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Original research

The perception of scar cosmesis following thyroid and parathyroid surgery: A prospective cohort study

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HIGHLIGHTS

- Scar-related issues are not uncommon following thyroid and parathyroid surgery.
- No correlation was found between scar length and patient satisfaction.
- The perception of an acceptable cosmetic result differs between patient and clinician.
- Asian and Afro-Caribbean ethnicity and a malignant diagnosis were associated with a poor cosmetic outcome.
- The majority of patients would choose to avoid a neck scar given the option.

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ABSTRACT

Introduction: Various "scarless" approaches have been described for thyroid and parathyroid surgery. The objective of the current study was to investigate patients' perception of neck scar cosmesis, its impact on quality of life (QoL) and evaluate patient preference with regards to scar location.
Methods: 120 patients undergoing thyroid or parathyroid surgery were followed-up over a 5-year period (2008–2013). Validated tools were used to assess scar perception and its impact on QoL. These were evaluated against sex, age, ethnicity, operation type, histopathology, time following surgery and scar length.
Results: Mean follow-up was 2.6 ± 3.8 years. One of the most common post-operative problems was scar-related (n = 18). Caucasian patients and those with benign histology expressed a lower impact on QoL ($p < 0.001$, $p = 0.038$). Sex and scar length did not significantly affect patients' perception for scar cosmesis ($p > 0.05$). Clinicians tended to score scar cosmesis higher than patients ($p = 0.02$). Most participants (75%) expressed a clear preference for an extracervical "scar-less in the neck" approach.
Discussion: Scar-related issues are frequently reported following thyroid and parathyroid surgery. The negative impact, often underestimated by clinicians, is more apparent amongst Asian and Afro-Caribbean patients and can significantly impact on their QoL. This, combined with the lack of correlation between scar length and patient satisfaction, indicates the need to divert research from miniaturising neck scars to concealing them in extracervical sites.
Conclusion: Patients prefer a scar-less in the neck approach when given the option. A prospective comparative study is required to compare the cervical and extracervical approaches.

1. Introduction

The standard approach to thyroidectomy uses an anterior neck incision known as "Kocher incision" that is usually 6–8 cm long [1]. In experienced hands, this approach leads to high success rates and low morbidity. However, thyroid surgery is continuously evolving in response to a number of concerns [1,2]. A particular concern with

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the Kocher incision is the possibility of scarring in the exposed anterior neck. Although in the majority of patients the incision heals well, a proportion of patients are left with a noticeable, aesthetically unattractive and psychologically distressing scar [3]. Individual patient characteristics such as age, race and sex can influence scar characteristics and its associated cosmetic perception. As a result, a multitude of surgical techniques have been described in an attempt to reduce the scar-related morbidity associated with thyroid surgery [4].

Minimally invasive video-assisted thyroidectomy (MIVAT) developed by Miccoli [5] is currently the most widely used minimal access technique. Despite MIVAT utilising a smaller incision, a visible neck scar remains. Extracervical endoscopic techniques for thyroid surgery were developed to address this exact problem. Although the literature supports "scarless" (in the neck) endoscopic thyroidectomy (SET) over conventional thyroidectomy in terms of its perceived aesthetic outcome [1,2], SET techniques have significant limitations due to the 2-dimensional view obtained and rigid instrumentation involved. Those ergonomic limitations have hindered the widespread adoption of SET.

SET was re-popularised in 2009, when a group from South Korea led by Chung pioneered the technique of robotic axillary thyroidectomy (RAT) using the da Vinci® robot (Intuitive Surgical, Inc, Sunnyvale, CA) [6,7]. Robotic instrumentation offers numerous advantages over both conventional and endoscopic thyroidectomy [8,9]. In addition to a "scarless" approach, the robotic system offers a superior 3-dimensional view associated with increased precision, tremor filtration, and greater articulation [10]. Despite these advantages, RAT also has some important disadvantages compared to conventional thyroidectomy approaches. Far from being minimally invasive, the robotic transaxillary approach to the thyroid gland involves additional dissection and an associated potential risk to neurovascular structures.

Despite extensive research into novel, "scarless" techniques, little is known about scar perception following conventional thyroid and parathyroid surgery. Moreover, the relationship between patients' and healthcare professionals' impression of scars is poorly understood. Consequently, before offering a RAT approach, it is fundamental to understand and consider the patients' perceptions and attitudes.

The objectives of this study were threefold: (1) to investigate patients' scar perception following conventional thyroid and parathyroid surgery in a UK population; (2) explore patients' attitudes towards "scar-less in the neck" surgery and (3) compare clinician to patient perception for the same scars. Particular attention was paid to the effects of sex, age and ethnicity on patients' perceptions and to the impact of scars on patients' quality of life (QoL).

2. Methods

Patients who underwent conventional thyroid or parathyroid surgery at St. Mary's Hospital, London, UK were surveyed over a 5-year period (December 2008–January 2013). A total of 120 patients consented to be evaluated. This was a prospective study that evaluated outcome measures as part of routine post-operative follow-up. Patients younger than 16 years of age, those with a history of radiotherapy to the head and neck and those who had also undergone lateral compartment neck dissection were excluded from the study.

With regards to cervical incision planning, this was based on whether an obvious skin crease was present on the patient's neck and the size of the thyroid nodule or parathyroid adenoma to be excised. Incision length was kept to a minimum (usually about 4 cm) though long enough to allow delivery of the lesion. The incision was always planned to be symmetrical with respect to the midline so as not to "catch the eye".

If an obvious skin crease was present, then this was opted for. If not, a suture was used to mark the incision which was commonly located around the cricoid area. A high incision is generally preferred for 3 reasons: (1) we believe it is cosmetically superior; (2) it improves access to the superior poles, the most challenging area to dissect during thyroid surgery and (3) in the event that the histopathological examination result of the excised specimen comes back as malignant and a neck dissection is required at a later stage, a high incision can be easily extended along the relaxed skin tension lines. In contrast, a low incision will necessitate superior diversion causing it to transgress the relaxed skin tension lines (i.e. extend across rather than along them) thus compromising wound healing in addition to being longer, wider and curved.

Wound closure was standardised for all patients comprising of 3-layer closure with interrupted 4-0 Vicryl sutures for the strap and platysma muscles followed by continuous 5-0 Vicryl Rapide subcuticular sutures. Following skin closure, Dermabond (Ethicon Endo-Surgery, Inc) tissue glue was applied on the wound. No drains were used. Post-operative wound management was identical throughout the cohort (standard wound care, no antibiotic ointment used routinely).

To quantify scar perception, a visual analogue scale (VAS) was used. This has been validated for the assessment of linear post-operative scars [11]. It can reliably discriminate between different types of scar quality and accurately evaluate patient satisfaction regarding scar cosmesis. Three sets of data were collected.

2.1. Demographic data

Details including age, sex and ethnicity were recorded (Appendix A). Other information included time elapsed since surgery and operation type. Post-operative complications, including hypertrophic and keloid scar formation, were recorded in free text. Histopathology data was collected using electronic medical records. The records were incomplete for 15 patients.

2.2. Patient self-assessment

Patients were asked to assess their scar as it appeared at particular time intervals following surgery (Appendix B). A VAS was used, where 0 indicated the poorest scar (completely unsatisfied) and 10, a "perfect" scar (completely satisfied). Patients were also asked to quantify the effect of the scar on their QoL using a VAS (where 0 indicated no effect and 10, a major effect). Patients were also given the opportunity to make free text comments. In addition, patients' attitudes to scar location (cervical or extracervical) were evaluated using the following question: "if all else were equal between surgical sites (i.e. recovery time, complications, etc.), which site, as indicated by the diagram, would you opt for?" The patients were subsequently given a pictorial representation of 4 anatomical scar sites; upper neck, lower neck, infraclavicular area and axilla, and asked to rank the 4 sites from 1 (most preferred) to 4 (least preferred) (see Appendix C).

2.3. Independent observer assessment

This involved a subjective blind evaluation of a patient's scar by 3 independent assessors: an ENT – Head & Neck surgeon, an endocrinologist and a medical student. The same VAS tool used for patient self-assessment was employed (Appendix D). This was performed on 44 patients, when all 3 evaluators were available in the clinic to assess the scar.

2.4. Statistical analysis

Values are reported as mean ± standard error of the mean (SEM). Comparison of nonparametric data was performed with the Mann–Whitney *U* Test for two variables, and the Kruskal–Wallis test for groups with more than two. Multiple linear regression analysis and partial correlation were performed to determine whether independent demographic and surgical characteristics were predictors of the VAS score. Possible factors considered in the logistic regression were age, sex, follow-up time, ethnicity, operation type, histopathology, and scar length. This was performed for both scar and QoL VAS scar scores. The Wilcoxon signed rank test was used to assess differences in VAS scar scores between patients and individual scores of the 3 independent observers. Pearson's correlation was carried out to identify any association between scar length and VAS self-assessment scar score. Significance was ascribed to any p-value less than 0.05. All statistical analyses were performed using SPSS® software v21.0 (SPSS Inc., Chicago, IL).

The research method was fully compliant with the STROBE criteria and was registered with the Research Registry UIN (protocol number 373).

3. Results

3.1. Demographics

The majority of patients investigated were female (n = 101; 84%) and their mean age (±SEM) at the time of surgery was 51.8 ± 1.3 years. Thirty-three patients (27.5%) described themselves as Caucasian. Forty-nine patients (40.8%) described their ethnicity as non-Caucasian and 38 patients (31.7%) did not declare their ethnicity. Demographic characteristics are shown in Table 1.

3.2. Surgical characteristics

The mean time (±SEM) elapse between surgery and scar evaluation was 2.6 ± 3.8 years. The majority of participants (n = 96, 80%) had undergone thyroid surgery: 34 (28%) having undergone thyroid lobectomy and 62 (52%) total thyroidectomy. Twenty-four patients (20%) underwent parathyroidectomy for primary hyperparathyroidism.

Twenty-three patients (19%) developed post-operative complications. The most commonly reported problems were scar-related (n = 18). The incidence of hypertrophic scars was 12.5% (n = 15). Of those patients with hypertrophic scars, 27% (n = 4) did not declare their ethnicity. The majority of the remaining 11 patients with scar-related issues were of Afro-Caribbean or Asian ethnicity (82%). Non-hypertrophic scar-related issues were cited by 3 patients and included scar discomfort, itching and burning. Other complications included 3 patients who developed recurrent laryngeal nerve (RLN) neurapraxia, all of which resolved within 3 months of surgery. Two patients developed a haematoma that required surgical evacuation. Calcium related problems were not recorded. Surgical characteristics are shown in Table 2.

Table 1
Demographic characteristics of study cohort. Patient ethnicity is divided into those who described their ethnicity as Caucasian and those who describe their ethnicity as non-Caucasian.

Characteristic	Number of patients (%)
Sex	
Male	19 (15.8%)
Female	101 (84.2%)
Age at surgery, years	*Mean (±SEM):* 51.8(1.3)
0–19	0 (0%)
20–39	28 (23.3%)
40–59	53 (44.2%)
>60	39 (32.5%)
Ethnicity	
Caucasian	33 (27.5%)
Non-Caucasian	49 (40.8%)
Afro-Carribean	20 (16.7%)
Asian	27 (22.5%)
South American	2 (1.7%)
Not declared	38 (31.7%)

3.3. Patient assessment

The mean VAS score for scar self-assessment across the entire cohort was 6.6 ± 2.9 (range: 1–10). The effect of independent variables on the VAS scar score is presented in Table 3.

Mean VAS score improved significantly with advanced patient age and progressive time elapsed following surgery. Patients over 60 years were more likely to rate their scars positively ($p = 0.045$). The statistical significance remained even after controlling for all confounding factors ($p = 0.011$, $dF = 46$). The perception of scar appearance improved over time; patients gave their scars the highest VAS score between 9 and 24 months following surgery ($p = 0.004$). Beyond this timeframe, the scar assessment score did not improve. There was a statistically significant difference between the mean VAS score of patients diagnosed with benign compared to malignant pathology as patients with a diagnosis of differentiated thyroid cancer (DTC) rated their scar worse than those with benign disease ($p = 0.003$). The mean VAS score was significantly higher in patients who underwent parathyroidectomy compared to those who underwent thyroidectomy ($p = 0.048$).

The average scar length was 5.84 cm (range: 2.5–10 cm). There was no significant correlation between scar length and patient satisfaction with scar appearance ($p = 0.535$). There was no effect of sex on mean scar VAS score ($p = 0.818$).

3.4. Impact on quality of life

Across the entire cohort, the mean VAS score for impact on QoL was 1.9 ± 2.4 (where 0 indicated no effect and 10 a major effect). The impact of the scar upon a patient's QoL was significantly higher in those patients that experienced scar-related complications ($p = 0.004$). Ethnicity also significantly impacted on QoL. Non-Caucasian patients reported a significantly higher (negative) impact on their QoL than those of Caucasian background ($p < 0.001$). The statistical significance remained after controlling for all other potentially confounding factors ($p = 0.031$, $dF = 46$). Similarly, after controlling for confounding factors, the impact of scar upon QoL was significantly more in patients diagnosed with malignant compared to benign pathology ($p = 0.038$, $dF = 46$).

There was no significant difference between the VAS QoL scores with increasing time at follow-up ($p = 0.192$) and for older patients ($p = 0.209$).

3.5. Scar location

105 patients provided information regarding scar location (15 patients returned incomplete questionnaires). The majority (n = 79, 75%) expressed a clear preference for an extracervical scar. This was irrespective of ethnic origin ($p = 0.739$). Given the choice, most patients (n = 70, 89%) opted for an axillary approach over an infraclavicular incision. Of the remaining 26 patients choosing a cervical approach, the majority (n = 23, 88%) expressed a preference for a lower compared to an upper neck scar (Fig. 1).

Table 2
Surgical characteristics of study cohort. DTC: differentiated thyroid cancer. Q1 (quartile 1, 25%); IQR (interquartile range); Q2 (quartile 2, 75%).

Characteristic	Number of patients (%)
Operation	
Hemi-thyroidectomy	34 (28.3%)
Total thyroidectomy	62 (51.7%)
Parathyroidectomy	24 (20%)
Postoperative complications	
None	97 (81%)
Hypertrophic/keloid scar	15 (12.5%)
Other scar-related	3 (2.5%)
Vocal cord palsy	3 (2.5%)
Haematoma	2 (1.5%)
Histopathology	
DTC	48 (40%)
Non-cancerous	57 (47.5%)
Not specified	15 (12.5%)
Age of scar at follow-up evaluation (months)	*Mean ± SEM:* 30.925 ± 4.3 *Median:* 12 (Q1: 2.27, IQR: 38.4, Q2: 40.67)
< 1	16 (13.3%)
1–3	16 (13.3%)
3–9	13 (10.8%)
9 -24	32 (26.7%)
>24	41 (34.2%)
Not recorded	2 (1.7%)
Average scar length (cm)	*Mean ± SD:* 5.84 ± 1.71 *Range:* 2.5–10

Table 3
Independent variables and scar score (VAS). Data are mean ± standard error of mean (SEM). The asterisk signifies statistically significant results whereby $p < 0.05$.

	n	Cosmetic satisfaction score	SEM	p value
Patient characteristics				
Sex				0.818
Male	19	6.68	0.71	
Female	101	6.62	0.29	
Age (years)				**0.045***
20-39	28	5.74	0.6	
40-59	53	6.49	0.4	
>60	39	7.48	0.43	
Ethnicity				0.314
Caucasian	33	6.44	0.49	
Non-Caucasian	49	5.77	0.44	
Surgical characteristics				
Operation				**0.048***
Thyroid surgery	96	6.4	0.3	
Parathyroid surgery	24	7.55	0.57	
Histopathology				**0.003***
DTC	48	5.83	0.43	
Benign	57	7.35	0.38	
Age of scar				**0.004***
< 1 month	16	5.28	0.81	
1–3 months	16	5.06	0.65	
3–9 months	13	7.43	0.87	
9–24 months	32	7.75	0.4	
> 24 months	41	6.68	0.47	
Scar length (cm)	105	6.4	0.31	0.535

3.6. Independent observer assessment

The mean VAS self-observed scar score for the subset of patients assessed (n = 44) was 5.7 ± 3.0. This subset of patients was defined by those assessed when all independent medical evaluators were available in the same multidisciplinary clinic. The endocrinologist rated the scars significantly better than the patients ($p = 0.02$). There was no statistically significant difference between the ENT surgeons and medical students when compared to patients (Fig. 2).

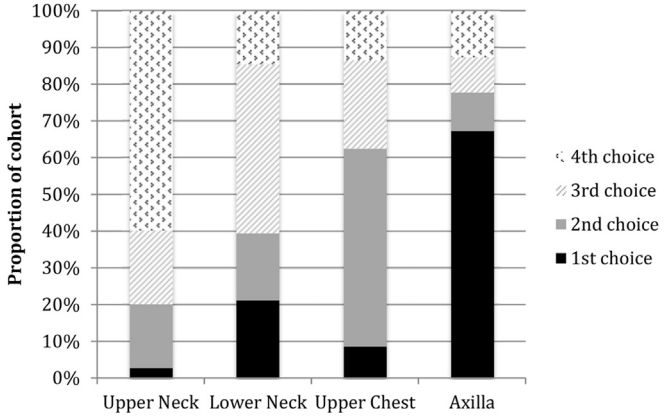

Fig. 1. Patient preference for scar location. Patients were asked to rank the sites (upper neck, lower neck, upper chest (infraclavicular), axilla) as 1 (most preferred) to 4 (least preferred) (see Appendix 2). Fig. 1 illustrates the breakdown of patient preferences for each site.

4. Discussion

This study evaluated the long-term results of conventional thyroid and parathyroid surgery to help guide the development of robotic thyroid and parathyroid surgery. The most important outcome measure was patient satisfaction with scar cosmesis and ranking of patient choice for scar location. Additionally, the main sociodemographic and surgical factors that impacted upon scar cosmesis and QoL were identified.

Cohort demographics were broadly in keeping with the profile associated with thyroid and parathyroid disorders, i.e. predominantly females with a modal age distribution in the 4th decade of life [12,13]. Almost half of the group were of Afro-Caribbean, Asian and South American ethnicity, reflecting the ethnic diversity of the patient population in the local region of London. Patients were recruited from a tertiary referral hospital which accounts for the relatively high proportion (nearly half) of patients being diagnosed with DTC.

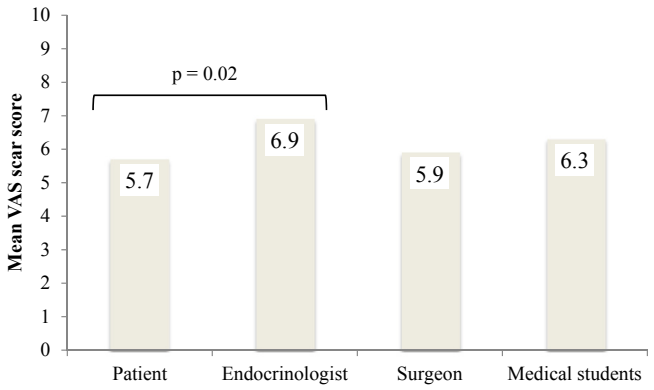

Fig. 2. Independent observer compared to patient assessment of the neck scar. A high score is desirable (0 indicates completely unsatisfied; 10 indicates completely satisfied).

First and foremost, the results of this study highlight the importance of taking the patient's perception of their scar into account when researching techniques for future surgical approaches. Previous studies have shown that clinicians often fail to consider how patients' opinion impacts on their practice [14,15]. Our results indicate that what may appear to be an acceptable cosmetic result to the clinician may not necessarily translate to the patient's perception of their scar: endocrinologists rated scar appearance better than the patients ($p = 0.02$). Therefore, it is important to ask for the patient's opinion of their scar in an effort to identify what is important and which factors have an influence on scar cosmesis. Our results indicate that a variety of factors impact on scar perception but of equal interest are those factors which do not seem to alter the results.

Patients for whom a greater time period had elapsed since surgery were more satisfied with their scars, a finding reinforcing the fact that scars generally improve with time. However, after 2 years, no further improvement was observed. The cellular processes that underpin scar remodelling are most active during the first 3 months after the creation of a wound [16]. However, scar remodelling remains active well beyond this period. Sahm et al. [17] stated that assessment of the scar during the first 6 months following surgery may be misleading as scars do not reach their final appearance until after this time. Those findings are reflected in this study where patients assessed at 3 or fewer months post-operatively were less satisfied with their scars.

A major driving force behind techniques of minimally invasive thyroid surgery is that a small incision is assumed to improve patient satisfaction. The published literature on MIVAT describes the average central incision between 1 and 3 cm [17]. In this study, no correlation was found between scar length and patient scar satisfaction. Similar findings have been reported for patients following thyroid and parathyroid surgery in other studies [18,19]. This suggests that the drive to miniaturise scars may be unnecessary, as patient scar satisfaction appears to be independent of scar length.

A key problem with long-term scar cosmesis is hypertrophic and keloid scarring [20,21]. Darkly pigmented skin is the primary risk factor, with individuals of Asian, Afro-Caribbean and South American ethnicity being far more likely to experience this complication than their Caucasian counterparts [22]. In this study, 15 patients developed hypertrophic scars. 82% of these patients (9/11) were of Asian, Afro-Caribbean and Hispanic ethnicity. Moreover, the impact of ethnicity upon a patient's QoL was significantly higher in those of Afro-Caribbean, Asian or South American origin ($p < 0.001$). These findings are compatible with other reports [23].

The mean scar rating of patients with a diagnosis of cancer was shown to be far worse than those with benign disease ($p = 0.03$). A recent study investigated the impact of post-thyroidectomy scars on the QoL of thyroid cancer patients [24]. The authors concluded that scars on the neck negatively affected the QoL of thyroid cancer patients. Moreover, the Thyroid Cancer Alliance published an article assessing the experience of thyroid cancer patients worldwide [25]. In this multinational cross-sectional survey, patients with thyroid cancer were found to suffer significant post-treatment psychosocial morbidity. Previous studies have explored the importance of supporting a patient's psychosocial requirements and the negative impact of failing to do so [26]. One possible explanation is that when faced with a diagnosis of cancer, the patient's psyche may negatively impact upon their scar satisfaction.

Patients who underwent parathyroidectomy rated their scar more favourably. This finding is unlikely to be due to scar size differences, as patient scar satisfaction remains independent of scar length. A potential reason for the difference in scar satisfaction is the underlying benign parathyroid pathology (100% ($n = 24$) parathyroidectomies were performed for primary hyperparathyroidism) compared to the thyroid group (DTC 50% ($n = 48$); benign 34% ($n = 33$); not recorded 16% ($n = 15$)). Our results regarding impact of histology on scar satisfaction score indicate that patients with benign pathology are more satisfied with their scar. An interesting avenue to explore would be to ask patients to quantify the impact of diagnosis pre-operatively (in terms of associated medical symptoms, such as those of hyperparathyroidism or hyperthyroidism) and compare these to their post-operative QoL scores.

Scar location underpins the rationale for offering patients robotic axillary thyroid and parathyroid surgery [27,28]. A recent study compared the impact of postoperative scars [29]. The authors concluded that the QoL in patients with visible scars is poorer than in those where the scar is hidden. This study concludes that a clear majority (75%) of patients expressed a preference for a scarless in the neck approach, with an axillary scar being the preferred extracervical site.

The findings of this study are compatible with those of a recent UK study that investigated the patient perspective of morbidity following thyroid surgery by means of a postal questionnaire sent to 312 patients [30]. Approximately 65% of the responders stated they would definitely/maybe be interested in a scarless in the neck approach. On the other hand, conflicting results have been reported from another large study ($n = 596$) where only a small proportion (11.6%) of patients surveyed would have opted for a robotic approach [31]. The main criticism of the latter study is that the authors informed the study population that “major drawbacks of this technique compared with conventional thyroidectomy are the longer duration of the procedure, higher postoperative pain, and higher cost”.

There are certain limitations in this study that are worth considering. The most important relates to a selection bias associated with patient recruitment. Secondly, the long average time at follow-up biases the cohort towards those suffering from malignant disease or a complex post-operative course. However, this limitation is advantageous in terms of evaluating scars once wounds have fully healed. Another limitation relates to the socio-demographic characteristics as ethnicity rather than an objective measure of skin colour, such as the Fitzpatrick skin classification, was used [32]. Finally, group heterogeneity needs to be acknowledged as thyroid and parathyroid surgery patients were analysed as one cohort. Nevertheless, this is clinically meaningful as both thyroid and parathyroid disorders are treated by the same surgical specialty.

5. Conclusion

This study shows that scar-related issues represent one of the most frequently reported problems following thyroid and parathyroid surgery. Patient perception of scar cosmesis and its associated impact upon QoL is significant and often underestimated by clinicians. The preference for an axillary incision was evident in this patient cohort. On the basis of this, and the clinical data emerging from South Korea regarding robotic axillary thyroidectomy, the next step will be to perform a head-to-head prospective comparison regarding long-term scar cosmesis and QoL between conventional and robotic axillary thyroidectomy patients in a UK population.

Ethical approval

UIN 373.

Favourable approval from the National Health Service (NHS) Health Research Authority (National Research Ethics Service Committee London). Protocol Reference Number: 08/H0721/97.

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Nothing to declare.

Author contribution

Asit Arora: study design, data collection, writing.
Chloe Swords: data collection, data analysis, writing.
George Garas: data collection, data analysis, writing.
Konstantinos Chaidas: data collection, data analysis.
Alexa Prichard: data collection, data analysis.
James Budge: data collection, data analysis.
D. Ceri Davies: study design, writing.
Neil Tolley: study design, data collection, writing.

Conflicts of interest

Nothing to declare.

Research registry

UIN 373.

Guarantor

Asit Arora.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.ijsu.2015.11.021.

References

[1] D.J. Terris, M.W. Seybt, N. Siupsinskiene, C.G. Gourin, E. Chin, Thyroid surgery: changing patterns of practice, Laryngoscope 116 (2006) 911–915.
[2] C.T.K. Tan, W.K. Cheah, L. Delbridge, "Scarless" (in the neck) endoscopic thyroidectomy (SET): an evidence-based review of published techniques, World J. Surg. 32 (2008) 1349–1357.
[3] B.S. Atiyeh, Nonsurgical management of hypertrophic scars: evidence-based therapies, standard practices, and emerging methods, Aesthetic Plast. Surg. 31 (2007) 468–492.
[4] D.J. Terris, C.G. Gourin, E. Chin, Minimally invasive thyroidectomy: basic and advanced techniques, Laryngoscope 116 (2006) 350–356.
[5] P. Miccoli, P. Berti, G. Materazzi, M. Minuto, L. Barellini, Minimally invasive video-assisted thyroidectomy: five years of experience, J. Am. Coll. Surg. 199 (2004) 243–248.
[6] K.E. Lee, J. Rao, Y.-K. Youn, Endoscopic thyroidectomy with the da Vinci robot system using the bilateral axillary breast approach (BABA) technique: our initial experience, Surg. Laparosc. Endosc. Percutan. Tech. 19 (2009) e71–e75.
[7] Y.S. Chung, J.H. Choe, K.H. Kang, S.W. Kim, K.W. Chung, K.S. Park, et al., Endoscopic thyroidectomy for thyroid malignancies: comparison with conventional open thyroidectomy, World J. Surg. 31 (2007) 2302–2306.
[8] Y.B. Ji, C.M. Song, H.S. Bang, S.H. Lee, Y.S. Park, K. Tae, Long-term cosmetic outcomes after robotic/endoscopic thyroidectomy by a gasless unilateral axillo-breast or axillary approach, J. Laparoendosc. Adv. Surg. Tech. A 24 (2014) 248–253.
[9] S.-W. Kang, J.J. Jeong, J.-S. Yun, T.Y. Sung, S.C. Lee, Y.S. Lee, et al., Robot-assisted endoscopic surgery for thyroid cancer: experience with the first 100 patients, Surg. Endosc. 23 (2009) 2399–2406.
[10] H.K.C. Goh, Y.H. Ng, D.T.W. Teo, Minimally invasive surgery for head and neck cancer, Lancet Oncol. 11 (2010) 281–286.
[11] J.A.L. Duncan, J.S. Bond, T. Mason, A. Ludlow, P. Cridland, S. O'Kane, et al., Visual analogue scale scoring and ranking: a suitable and sensitive method for assessing scar quality? Plast. Reconstr. Surg. 118 (2006) 909–918.
[12] W.M.G. Tunbridge, G. Caldwell, The epidemiology of thyroid diseases, in: L.E. Braverman, R.D. Utiger (Eds.), Werner and Ingbar's the Thyroid: a Fundamental and Clinical Text, sixth ed., J.B. Lippincott Company, Philadelphia, 1991, pp. 578–588.
[13] M.P.J. Vanderpump, The epidemiology of thyroid disease, Br. Med. Bull. 99 (2011) 39–51.
[14] L.L. Swanstrom, E. Volckmann, E. Hungness, N.J. Soper, Patient attitudes and expectations regarding natural orifice translumenal endoscopic surgery, Surg. Endosc. Other Interv. Tech. 23 (2009) 1519–1525.
[15] D. Martin, N. Umraw, M. Gomez, R. Cartotto, Changes in subjective vs objective burn scar assessment over time: does the patient agree with what we think?, J. Burn Care Rehabil. 24 (n.d.) 239–244; discussion 238.
[16] C.L. Baum, C.J. Arpey, Normal cutaneous wound healing: clinical correlation with cellular and molecular events, Dermatol Surg. 31 (2005) 674–686 discussion 686.
[17] M. Sahm, B. Schwarz, S. Schmidt, M. Pross, H. Lippert, Long-term cosmetic results after minimally invasive video-assisted thyroidectomy, Surg. Endosc. Other Interv. Tech. 25 (2011) 3202–3208.
[18] E.C. Toll, P. Loizou, C.R. Davis, G.C. Porter, D.D. Pothier, Scars and satisfaction: do smaller scars improve patient-reported outcome? Eur. Arch. Oto-Rhino-Laryngology 269 (2012) 309–313.
[19] D. Linos, K.P. Economopoulos, A. Kiriakopoulos, E. Linos, A. Petralias, Scar perceptions after thyroid and parathyroid surgery: comparison of minimal and conventional approaches, Surg. (United States) 153 (2013) 400–407.
[20] N. Tolley, A. Arora, F. Palazzo, G. Garas, R. Dhawan, J. Cox, et al., Robotic-assisted parathyroidectomy: a feasibility study, Otolaryngol. Head. Neck Surg. 144 (6) (2011) 859–866.
[21] G. Garas, A. Arora, N. Tolley, Robotic surgery of the Parathyroid Glands, in: G.A. Grillone, S. Jalisi (Eds.), Robotic Surgery of the Head and Neck: a Comprehensive Guide, Springer, New York, 2015, pp. 133–146.
[22] G. Juckett, H. Hartman-Adams, Management of keloids and hypertrophic scars, Am. Fam. Physician 80 (2009) 253–260.
[23] P. Quatresooz, J.F. Hermanns, P. Paquet, G.E. Piérard, Mechanobiology and force transduction in scars developed in darker skin types, Ski. Res. Technol. 12 (2006) 279–282.
[24] Y. Choi, J.H. Lee, Y.H. Kim, Y.S. Lee, H.S. Chang, C.S. Park, M.R. Roh, Impact of postthyroidectomy scar on the quality of life of thyroid cancer patients, Ann. Dermatol 26 (2014) 693–699.
[25] R. Banach, B. Bartès, K. Farnell, H. Rimmele, J. Shey, S. Singer, et al., Results of the Thyroid Cancer Alliance international patient/survivor survey: psychosocial/informational support needs, treatment side effects and international differences in care, Hormones 12 (2013) 428–438.
[26] L. Buchmann, S. Ashby, R.B. Cannon, J.P. Hunt, Psychosocial distress in patients with thyroid cancer, Otolaryngol. Head. Neck Surg. 152 (2015) 644–649.
[27] N. Tolley, G. Garas, F. Palazzo, A. Prichard, K. Chaidas, J. Cox, et al., Long-term prospective evaluation comparing robotic parathyroidectomy with minimally invasive open parathyroidectomy for primary hyperparathyroidism, Head. Neck (2014 Dec 24). http://dx.doi.org/10.1002/hed.23990. [Epub ahead of print].
[28] G. Garas, F.C. Holsinger, D.G. Grant, T. Athanasiou, A. Arora, N. Tolley, Is robotic parathyroidectomy a feasible and safe alternative to targeted open parathyroidectomy for the treatment of primary hyperparathyroidism? Int. J. Surg. 15 (2015) 55–60.
[29] O. Bock, G. Schmid-Ott, P. Malewski, U. Mrowietz, Quality of life of patients with keloid and hypertrophic scarring, Arch. Dermatol. Res. 297 (2006) 433–438.
[30] G. Grover, G.P. Sadler, R. Mihai, Morbidity after thyroid surgery: patient perspective, Laryngoscope 123 (2013) 2319–2323.
[31] D. Linos, A. Kiriakopoulos, A. Petralias, Patient attitudes toward transaxillary robot-assisted thyroidectomy, World J. Surg. 37 (2013) 1959–1965.
[32] W.E. Roberts, Skin type classification systems old and new, Dermatol. Clin. 27 (2009) 529–533.