

Cosmetic aspects in minimally invasive parathyroidectomy: Is minimally invasive approach superior?

Kozmetik yönüyle minimal invaziv paratiroidektomi: Minimal invaziv yaklaşım daha mı üstün?

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Abstract

Aim: The aim of this study was to determine whether minimally invasive parathyroid surgery has any positive impact on cosmesis.

Materials and Methods: This case control study included 28 parathyroidectomized patients, who had been operated between January 2006 – December 2008. All patients were called back for at least 8 months after surgery. Demographics were recorded. Minimally invasive parathyroidectomy versus conventional parathyroidectomy were compared by means of skin features (using Fitzpatrick's classification), results of patient and independent observer scar assessment scales and photographic scar analysis by the blinded plastic surgeon.

Results: There were no differences in demographics and Fitzpatrick's classification between both groups. As expected, incision length of the minimal invasive group was significantly shorter (2.6 ± 0.5 cm vs. 4.9 ± 1.0 cm, $p=0.02$). Meanwhile, no significant difference in objective outcomes of patients between groups was recorded. There was also no significant difference in photographic scar analysis between groups, while independent observer scar assessment scale scores were better in the minimal invasive group ($p=0.03$).

Conclusion: Although superior results of an independent observer, assessment of cosmesis by the plastic surgeon and the patient him/herself revealed no superiority of the minimally invasive approach, when compared to conventional parathyroid surgery.

Keywords: Parathyroidectomy, minimally invasive surgery, cosmesis, scar.

Öz

Amaç: Bu çalışmanın amacı minimal invaziv paratiroidektominin kozmetik üzerine olumlu bir etkisinin olup olmadığının belirlenmesidir.

Gereç ve Yöntem: Bu olgu kontrol çalışması, Ocak 2006-Aralık 2008 tarihleri arasında opera edilen 28 paratiroidektomili hastayı kapsamaktadır. Tüm hastalar operasyondan en az 8 ay sonra kontrole çağırıldı. Demografik verileri kaydedildi. Minimal invaziv paratiroidektomi ve konvansiyonel paratiroidektomi, operasyon sonrası cilt özellikleri açısından (Fitzpatrick's sınıflaması kullanılarak belirlenen) bir plastik cerrah tarafından hasta sonuçları ve bağımsız gözlemci skar değerlendirme skalası, fotografik skar analizi vasıtasıyla karşılaştırıldı.

Bulgular: İki grup arasında demografik veriler ve Fitzpatrick's sınıflaması açısından farklılık saptanmadı. Beklendiği gibi minimal invaziv grubun insizyon uzunluğunun daha kısa olduğu belirendi (2.6 ± 0.5 cm'ye 4.9 ± 1.0 cm; $p=0.02$). İki grup arasında objektif sonuçlar açısından anlamlı bir fark belirlenmedi. Fotografik skar analizi açısından iki grup arasında anlamlı bir fark belirlenmezken, bağımsız gözlemci skar değerlendirme skalası sonuçlarının minimal invaziv cerrahi grubunda daha iyi olduğu belirlendi ($p=0.03$).

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Sonuç: Bağımsız bir gözlemci tarafından daha iyi sonuçlar olduğu belirtilse de, kozmetik sonuçlar bir plastik cerrah ve hasta tarafından değerlendirildiğinde minimal invaziv cerrahinin konvansiyonel cerrahiye göre bir üstünlüğünün olmadığı belirlendi.

Anahtar Sözcükler: Paratiroidektomi, minimal invaziv cerrahi, kozmetik, skar.

Introduction

Beauty has been an incredible source of inspiration to people for centuries. This has led to the emergence of a myriad of artwork. Besides, in history, wars have been carried out for the sake of 'beauty'. Beauty influenced the art of surgery as well. Since remaining scars after surgeries were believed to shadow beauty, surgeons forced themselves to hide the traces of their artwork and to decrease the length of incision and area of surgical dissection in years. Since it is more common in women and considering the anatomical site of surgery, which is the bare neck, this paradigm shift affected thyroid and parathyroid surgery, as expected. The consequences of surgical wound trauma and the final appearance of the surgical scar are of considerably priority, since these neck surgeries are considered safe surgical procedures due to modern surgical techniques.

The first endoscopic cervical parathyroidectomy was defined by Gagner (1) in 1996, and the first endoscopic thyroidectomy by Huscher et al. (2) in 1997. The first minimally invasive video-assisted thyroidectomy (MIVAT) for thyroid lesions with a diameter minor than 3 cm had been described in 1998 by Miccoli (3) and he defined this method as safe and effective, resulting with excellent cosmetic outcomes in all patients. Another original technique was described in 2000 by Ohgami et al. (4). They introduced an endoscopic thyroidectomy, using the breast approach, to avoid an operative scar in the neck (4). Ikeda et al. (5), introducing endoscopic thyroidectomy using transaxillary approach in 2000, reported that the cosmetic result of the procedure was excellent and sensory loss in the neck could be neglected.

Until recently, a number of studies have examined patient satisfaction with scar cosmesis following the so-called minimally invasive parathyroidectomy and/or thyroidectomy (6-14). Most of these (6-9,13) reported an increase in patient satisfaction with scar aesthetic after minimally invasive surgery. However, only a very few examined cosmetic outcomes or patient satisfaction using validated systematic measures or assessment scales, or had a follow-up, more than 6 months after surgery (10-12,14). Despite the propensity for smaller incisions or scarless surgical techniques, the issue of incision length still appears to be controversial. In this study, we aimed to determine whether minimally invasive parathyroid surgery had any positive impact on cosmetic outcomes by using different scales, carried out by the patient, an observer and the plastic surgeon.

Materials and Methods

A total of 58 patients had been operated between January 2006 – December 2008 due to parathyroid adenoma. Out of these 58 cases, 35 cases reported to come for the long-term follow-up. Twenty-eight of them were included in this case control study. The primary endpoint was objective wound appearance after more than 8 months postoperatively. Our secondary endpoints were patient and observer tendency on scar formation. Exclusion criteria included repeat operations (for recurrent disease or complications); those with concomitant conditions that might influence wound healing, such as immunosuppression or allergies to adhesive tape; those converted to longer incisions or those having applied any local chemical that actively promotes the healing process of the skin and reduces scarring. Telephone interviews were conducted and patients were invited for an assessment at the outpatient clinic. Based on a previously reported, similar, but prospective study, conducted by O'Connell et al. (12), using an α of .05 and a power of 0.8, the required sample size to show a conservative difference of 3 points on a 10-point scale between groups was calculated as 9 patients for each group of the study. We did not perform another 'a priori' power analysis.

Seven patients out of the 58 cases were excluded; 5 due to revised surgeries (previous surgeries performed elsewhere) and 2 due to local application of chemicals, else than sunscreen that was advised to all patients postoperatively. The overall response rate was 55%. A total of 28 returned for long-term follow-up assessment and an informed consent had been obtained. All patients were called back for at least 8 months after surgery. The reason why we used a minimum of 8 months after surgery was based on the knowledge that wound healing is being completed at that time (15).

Demographics were recorded. Minimally invasive parathyroidectomy (MIP) vs. conventional parathyroidectomy (CP) were compared by means of skin features (using Fitzpatrick's classification) (Table-1), results of patient and independent observer scar assessment scales and photographic scar analysis by the blinded plastic surgeon (OA) (Table-2).

MIP was defined as surgery carried out with a <2.5 cm skin incision, at the level of the traditional Kocher's incision. Nevertheless, MIP was not only depending on the small incision, but also in respect of the extent of the dissection and whether the surgery was targeted on one specific parathyroid gland, based on preoperative work-

up. Due to traction of the skin, caused by retractors, the length of the incision might increase up to 3 cm. CP was defined as surgery carried out with a 4-6 cm skin incision, where four parathyroid glands generally had been explored. Once the hyperfunctioning parathyroid glands had been removed successfully, strap muscles were closed with an absorbable suture (3/0 vicryl) and the platysma muscle, as well as the subdermal layer, were closed with running absorbable sutures, using 3/0 vicryl. Adhesive strips were used to close the epidermal layer. These were placed vertically along the wound with no separation between each strip. The adhesive strips were left in situ until they fell off (typically 7–14 days). All operations were performed by surgeons who are specialized in endocrine surgery (OM, GI, MA). In the conventional approach, the patients received a cervical incision of at least 3 cm.

Table-1. Fitzpatrick's Classification Scale (17).

Skin Type	Skin Color	Characteristics
I (scores 0-7)	White; very fair; red or blond hair; blue eyes; freckles	Always burns, never tans
II (scores 8-16)	White; fair; red or blond hair; blue, hazel or green eyes	Usually burns, tans with difficulty
III (scores 17-25)	Cream white; fair with any eye or hair color; very common	Sometimes mild burn, gradually tans
IV (scores 25-30)	Dark Brown; typical Mediterranean Caucasian skin	Rarely burns, tans with ease
V (scores over 30)	Dark brown; Middle Eastern skin types	Very rarely burns, tans very easily
VI	Black	Never burns, tans very easily

Table-2. Outcomes of Demographic Data.

	Minimally invasive surgery (n=13)	Conventional surgery (n=15)	p value
Age	52±9.2	57±10.7	0.07
Gender			
Male	2	1	
Female	11	14	0.21
Follow-up (months)	22±6.4	28±10.4	0.15
Fitzpatrick's classification scale			
1	1	1	
2	3	4	
3	7	9	0.1
4	2	2	

We used three scales to evaluate the results of the scar formation, as mentioned above. Before, we wanted to know the natural state of the skin in both groups. The Fitzpatrick Scale is a numerical classification schema for the color of the skin that has been used by many skin care professionals, in order to determine how someone will respond or react to different treatments (16). This scale was developed in 1988 by Thomas B. Fitzpatrick (17), as a way to classify the response of different types of skin to ultraviolet light (Table-1). It classifies a person's complexion and the tolerance of sunlight.

The aesthetic evaluation was assessed by the patients and an independent observer, namely the Patient and Observer Scar Assessment Scale (POSAS). This is a validated scar assessment tool that has been shown to be a reliable method for scar assessment by Draaijers et al. (18) and has been used in a similar and well-designed study by O'Connel et al. (12).

Patient scar assessment scale (PSAS) included 6 parameters and was used to assess patients' complaints as well. In this scale, patients were asked to rate their perception to; scar pain, itching, colour, stiffness, thickness and regularity of the scar. A score of 10 represented the worst possible outcome. The observer scar assessment scale (OSAS) included 5 parameters; vascularization, pigmentation, thickness, relief and pliability of the scar. A fourth year medical student (AK) was asked to rate these and a score of 10 represented the worst possible outcome.

Photographs (all frontal views) of the wounds were obtained with a Finepix S5200, Fuji, 18-55 mm lens stabilized on a tripod with standardized lighting and background features (Figure-1). The image files were assessed by a consultant plastic surgeon on the same computer monitor in a blinded manner. The 'plastic surgeon scar assessment scale' included 3 parameters; pigmentation, thickness and distortion of the scar. Wound appearance was asked to be assessed using a Likert scale, based on these 3 parameters. A score of 10 represented the worst possible outcome.

Ethics committee approval was received for this study from the Ethics Committee of Ege University faculty of Medicine.

Statistical analysis

Statistical analysis was carried out using SPSS release 17.0 for Windows (SPSS Inc., Chicago, IL, USA). All quantitative data were presented as mean values ± standard error of the mean. Continuous variables were assessed using the Mann-Whitney U and Fisher Exact test. A p<0.05 was considered statistically significant.



Figure-1. Postoperative views of recovered incisions. **A1.** Mini incision parathyroidectomy (well-healed); **B1.** Conventional thyroidectomy (well-healed); **B2.** Mini-incision parathyroidectomy (bad-healed).

Results

Of the 28 cases, 25 (89.3%) were women and only 3 (10.7%) were men. The MIP and CP groups were matched in terms of age, gender, follow-up time and Fitzpatrick's classification. Demographic data, including results of Fitzpatrick's classification scale has been presented in Table-3. The mean follow-up period was 22 ± 6.4 months in the minimally invasive group and 28 ± 10.4 months in the conventional surgery group ($p=0.15$). As expected, incision length of the minimal invasive group was significantly shorter (2.6 ± 0.5 cm vs. 4.9 ± 1.0 cm; $p=0.02$). The parathyroid adenoma was successfully identified and removed in all cases and histopathological evaluation of the specimen confirmed a hypercellular parathyroid tissue. No complications related to parathyroid surgery such as recurrent laryngeal nerve palsy, bleeding, surgical site infection or hypocalcaemia were noted in either the MIP group or the CP group.

Table-3. Results of Assessment Scales.

	Minimally invasive surgery (n=13)	Conventional surgery (n=15)	p value
Patient scar assessment scale (PSAS)	8.6 ± 1.1	8.2 ± 2.8	0.59
Observer scar assessment scale (OSAS)	8.2 ± 1.8	12.2 ± 2.7	0.03
Plastic surgeon assessment scale	4.5 ± 1.7	5.2 ± 0.7	0.92

Results of PSAS, OSAS and plastic surgeon scar assessment scale are presented in Table-3. There was no improvement in both wound appearance and complaints related to the scar in the MIP group,

compared to the CP group using the patient assessment scale (8.6 ± 1.1 vs. 8.2 ± 2.8 ; $p=0.59$) and plastic surgeon assessment scale (4.5 ± 1.7 vs. 5.2 ± 0.7 ; $p=0.92$). The observer score performed by the independent assessor revealed an improvement in wound healing in the MIP group, compared to the CP group (8.2 ± 1.8 vs. 12.2 ± 2.7 ; $p=0.03$).

Discussion

This study reveals that the benefits regarding cosmetic outcomes after minimally invasive surgery, seen previously in other reports, could not be documented. Minimally invasive surgery had no positive effect on patients' scar evaluation after MIP, based on assessment scales. This reflects the result that patients were as well satisfied with cosmetic results of the conventional surgery, as the minimally invasive procedure. Patients' late postoperative symptoms were minimal and the appearances of scars were acceptable after MIP or CP. According to the plastic surgeon's blinded assessment, there was no significant difference between both groups. Thus, the relationship between scar length and patient assessment scores does not appear to be as certain as previously thought.

Parathyroid surgery has evolved over the last decades, particularly with the advent of minimally invasive thyroid surgery, resulting in shorter incision lengths. A shorter incision, however, does not necessarily mean an improvement of patient's overall satisfaction (19). Despite the fact that smaller incisions are regarded as improving wound appearance in general, the exposure is often very limited. Significant retraction during surgery is warranted to provide adequate access to target the pathologic gland. 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, which may alter normal wound healing.

Until recently, several so-called minimally invasive techniques have been described and carried out safely for parathyroid gland surgery; the unilateral approach, radioguided surgery, open minimally invasive (mini-incision) surgery, video-assisted and fully endoscopic parathyroidectomy, as well as robot-assisted surgery. These have been proposed to improve cosmetic outcomes (19). MIP has become very popular and an incision of 3 cm or less in length or no scar in the neck has been the main features differentiating minimally invasive approaches from traditional approaches (11). General characteristics of minimally invasive techniques are; a smaller incision, when compared to classic open transverse cervical incision and a targeted approach, focused on the pathological parathyroid gland(s). Especially focused parathyroidectomy has been adopted widely, since it is accepted to be a simple procedure carried out without the need for any additional equipment

on hand, and as successive as the traditional approach on the other hand. According to the International Association of Endocrine Surgeons' Survey, more than half of the surgeons implemented the MIP (20). MIP must be recommended only for patients with sporadic hyperparathyroidism and when preoperative concordant imaging studies have localized a single adenoma. Patients suspected for multiglandular disease on imaging studies or patients with familial hyperparathyroidism may not be eligible for these limited procedures. The advantages of MIP are reported as follows: decreased operating times, decreased hospital stay, reduced level of physical invasiveness, and better cosmetic results (21).

To evaluate the expectations of the surgical patient is of utmost importance, since expectations influence the patient's perception of the surgical outcome. It is this perception that determines the ultimate psychological response to the results of the operation (22). The concept of image is important for understanding the psychological reaction to sequelae of surgery. The cosmetic importance of the front of the neck comes from its anatomical visibility. This is why in patients undergoing thyroid and parathyroid surgery, it is important to assess patients' expectations before the procedure. These expectations influence patient's perception on the surgical outcome. The potentially important body image factors affecting patient satisfaction, include patients' subjective perception to the surgical change, patients' expectations, social evaluation of surgical change and age, as well as gender (23). Since surgeons are aware of these expectations awaiting better patients' satisfaction after smaller or no neck scar, a lot of new surgical techniques, like mini-incision, endoscopic, robotic, transaxillary and video-assisted techniques have been developed, as presented above. Meanwhile, new techniques describe for thyroid and parathyroid surgery carry potential new risks, as expected (24). Increased satisfaction with scar cosmesis is expected to be the primary clinical advantage of these approaches. However, not all studies showed statistically significant difference in scar cosmesis between the groups beyond months (11,12,14).

Long-term follow-up regarding scar assessment is important, because of the time warranted for the natural wound healing process. A criticism may be made towards why at least 8 months' time point to perform wound assessment after surgery was chosen as an appropriate time. As previously reported by O'Connell et al (12), the cellular processes that underlie scar remodeling are most active during the first 6 months following the creation of a wound. These wounds then undergo greatly reduced remodeling over the subsequent 6 months, with indefinite minimal remodeling that is lifelong (12). This means that any study reporting

early postoperative data regarding scar assessment should be criticized.

In this study, approximately half of the patients were treated with MIP and experienced skin incisions and scars less than 3 cm (mean 2.6 cm) in length. Although superior results of independent observers, assessment of cosmesis by the plastic surgeon and the patient him/herself revealed no superiority of the minimally invasive approach, when compared to conventional parathyroid surgery. These results are supported by the prospective cohort study by O'Connell et al (12). A combined group of 11 patients treated by conventional-access thyroidectomy and parathyroidectomy (mean incision length, 7.6 cm) were compared to a group of 11 patients treated by minimal access parathyroidectomy (mean incision length, 3.4 cm). Patients with smaller incision were not more satisfied than patients having longer incision. No significant differences were found between objective measures of scar appearance such as the Vancouver and Patient & Observer Scar Assessment Scales (POSAS). Besides, there was increased visibility of the conventional surgery group scars by the named naive viewers. That study gives us further evidence that the length of incision does not affect patient satisfaction and suggests that the issue of parathyroidectomy scar satisfaction is not only simply being a question of length. However, the study of O'Connell et al. may be criticized due to its small sample size and the mean age of the population reaching 70 years. This came in for criticism by Terris and Seybt (25) and they comment that elderly women would not be concerned with the appearance of their scar as the young patients do. The mean age of our study group was 54+9.3. This confirms the results regarding PSAS of the latter study and shows that scar perception is not changing between young and old patients, as asserted by Terris and Seybt.

Another study, carried out by Linos et al. (11), reported that minimally invasive procedures for the thyroid and parathyroid gland were not associated with statistically significant improvements in patient satisfaction. A recent paper systematically reviewed the evidence for whether minimally invasive techniques were comparable to conventional bilateral neck exploration methods in terms of success and complication rate; and if they were comparable, which technique is likely to be best for cosmesis, patient safety and satisfaction (26). Based on the evidence, long term cosmetic satisfaction has not been shown to be significantly better for bilateral neck exploration compared with minimally invasive parathyroidectomy. Another long-term study, with a higher number of cases assigned to each group is therefore essential to verify the findings of these studies.

Despite this, since the lack of studies regarding parathyroid surgery, there are studies reporting surgical

approaches like minimally invasive video-assisted surgery may result in additional advantages compared to conventional surgery for the thyroid in terms of pain relief and cosmetic outcomes (6,8,27). A trial of video-assisted thyroidectomy versus conventional thyroidectomy showed that although lasting longer, the minimally invasive approach was related to an improved cosmetic outcome and less post-operative pain scores (6). These results are supported by Gal et al (27). who also found that the minimally invasive approach offered distinct advantages to selected patients in terms of very good to excellent cosmetic results and reduced postoperative distress. A recent meta-analysis reported that minimally invasive video-assisted thyroidectomy is superior to conventional surgery in terms of cosmesis and pain relief (28).

The limitation of most of these studies is the method of scar assessment, which has generally been conducted via a simple patient-reported Likert scale of satisfaction. A better analysis of scar appearance and patient satisfaction would be gained by use of a validated scar assessment tool that includes objective scoring of scar appearance by an independent observer, such as the 'Patient & Observer Scar Assessment Scale (POSAS)' or Vancouver Scar Assessment Scale. These assessment scales are assessing more than just the appearance of scars using parameters like vascularity, pigmentation, thickness, relief, pliability, color, stiffness, regularity of the wound and patient factors such as pain and itching. Another point to criticize is the short follow-up time for scar assessment.

As other studies do, this study also possesses certain limitations. One of these limitations is its retrospective nature and the small sample size. Recall bias represents

a major threat to the internal validity of retrospective studies. Nevertheless, regarding the power analysis of the similar prospective cohort study of O'Connell et al (12), using an α of 0.05 and a power of 0.8, at least 9 samples for each group would be sufficient to show a difference of 3 points on a 10-point scale. We therefore assume the risk of type II error to be low in this study. Another limitation is the lack of patient satisfaction assessment. This may be achieved by carrying out future studies, using approved questionnaires and surveys regarding health-related quality of life as well.

Overall, this is one of the very few studies addressing the impact of the incision length of parathyroid surgery on cosmetic outcome in the long term. In addition, this study reveals that parathyroidectomy needs not be performed through excessively short incisions for the sake of scar appearance. Although observers were more able to point out a worse cosmetic appearance in the conventional surgery group, the patients themselves did not seem to notice any benefit with smaller scars.

Conclusion

Although superior results of an independent observer, assessment of cosmesis by the plastic surgeon and the patient him/herself revealed no superiority of the minimally invasive approach, when compared to conventional parathyroid surgery.

Informed consent. Written informed consent was obtained from patients who participated in this study.

Conflict of interest. The authors declare they have no conflict of interest. The authors received no funding for this study.

References

1. Gagner M. Endoscopic subtotal parathyroidectomy in patients with primary hyperparathyroidism. *Br J Surg* 1996;83(6):875.
2. Huscher CS, Chiodini S, Napolitano C, Recher A. Endoscopic right thyroid lobectomy. *Surg Endosc* 1997;11(8):877.
3. Miccoli P, Berti P, Conte M, Bendinelli C, Marcocci C. Minimally invasive surgery for thyroid small nodules: preliminary report. *J Endocrinol Invest.* 1999;22(11):849-51.
4. Ohgami M, Ishii S, Arisawa Y, et al. Scarless endoscopic thyroidectomy: breast approach for better cosmesis. *Surg Laparosc Endosc Percutan Tech* 2000;10(1):1-4.
5. Ikeda Y, Takami H, Niimi M, Kan S, Sasaki Y, Takayama J. Endoscopic thyroidectomy by the axillary approach. *Surg Endosc* 2001;15(11):1362-4.
6. Miccoli P, Berti P, Raffaelli M, Materazzi G, Baldacci S, Rossi G. Comparison between minimally invasive video-assisted thyroidectomy and conventional thyroidectomy: A prospective randomized study. *Surgery* 2001;130(6):1039-43.
7. Miccoli P, Bendinelli C, Berti P, Vignali E, Pinchera A, Marcocci C. Video-assisted versus conventional parathyroidectomy in primary hyperparathyroidism: a prospective randomized study. *Surgery* 1999;126(6):1117-22.
8. Bellantone R, Lombardi CP, Bossola M, et al. Video-assisted vs conventional thyroid lobectomy: A randomized control trial. *Arch Surg* 2002;137(3):301-4.
9. Ikeda Y, Takami H, Sasaki Y, Takayama J, Niimi M, Kan S. Clinical benefits in endoscopic thyroidectomy by the axillary approach. *J Am Coll Surg* 2003;196(2):189-95.
10. Böhm B, Minner S, Engelhardt T, Rodiger H. Long term cosmetic results following thyroid resection. *Chirurg* 2005;76(1):54-7.

11. Linos D, Economopoulos KP, Kiriakopoulos A, Linos E, Petralias A. Scar perceptions after thyroid and parathyroid surgery: Comparison of minimal and conventional approaches. *Surgery* 2013;153(3):400-7.
12. O'Connell DA, Diamond C, Seikaly H, Harris JR. Objective and subjective scar aesthetics in minimal access vs conventional access parathyroidectomy and thyroidectomy surgical procedures: A paired cohort study. *Arch Otolaryngol Head Neck Surg* 2008;134(1):85-93.
13. Toll EC, Loizou P, Davis CR, Porter GC, Pothier DD. Scars and satisfaction: do smaller scars improve patient-reported outcome? *Eur Arch Otorhinolaryngol* 2012;269(1):309-13.
14. Tolley N, Garas G, Palazzo F, et al. Long-term prospective evaluation comparing robotic parathyroidectomy with minimally invasive open parathyroidectomy for primary hyperparathyroidism. *Head Neck* 2016 Apr; 38(Suppl 1):E300-6.
15. Baum CL, Arpey CJ. Normal cutaneous wound healing: Clinical correlation with cellular and molecular events. *Dermatol Surg* 2005;31(6):674-86.
16. Wang LZ, Ding JP, Yang MY, Chen DW, Chen B. Treatment of facial post-burn hyperpigmentation using micro-plasma radiofrequency technology. *Lasers Med Sci* 2015;30(1):241-5.
17. Fitzpatrick TB. The validity and practicality of sun-reactive skin types I through VI. *Arch Dermatol* 1988;124(6):869-71.
18. Draaijers LJ, Tempelman FRH, Botman YAM, et al. The patient and observer scar assessment scale: A reliable and feasible tool for scar evaluation. *Plast Reconstr Surg* 2004;113(7):1960-5.
19. Henry JF. Minimally invasive thyroid and parathyroid surgery is not a question of length of the incision. *Langenbecks Arch Surg* 2008;393(5):621-6.
20. Sackett WR, Barraclough B, Reeve TS. Worldwide trends in the surgical treatment of primary hyperparathyroidism in the era of minimally invasive parathyroidectomy. *Arch Surg* 2002;137(9):1055-9.
21. Henry JF, Thakur A. Minimal access surgery - thyroid and parathyroid. *Indian J Surg Oncol* 2010;1(2):200-6.
22. O'Hara MW, Ghoneim MM, Hinrichs JV, Mehta MP, Wright EJ. Psychological consequences of surgery. *Psychosom Med* 1989;51(3):356-70.
23. Massetti M, Nataf P, Babatasi G, Khayat A. Cosmetic aspects in minimally invasive cardiac surgery. *Eur J Cardiothorac Surg* 1999;16(2):73-5.
24. Dralle H, Machens A, Thanh PN. Minimally invasive compared with conventional thyroidectomy for nodular goitre. *Best Pract Res Clin Endocrinol Metab* 2014;28(4):589-99.
25. Terris DJ, Seybt MW. Cosmesis in thyroid and parathyroid surgery: a matter of perspective. *Arch Otolaryngol Head Neck Surg* 2008;134(10):1120; author reply 1120-1.
26. Gracie D, Hussain SS. Use of minimally invasive parathyroidectomy techniques in sporadic primary hyperparathyroidism: systematic review. *J Laryngol Otol* 2012;126(3):221-7.
27. Gal I, Solymosi T, Szabo Z, Balint A, Bolgar G. Minimally invasive video-assisted thyroidectomy and conventional thyroidectomy: A prospective randomized study. *Surg Endosc*. 2008;22(11):2445-9.
28. Radford PD, Ferguson MS, Magill JC, Karthikesalingham AP, Alusi G. Meta-analysis of minimally invasive video-assisted thyroidectomy. *Laryngoscope* 2011;121(8):1675-81.