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Analysis of Risk Factors to Predict Occurrence and Prognosis of Postsurgical Hypertrophic Scar Development: A Review of 4238 Cases

Mi Yeon Cho[1*], Sang Gyun Lee[2*], Jee Eun Kim[3], Yong Sang Lee[4], Hang-Seok Chang[4], and Mi Ryung Roh[2]

[1]Department of Dermatology, Yongin Severance Hospital, Cutaneous Biology Research Institute, Yonsei University College of Medicine, Yongin;
[2]Department of Dermatology, Gangnam Severance Hospital, Cutaneous Biology Research Institute, Yonsei University College of Medicine, Seoul;
[3]Department of Dermatology, National Health Insurance Service Ilsan Hospital, Goyang;
[4]Department of Surgery, Gangnam Severance Hospital, Yonsei University College of Medicine, Seoul, Korea.

Purpose: This study aimed to identify the risk factors associated with the occurrence and prognosis of hypertrophic scarring following thyroidectomy.
Materials and Methods: A total of 4238 patients who underwent thyroidectomy were included in this study. A multivariable logistic regression model was developed to identify the risk factors for hypertrophic scar development and its prognosis.
Results: Our analysis revealed that hypertrophic scar development was associated with younger age [odds ratio (OR)=0.949, p<0.0001], male sex (OR=0.562, p<0.0001), higher body mass index (OR=1.137, p<0.0001), prominent sternocleidomastoid muscles (OR=2.522, p<0.0001), scarring located within 1 cm of the sternal notch (OR=4.345, p<0.0001), and a history of keloid development (OR=2.789, p=0.0031). Additionally, scar location within 1 cm of the sternal notch (beta=4.326, p=0.0429) and a history of keloid development (beta=23.082, p<0.0001) were found to be associated with the prognosis of hypertrophic scarring.
Conclusion: The findings of this study provide valuable insights into the risk factors associated with hypertrophic scarring following thyroidectomy. Clinicians can use this information to predict the occurrence of hypertrophic scarring and its prognosis, and take preventative measures accordingly.

Key Words: Hypertrophic scars, thyroidectomy, risk factors, prognosis, logistic models, keloid

INTRODUCTION

Postsurgical wound is important for both patients and physicians. If hypertrophic scarring develops rather than just linear scarring, it can cause physical symptoms as well as cosmetic disfigurement. Patients with hypertrophic scars experience itching, pain, and tightness. In our clinical experience, we found that it is important to identify the patients who will need close follow-up for development of a hypertrophic scar, since early intervention can prevent prolonged and severe hypertrophic scars. Early detected postsurgical hypertrophic scar development may respond well to treatments such as gel sheets, corticosteroid injection, or laser.

However, predicting which case will develop hypertrophic scarring is quite difficult, even for board-certified dermatologists. Risk factors which promote postsurgical hypertrophic scar include systemic factors (e.g., genetic factor, disease factor, hormonal factor) and local factors (e.g., tension on the wound, inflammation after surgery). Since there are various factors to consider, it is important to analyze the risk factors in a cohort with a single type of postsurgical scar.

Among the various surgical interventions to treat visceral

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Corresponding author: Mi Ryung Roh, MD, PhD, Department of Dermatology, Gangnam Severance Hospital, Cutaneous Biology Research Institute, Yonsei University College of Medicine, 211 Eonju-ro, Gangnam-gu, Seoul 06273, Korea.
E-mail: karenroh@yuhs.ac

*Mi Yeon Cho and Sang Gyun Lee contributed equally to this work.
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organs, thyroidectomy particularly induces scarring in an exposed area. These scars can also cause limitations in the range of movement when the patient turns or moves the neck. Although many surgical methods have been developed to avoid scarring on the neck, there are numerous cases for which an incision is required in an exposed area.[1] As scars on the neck are more noticeable than those in other areas, they tend to cause psychosocial morbidity in patients after thyroidectomy. This cosmetic problem can eventually affect the patient's quality of life.[2]

If a hypertrophic scar does occur, many patients would want information on the treatment and prognosis. This study investigated the risk factors for predicting the occurrence and prognosis of hypertrophic scar development after thyroidectomy.

MATERIALS AND METHODS

Patient selection

This clinical study was approved by the Institutional Review Board of Gangnam Severance Hospital, Yonsei University (Seoul, Korea) (IRB No. 3-2021-0511) before review of electronic medical records and digital photographs of the patients for data acquisition. Data from patients (n=4238) who visited the dermatology department (Gangnam Severance Hospital, Seoul, Korea) during 2010–2019 were analyzed for this retrospective study. The inclusion criteria included patients who visited our department after a thyroidectomy operation and had scar photographs taken. Exclusion criteria included cases without accompanying photographs or with photographs not suitable for evaluation. Demographic and medical history information that was extracted included age, sex, body mass index (BMI), sternocleidomastoid (SCM) muscle prominence, scar location, history of keloid and cesarean section (CS) hypertrophic scar development, and total triamcinolone treatment dosage.

Variables

Data including age, sex, BMI, SCM muscle prominence, scar location, history of keloid and CS hypertrophic scar development, and total triamcinolone treatment dosages were collected and analyzed. All variables were verified with medical records and serial photographs. BMI was calculated as weight (kg)/height (m^2). Scar location was categorized into two groups: within 1 cm, or not, from the middle portion of the sternal notch to the scar in the mid-line of the body. We defined SCM muscle prominence as when the SCM muscle could be visualized in a straight head position without neck flexion in a photograph. The same dermatologist examined all cases and controls.

Statistical analysis

The results for measured values were expressed as mean±standard deviation values. Independent two sample t-tests, chi-square tests (or Fisher's exact tests), and logistic and linear regression modeling were performed. All analyses were performed using SAS version 9.4 for Windows (SAS Inc., Cary, NC, USA). Statistical significance was set at $p<0.05$.

RESULTS

Baseline patient demographics and characteristics

We analyzed data from 4238 patients, including 1494 patients with hypertrophic scars (group 1) and 2744 patients without scar hypertrophy (group 2) (Table 1). The overall mean patient age was higher in group 2 (39.042±9.515 years) than in group 1 (35.965±8.792 years). In group 1 (11.379%), the proportion of males was higher compared to group 2 (5.175%). The mean BMI was greater in group 1 (23.436±3.934) than in group 2 (22.280±3.259). The number of patients with SCM muscle prominence was higher in group 1 (30.563%) compared to group 2 (18.755%). The number of patients with a scar located within 1 cm of the sternal notch was higher in group 1 (13.239%) than in group 2 (3.056%). There were more patients with a history of keloid development at the other body sites in group 1 (2.008%) compared to group 2 (0.620%). Patients who underwent CS and developed hypertrophic scarring at the pubic area were similarly distributed between group 1 (1.660%) and group 2 (1.537%).

Risk factors of hypertrophic scar occurrence

Of the total 4238 patients included in the analysis, the overall occurrence rate of hypertrophic scarring was 35.3%. Variables that were significant in the univariate analysis were combined for the multivariate analysis (Table 2). Multivariable analysis showed that hypertrophic scar development was associated with younger age [odds ratio (OR)=0.949, $p<0.0001$], male sex (OR=0.562, $p<0.0001$), high BMI (OR=1.137, $p<0.0001$), prominent SCM muscles (OR=2.522, $p<0.0001$), scar located within 1 cm of the sternal notch (OR=4.345, $p<0.0001$), and history of keloid development (OR=2.789, $p=0.0031$).

Factors affecting treatment outcome of hypertrophic scarring, as measured by total amount of triamcinolone injected

Of the 1494 patients with hypertrophic scar development, 1492 patients received triamcinolone injection treatment. A prolonged treatment outcome was considered when the total amount of triamcinolone injected was higher. Univariate analysis revealed factors that affected the total amounts of injected triamcinolone (Table 3). Scar location within 1 cm of the sternal notch and history of keloid development were significant variables associated with a poor treatment outcome or a greater total amount of triamcinolone. Two significant variables were combined for the multivariate analysis (Table 3). The prognosis for hypertrophic scar was associated with scar location within 1 cm of the sternal notch (beta=4.326, $p=0.0429$) and a his-

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Table 1. Baseline Patient Demographics and Characteristics

Variables	Hypertrophic scar (n=1494)	Non-hypertrophic scar (n=2744)	*p* value
Age (yr)	35.965±8.792	39.042±9.515	<0.0001*
Sex			<0.0001†
Male	170 (11.379)	142 (5.175)	
Female	1324 (88.621)	2602 (94.825)	
BMI (kg/m^2)	23.436±3.934	22.280±3.259	<0.0001*
SCM muscle prominence			<0.0001†
No	986 (69.437)	2127 (81.245)	
Yes	434 (30.563)	491 (18.755)	
Scar location within 1 cm of the sternal notch			<0.0001†
No	1232 (86.761)	2538 (96.944)	
Yes	188 (13.239)	80 (3.056)	
Past history of keloid			<0.0001†
No	1464 (97.992)	2727 (99.380)	
Yes	30 (2.008)	17 (0.620)	
Past history of CS hypertrophic scar			0.7698†
No	1303 (98.340)	2562 (98.463)	
Yes	22 (1.660)	40 (1.537)	

BMI, body mass index; SCM, sternocleidomastoid; CS, cesarean section.
Data are presented as mean±standard deviation or n (%).
*by independent two sample t-test; †by Fisher's exact test.

Table 2. Risk Factors for Hypertrophic Scar Occurrence

Variables	Univariate analysis		Multivariate analysis	
	OR (95% CI)	*p* value	OR (95% CI)	*p* value
Age	0.964 (0.957–0.971)	<0.0001	0.949 (0.941–0.957)	<0.0001
Sex				
Male	Ref		Ref	
Female	0.425 (0.337–0.536)	<0.0001	0.562 (0.432–0.730)	<0.0001
BMI	1.095 (1.075–1.115)	<0.0001	1.137 (1.113–1.161)	<0.0001
SCM muscle prominence				
No	Ref		Ref	
Yes	1.907 (1.642–2.214)	<0.0001	2.522 (2.122–2.997)	<0.0001
Scar location within 1 cm of the sternal notch				
No	Ref		Ref	
Yes	4.841 (3.694–6.344)	<0.0001	4.345 (3.253–5.806)	<0.0001
Past history of keloid				
No	Ref		Ref	
Yes	3.284 (1.806–5.974)	<0.0001	2.789 (1.415–5.497)	0.0031

OR, odds ratio; CI, confidence interval; BMI, body mass index; SCM, sternocleidomastoid.

Table 3. Factors Affecting Hypertrophic Scar Treatment Outcomes, Measured by the Total Amounts of Triamcinolone Injected

Variables	Univariate analysis		Multivariate analysis	
	Beta (standard error)	*p* value	Beta (standard error)	*p* value
Scar location within 1 cm of the sternal notch				
No	Ref		Ref	
Yes	4.386 (2.112)	0.0380	4.326 (2.135)	0.0429
Past history of keloid				
No	Ref		Ref	
Yes	23.066 (4.905)	<0.0001	23.082 (5.170)	<0.0001

tory of keloid development (beta=23.082, p<0.0001). In other words, patients with scarring located within 1 cm of the sternal notch received, on average, 4.326 mg more triamcinolone than those without. Patients with a history of keloid development received, on average, 23.082 mg more triamcinolone than those without.

Female patients and CS hypertrophic scar

Of the 3926 female patients, univariate analysis found that a history of CS hypertrophic scar was not a significant risk factor for the occurrence of thyroidectomy hypertrophic scar (Supplementary Table 1, only online). A history of CS hypertrophic scar was also not a significant predictive factor for a poor prognosis associated with treatment of thyroidectomy hypertrophic scar (Supplementary Table 2, only online).

DISCUSSION

In this study, we retrospectively evaluated which factors were linked to the occurrence and prognosis of hypertrophic scars following thyroidectomy. We found that young age, male sex, high BMI, prominent SCM muscles, scar located near the sternal notch, and history of keloid development were associated with hypertrophic scar development. Factors affecting the prognosis of hypertrophic scar treatment were identified as the scar location relative to sternal notch and a history of keloid development.

Postsurgical scarring is an important factor to consider. These visible scars can have negative effects on the patient's quality of life. Many alternative approaches for thyroid surgery methods, including cervical minimally invasive, extra-cervical endoscopic, and transoral operations, have been developed to avoid scarring on the neck. However, conventional thyroidectomy performed via an incision on the neck area is a standardized procedure with low complication rates.[3] Conventional thyroidectomy causes visible scars on an exposed area of the neck. Due to the hypertrophic scarring, patients may suffer from poor cosmetic outcomes or symptoms, such as pain or pruritus. To minimize post-surgical discomfort, our institute recommends several products aimed at reducing scar aggravation. As part of routine care, physicians apply adhesive strips perpendicular to the incision line to alleviate tension during the first month after surgery. Additionally, patients are educated to apply silicone bandages during daytime and silicone ointment before sleep. These measures are intended to promote optimal healing and minimize scar formation.

When patients visit the dermatology department after a thyroidectomy, it is important to inform them on not only how to manage the scar, but also how the scar will change in appearance. Proper treatment is essential for these patients, and the patient's discomfort can be reduced if an intervention is implemented quickly before the hypertrophy becomes more severe.

To investigate the risk factors for hypertrophic scar development after thyroidectomy, our teams of authors previously analyzed data from a 96-patient cohort.[4] In this previous study, we found that the risk factors related to hypertrophic scar development were scar location, SCM muscle prominence, and BMI. Based on the results of the previous study, we analyzed data from a larger cohort of 4238 patients and found other significant risk factors, including young age, presence of a keloid history, and male sex. Young age is a well-known risk factor for hypertrophic scarring.[5,6] The fact that we found that male sex was a risk factor for hypertrophic scarring was contrary to the results of previous studies.[7,8] However, considering that the neck area is subjected to a lot of mechanical stress, stronger tension on the male skin may cause the male sex to act as a risk factor under these circumstances.[9]

Our study also analyzed risk factors to predict the prognosis of treatment of hypertrophic scar following thyroidectomy. Among the subgroup of 1492 patients, we assumed that the higher the treatment dose, the poorer the prognosis. As a result, scar location near the sternal notch and history of keloid development could be risk factors for a poor prognosis for hypertrophic scar on the neck. This result indicated that physicians need to inform patients with a scar within 1 cm of the sternal notch and keloid on other body sites of the long treatment period.

Since the present study included multivariate analysis, there may be some limitations associated with confounding factors. Nevertheless, this study provided results of analyses of data from numerous patients after thyroidectomy. To the best of our knowledge, this was the first multivariate study to evaluate the prognosis of hypertrophic scar after thyroidectomy.

In conclusion, the current study revealed that the occurrence of hypertrophic scar was associated with specific factors, such as age, sex, BMI, incision site near the sternal notch, prominent SCM muscles, and history of keloid development. Prognosis after the treatment of hypertrophic scar was associated with scar location relative to the sternal notch and a history of keloid development.

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AUTHOR CONTRIBUTIONS

Conceptualization: Mi Ryung Roh. Data curation: all authors. Formal analysis: Jee Eun Kim, Sang Gyun Lee, Mi Yeon Cho, and Mi Ryung

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ORCID iDs

Mi Yeon Cho https://orcid.org/0000-0001-9676-6681
Sang Gyun Lee https://orcid.org/0000-0001-6455-8888
Jee Eun Kim https://orcid.org/0000-0003-0795-5742
Yong Sang Lee https://orcid.org/0000-0002-8234-8718
Hang-Seok Chang https://orcid.org/0000-0002-5162-103X
Mi Ryung Roh https://orcid.org/0000-0002-6285-2490

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