI, 0.9 to 2.3 mm). Five of the 9 patients returned for 14-week postoperative follow-up. The length of the incision decreased by an average of 6.4 mm since wound closure (95% CI, –12.3 to –0.7 mm), which was statically significant (\( P = .05 \)).

**Discussion**

As interest in minimally invasive surgery has grown, several minimally invasive thyroidectomy and parathyroidectomy approaches have emerged and appear to provide significant advantages over conventional ones. A wide variety of minimal access approaches have been described including open cervical, video-assisted, and extracervical approaches. While extracervical entrance techniques may confer a theoretical cosmetic advantage over the cervical-approach alternatives, these procedures may not be reasonably described as minimally invasive as they often require extensive tissue dissection. Demonstrated to be safe and oncologically sound, the purported advantages of minimal access surgery are reduced postoperative pain, decreased hospital length of stay, and more acceptable cosmesis.

Operating through a smaller incision however often necessitates significant intraoperative retraction. The force of retraction, which may give way to inadvertent stretching and lengthening of the incision, has also been considered to be associated with damage to the wound edge. Prior work by Ezzat et al., however, demonstrated no immediate histological changes of the dermis in the excised wound edges of 9 patients who underwent MIT. The issue of cosmetic benefit with minimally invasive thyroid and parathyroid approaches is a controversial one. Empirically, it is assumed that shorter incisions will yield better patient acceptance of the cosmetic result. Yet, this concept has been challenged in 2 recent studies.

Our study aimed to quantify changes in incision length for MIT and MIP and to determine if such changes persisted postoperatively. Our findings suggest that significant incision lengthening occurs intraoperatively during MIP and MIT but that the changes in incision length were mostly transient. When incisions were measured postoperatively at 2-week and 14-week follow-up visits, surgical incision lengthening appeared to resolve with ongoing wound maturation (Figure 1).

Subgroup analysis revealed a difference in intraoperative and postoperative incision length change among the 3 study groups. However, the change in incision length for patients who underwent minimally invasive total thyroidectomy was not statistically significant at any point of observation. Conversely, significant intraoperative and postoperative change in the incision length was observed for patients who underwent either thyroid lobectomy or parathyroidectomy. Longer incisions were generally necessary in cases of total thyroidectomy, and in theory, less retraction would be needed with longer incisions for adequate tissue exposure. In contrast, thyroid lobectomy and parathyroidectomy are able to be performed through a smaller incision and would require greater intraoperative retraction.

The mechanism by which incisions lengthen is likely analogous to the intraoperative tissue expansion actions described by Sasaki for reconstructive surgery. These include a mechanical creep with tissue expansion occurring through innate visoelastic properties of the skin rather than overt increases in incision length. Mechanical creep is thought to result from disruption of dermal elastin and collagen fibers, displacement of adjacent tissues, and reduction in surrounding interstitial fluids. Removal of external retraction results in realignment of elastin and collagen fibers, with eventual restoration of natural dermal dimensions.

In our study, the incisions that underwent more intraoperative stretch also underwent more postoperative contraction, supporting a role for the restorative forces of innate dermal visoelastic properties. The concept of intraoperative stretch secondary to excessive external retraction during minimally invasive surgery has yet to be fully elucidated upon in the literature. Our study provides evidence for transient incision stretch with wound length resolution upon postoperative follow-up.

There are limitations to our current study. Most significant is the absence of a matched control group. Also, a wide range of techniques for MIT and MIP surgery exist. These data represent our experience with minimally invasive surgery through a limited open cervical incision. Comparable data from patients undergoing conventional thyroidectomy and parathyroidectomy as well as endoscopically assisted thyroidectomy may further expound on the phenomenon of intraoperative surgical wound stretch and long-term postoperative wound contractions.

**Conclusion**

Significant incision stretch is likely to occur during any surgical procedure that utilizes limited incision length as a component of a minimal access approach. The minimally invasive thyroid and parathyroid procedures are examples of this phenomenon. This study suggests that stretch may be...
more prominent with smaller surgical incisions and is not likely permanent. The observed increase in incision length appears to dissipate after patients are followed for several weeks postoperatively.

**Author Contributions**

Nan Chen, conception and design, acquisition of data, interpretation of data, article drafting, and final approval of submitted version; Lauren A. Stephenson, analysis and interpretation of data, article revision, and final approval of submitted version; Jeffrey B. Jorgensen, conception and design, article revision, and final approval of submitted version; Robert P. Zitsch, III, conception and design, article revision, and final approval of submitted version.

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