**Musculoskeletal neck disorders in thyroid cancer patients after thyroidectomy**

**ABSTRACT**

Thyroid cancer (TC) is the most common type of cancer in the endocrine system and thyroidectomy is the preferred treatment. Complications associated are still common and 80% of patients complain of posterior neck pain. The aim of this study was to analyse the long-term musculoskeletal disorders in TC patients who had undergone thyroidectomy.An observational case-control study was carried out. Twenty-eight patients who had undergone thyroidectomy and 28 healthy control patients were included. Outcomes were collected six months after surgery and included: musculoskeletal neck disorders (neck range of movement, trigger points) and functional variables (pain intensity and disability).Significant differences were found between groups in flexion (p=0.002) and extension (p=0.005), with lower values in the thyroidectomy group.The number of trigger points was higher in the thyroidectomy group in both scalenes (p<0.001), both sternocleidomastoids (p<0.001), both upper trapezius (p=0.005 and p=0.008), right levator scapulae (p=0.002) and both suboccipitalis (p=0.002). Pain intensity (p<0.001) and the Neck Outcome Scale subscales (p<0.05) also presented significant differences. Thyroidectomy patients, six months after surgery, show a significant decrease of neck range of movement and an increase in the number of trigger points. They also show greater pain intensity and more disability six months after surgery.

**Key words:** thyroid cancer, thyroidectomy, surgery, neck pain, disability, trigger points.

**INTRODUCTION**

Lung, breast, prostate, and colorectal cancer are considered to be the "big four" cancer types in the United States (Siegel et al., 2014). However, the incidence of thyroid cancer is steadily increasing (Aschebrook-Kilfoy et al., 2013; Hankey et al., 1999) and, by 2030, thyroid cancer is expected to replace colorectal cancer as the fourth leading cancer diagnosis (Rahib et al., 2014).

Thyroid cancer is the most common type of cancer in the endocrine system, representing 4% of all new cancer cases worldwide, with an age-standardized (world population) rate of 6.10/100,000 women and 1.90/100,000 men in 2012 (Ferlay et al., 2012).

Within therapeutic options, surgical resection is the mainstay of treatment of thyroid cancer patients (Cooper et al., 2006) and thyroidectomy the most common technique performed (Delbridge et al., 2003),with the best results in recurrence and long-term survival rates (Bilimoria et al., 2007). Surgical advances have reduced mortality by a large scale (Sakorafas et al., 2010), globally in 2012, estimated numbers of deaths from thyroid cancer were 27,000 in women and 13,000 in men, corresponding to mortality rates of approximately 0.6/100,000 women and 0.3/100,000 men (La Vecchia et al., 2015). However, associated complications are still common and cause significant morbidity for patients (Terell et al., 2015).

The primary and most studied complications following a thyroidectomy are reported to be recurrent laryngeal nerve palsy and hypoparathyroidism (Bellantone et al., 2002). Musculoskeletal complications are also common because nerves, parathyroid, and surrounding structures are all at risk of injury during the procedure (Moshtaghi et al., 2017).

According to a previous study, more than 80% of patients complain of posterior neck pain following thyroidectomy (Han et al., 2006). Thyroidectomy surgery is performed in the supine position while the patient’s neck is placed at full extension (Park et al., 2015). Park et al. (2015) suggested that this prolonged neck extension generates nociceptive stimuli and neural transmission intraoperatively, resulting in posterior neck pain following surgery. Moreover, muscle strain, ischemia, anterior longitudinal ligament injury, and hyperextension of cervical facet joints could contribute to neck pain development (Park et al., 2015). Takamura et al. (2005) showed that patients, during the early postoperative period, used not to move their necks and to walk robotically, possibly to prevent exacerbating the neck pain and to protect their incisions, and that this fact could be involved in a long-term neck pain.

Many patients complain about a stretching, choking, or pressing feeling or discomfort in the neck, headache, shoulder stiffness, and difficulty moving the neck or shoulders (Roerink et al., 2017; Takamura et al., 2005). Experiencing neck discomfort symptoms has negative effects on patients’ quality of life after a thyroidectomy (Takamura et al., 2005). Additionally, these symptoms may continue for a long time after surgery and may even influence the daily life of these patients (Takamura et al., 2005). Despite the high incidence, there are not many studies regarding long-term neck musculoskeletal disorders in thyroid cancer patients undergoing thyroidectomy. To have profound knowledge of neck musculoskeletal complications could be important to improve the clinical approach of these patients. Most patients recover from mayor complications within 6 months after surgery (Choi et al., 2018; Dionigi et al., 2010), so, to know if musculoskeletal disorders remain after this time is important. Thus, the aim of this study was to analyze the long-term musculoskeletal disorders in thyroid cancer patients who underwent thyroidectomy.

**METHODS**

An observational case-control study has been carried out. The study protocol was reviewed and approved by the University of Granada Ethics Committee (Granada, Spain). Patients diagnosed with thyroid cancer who had undergone total thyroidectomies were recruited from the “Complejo Hospitalario Universitario” (Granada) six months after surgery, between April 2016 and January 2018. They had to be between 18 and 80 years old, and all were informed and signed the informed consent. The control group consisted of age and sex matched healthy volunteers who had never undergone a thyroidectomy intervention. Patients in both groups were excluded if they were suffering from one of the following conditions: cognitive impairment, orthopedic pathologies which limited the test performance, neurologic pathologies limiting voluntary mobility, neck dissection or previous neck pathologies. This study was performed in accordance with the Declaration of Helsinki (General Assembly of the World Medical Association, 2014) and it was app

All the data was collected by an independent researcher who did not know the purpose of the study or that the evaluated participants belonged to the same study. Participants were asked to avoid any analgesic drugs or muscle relaxants 24 hours prior to the examination. A normalized interview and an initial assessment were carried out when inclusion criteria was confirmed. Demographic and clinical data including age, body mass index (BMI), operation time and tumor size were collected. Additionally, anxiety and depression symptoms were measured with the Hospital Anxiety and Depression Scale (HADS), to control their influence on the main variables (Snaith et al., 2003).

The main variables evaluated were musculoskeletal neck disorders and functional variables, including pain intensity and disability related to impairment (body functions and structure), activity limitations (activity), and participation restrictions (participation). Outcomes were collected six months after thyroidectomy in the thyroid cancer group.

*Musculoskeletal neck disorders*

Active range of neck movement (AROM): Neck mobility was assessed with subjects sitting comfortably on a chair with both feet on the floor and, hips and knees, placed at 90°. The Cervical Range of Movement (CROM) is a device designed to assess cervical movements (Performance Attainment Associates, Lindstrom, MN). It was placed on the top of the head, and the subject was asked to move the head as far as possible in flexion, extension, right lateral-flexion, left lateral-flexion, right rotation, and left rotation, avoiding positional compensations. Three trials were recorded for each direction of movement, and the mean was used in the statistical analysis (Fletcher et al., 2008).

Trigger points (TrPs): Myofascial TrPs were explored bilaterally by a physiotherapist who had more than three years’ experience in TrPs diagnosis, and who was blinded to the subjects’ distribution. Both scalenes, sternocleidomastoids, upper trapezius, levator scapulae and suboccipitalis were included in the evaluation. The order in which TRPs were explored was randomized between subjects with a two-minute rest period between muscles, as previously used (Simons et al., 1999), in order to avoid the referred pain interfering with the patient’s response. TrP diagnosis was performed following the Simons et al. diagnostic criteria: (1) presence of a palpable taut band in a skeletal muscle; (2) presence of a hypersensitive tender spot in the taut band; (3) local twitch response elicited by the snapping palpation of the taut band; and (4) reproduction of the typical referred pain pattern of the TrP in response to compression. A total of 44 points were included in the assessment. The number of trigger points per muscle was collected and then, an average across the group was calculated. Inter-rater reliability has shown to vary between studies (Torres-Chica et al., 2015).

*Functional outcomes*

The Numeric Pain Rating Scale (NPRS; range, 0, no pain, to 10, maximum pain) was used to assess the mean spontaneous neck pain intensity. Patients were asked to rate how bad their neck pain was, on average, during the last week. The NPRS has been shown to be a reliable and valid method for pain assessment (Katz et al., 1999).

Neck disability was assessed with the Neck OutcOme Score (NOOS) (Juul et al., 2015; Jull et al., 2016). It is a validated tool to evaluate patients’ disability produces by neck pain. It includes 34 items divided into five subscales: ‘‘Mobility’’ (7), ‘‘Symptoms’’ (5), ‘‘Sleep disturbance’’ (4), ‘‘Every day activity and pain’’ (8), and ‘‘Participation in everyday life’’ (10). A normalized score (100 indicating ‘‘no symptoms’’ and 0 indicating ‘‘extreme problems’’) is calculated for each subscale, which displayed together creates an outcome profile.

Statistical analysis

G Power 3.1.9.2. was used to calculate the sample size with the NRPS as the primary outcome measure, considering a between-group difference of 1,74 points should be considered as clinically important (Farrar et al., 2001). In order to assure 90% statistical power and 5% type I error, 52 patients were required, but 56 were recruited to allow for a drop-out rate of 10%, 28 per group. Statistical Package version 20.0 (International Business Machines, Armonk, NY) was used to analyze the data obtained. Descriptive statistics mean (standard deviation) was used to describe sample baseline characteristics. The Shapiro-Wilk test was used to determine the normality of the data. For data with a normal distribution, a t-Student test was performed and a Mann-Whitney test to non-parametric variables. The level of confidence was chosen as 95% (p < 0.05).  
**RESULTS**

Of 35 potential patients, a total of 28 patients were deemed eligible and accepted to participate in this study. A control group of 28 patients was age and sex-matched. The distribution of participants is shown in Figure 1.

*Please, insert figure 1.*

Baseline characteristics of the sample are represented in table 1.

*Please, insert table 1.*

In table 1, baseline characteristics of the sample were presented. Both groups presented similar mean age (p=0.117) and BMI (p=0.522). The sex distribution was also similar in both groups (p=0.718). Results in anxiety (p=0.492), depression (p=0.212) and total (p=0.303) subscales were similar in both groups.

*Please, insert table 2.*

In table 2, results for musculoskeletal neck disorders are presented. Significant differences were found between groups in flexion (p=0.002) and extension (p=0.005). Left and right lateral-flexion were lower in the group with thyroidectomy, however, no statistically significant differences were found. Right and left rotation were similar in both groups. Significant differences were also found in the number of trigger points found in both scalenes (p<0.001), both sternocleidomastoids (p<0.001), both upper trapezius (p=0.005 and p=0.008), right levator scapulae (p=0.002) and both suboccipitalis (p=0.002), with a higher number in the group with thyroidectomy. The total of trigger points also presented significant differences between groups, with more points in the thyroidectomy group in both sides (p<0.001).

*Please, insert table 3.*

In table 3, results of both groups for neck pain and disability are presented. Significant differences were found in pain intensity (p<0.001) and all subscales of NOOS: mobility (p<0.001), symptoms (p<0.001), sleep disturbance (p=0.011), activity (p<0.001), participation (p=0.002) and total (p<0.001), with worse results in the group with thyroidectomy.

**DISCUSSION**

The aim of this study was to analyze the long-term musculoskeletal disorders in thyroid cancer patients who had undergone thyroidectomy. Our findings show that patients after thyroidectomy present a significant decrease of neck AROM and an increase in trigger points, compared with a control group matched for age and sex. They also show greater pain intensity and greater disability six months after surgery. These disorders could be initiated by the maintained neck position during surgery or the antalgic position acquired after it, usually with a neck flexion to protect the incision area.

The sample of subjects included in this study is representative of the general population undergoing thyroidectomy, with similar sociodemographic characteristics (Takamura et al., 2005; Ayhan et al., 2016).

Takamura et al. (2005) observed neck pain symptoms in thyroidectomy patients, which continue for a long time after surgery and influence the daily life activities. However, they did not analyze these disorders and only reported patients’ complaints. They carried out a stretching treatment which resulted in a decrease of the symptoms, even one year after treatment, suggesting the presence of a tissue disorder (rigidity) that could cause this neck pain. There is evidence suggesting that patients after cancer surgery present changes in nociceptive processing, increasing the central nervous system sensibility due to the nociception originated from damaged small nerve fibers during surgery (Andrykwosky et al., 1999; Gottrup et al., 2000) which could be related to the trigger points activation. Similarly to our study, Chaplin et al. (1999) observed myofascial neck pain in 13% of patients with head and neck cancer. They also used the presence of painful muscles with tender spots on palpation or painful trigger points to assess this pain.

Our study also shows higher levels of pain intensity in the thyroidectomy group six months after surgery, compared with a control group. Pain is the first symptom in 85% of patients with head and neck cancer (Ortíz et al., 2017) and 50 % of them are associated with neck surgery (Gellrich et al., 2002; Astrup et al., 2015). Vecht et al. (1992) and Grond et al. (1993) found that 23% and 28% respectively, of head and neck cancer patients have neuropathic pain caused by surgical treatment, although we have not found long-term studies. According to Talmi et al. (2000),this can be attributed to the interruption of the nerve fibres, and could result in other symptoms such as of dysaesthesia, paraesthesia and hypersensitivity. However, we have not found specific studies in thyroidectomy patients.

In the current study, higher disability levels in thyroidectomy patients were found. Neck dissection has been found to significantly influence levels of disability (Taylor et al., 2004). In published reports of patients after head and neck surgery (Van Wilgen et al., 2004), several postoperative factors have been described that interfere with functionality: depression (D’Antonio et al., 1998), physical function (De Graeff et al., 1999), fatigue, shoulder discomfort and neck tightness (Shah et al., 2001). Because of its anatomic localization alone, head and neck cancer can entail significant changes in vital functions and social interaction, disrupting the everyday life of these patients (Hassan et al., 1993; Mehanna et al., 2006).

We should recognize potential limitations to the current study. Firstly, the study design, a prospective study which included a pre and post evaluation could have been more appropriate, allowing each patient to be their own control. However, we have carefully selected the control group, avoiding other pathologies which could affects the results or introduce a possible source of bias. Secondly, cancer-related fatigue could have been an important variable to include because it could influence musculoskeletal function. However, previous studies on thyroidectomy patients have not include this variable (Lee et al., 2018; Genç et al., 2018).

**CONCLUSIONS**

Our findings show that patients six months after thyroidectomy show a significant decrease of neck AROM and an increase in trigger points, compared with a control group matched for age and sex. They also show a greater pain intensity and greater disability six months after surgery. Current findings suggest that neck pain and associated factors are important and need to be taken into account in these patients’ clinical approach. Multidimensional programs with pain control strategies, mobility exercises and trigger point treatment could help thyroidectomy patients cope with neck pain and disability.

**REFERENCES**

Andrykowski, M. A., Curran, S. L., Carpenter, J. S., Studts, J. L., Cunningham, L., McGrath, P. C., et al. (1999). Rheumatoid symptoms following breast cancer treatment: A controlled comparison.*Journal of Pain and Symptom Management, 18*(2), 85-94.

Aschebrook-Kilfoy, B., Schechter, R. B., Shih, Y. C., Kaplan, E. L., Chiu, B. C., Angelos, P., et al. (2013). The clinical and economic burden of a sustained increase in thyroid cancer incidence.*Cancer Epidemiology, Biomarkers & Prevention : A Publication of the American Association for Cancer Research, Cosponsored by the American Society of Preventive Oncology, 22*(7), 1252-1259.

Astrup, G. L., Rustoen, T., Miaskowski, C., Paul, S. M., & Bjordal, K. (2015). Changes in and predictors of pain characteristics in patients with head and neck cancer undergoing radiotherapy.*Pain, 156*(5), 967-979.

Ayhan, H., Tastan, S., Iyigün, E., Oztürk, E., Yildiz, R., & Görgülü, S. (2016). The effectiveness of neck stretching exercises following total thyroidectomy on reducing neck pain and disability: A randomized controlled trial.*Worldviews on Evidence‐Based Nursing, 13*(3), 224-231.

Bellantone, R., Lombardi, C. P., Bossola, M., Boscherini, M., De Crea, C., Alesina, P., et al. (2002). Total thyroidectomy for management of benign thyroid disease: Review of 526 cases.*World Journal of Surgery, 26*(12), 1468-1471.

Bilimoria, K. Y., Bentrem, D. J., Ko, C. Y., Stewart, A. K., Winchester, D. P., Talamonti, M. S., et al. (2007). Extent of surgery affects survival for papillary thyroid cancer.*Annals of Surgery, 246*(3), 375-81; discussion 381-4.

Chaplin, J. M., & Morton, R. P. (1999). A prospective, longitudinal study of pain in head and neck cancer patients.*Head & Neck, 21*(6), 531-537.

Choi, Y. S., Joo, Y. H., Park, Y. H., Kim, S. Y., & Sun, D. I. (2018). Factors Predicting the Recovery of Unilateral Vocal Fold Paralysis After Thyroidectomy. *World journal of surgery*, *42*(7), 2117-2122.

Cooper, D. S., Doherty, G. M., Haugen, B. R., Kloos, R. T., Lee, S. L., Mandel, S. J., et al. (2006). Management guidelines for patients with thyroid nodules and differentiated thyroid cancer: The american thyroid association guidelines taskforce.*Thyroid, 16*(2), 109-142.

D'antonio, L. L., Long, S. A., Zimmerman, G. J., Peterman, A. H., Petti, G. H., & Chonkich, G. D. (1998). Relationship between quality of life and depression in patients with head and neck cancer.*The Laryngoscope, 108*(6), 806-811.

de Graeff, A., de Leeuw, J. R., Ros, W. J., Hordijk, G. J., Blijham, G. H., & Winnubst, J. A. (1999). A prospective study on quality of life of patients with cancer of the oral cavity or oropharynx treated with surgery with or without radiotherapy.*Oral Oncology, 35*(1), 27-32.

Delbridge, L. (2003). Total thyroidectomy: The evolution of surgical technique.*ANZ Journal of Surgery, 73*(9), 761-768.

Dionigi, G., Boni, L., Rovera, F., Rausei, S., Castelnuovo, P., & Dionigi, R. (2010). Postoperative laryngoscopy in thyroid surgery: proper timing to detect recurrent laryngeal nerve injury. *Langenbeck's archives of surgery*, *395*(4), 327-331.

Farrar, J. T., Young Jr, J. P., LaMoreaux, L., Werth, J. L., & Poole, R. M. (2001). Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale. *Pain*, *94*(2), 149-158.

Ferlay, J., Soerjomataram, I., Dikshit, R., Eser, S., Mathers, C., Rebelo, M., et al. (2015). Cancer incidence and mortality worldwide: Sources, methods and major patterns in GLOBOCAN 2012.*International Journal of Cancer, 136*(5)

Fletcher, J. P., & Bandy, W. D. (2008). Intrarater reliability of CROM measurement of cervical spine active range of motion in persons with and without neck pain.*Journal of Orthopaedic & Sports Physical Therapy, 38*(10), 640-645.

Gellrich, N. C., Schimming, R., Schramm, A., Schmalohr, D., Bremerich, A., & Kugler, J. (2002). Pain, function, and psychologic outcome before, during, and after intraoral tumor resection.*Journal of Oral and Maxillofacial Surgery : Official Journal of the American Association of Oral and Maxillofacial Surgeons, 60*(7), 772-777.

General Assembly of the World Medical Association. (2014). World medical association declaration of helsinki: Ethical principles for medical research involving human subjects.*The Journal of the American College of Dentists, 81*(3), 14-18.

Gottrup, H., Andersen, J., Arendt-Nielsen, L., & Jensen, T. S. (2000). Psychophysical examination in patients with post-mastectomy pain.*Pain, 87*(3), 275-284.

Grond, S., Diefenbach, C., Zech, D., Schug, S. A., Lynch, J., & Lehmann, K. A. (1993). Validation of world health organization guidelines for pain relief in head and neck cancer: A prospective study.*Annals of Otology, Rhinology & Laryngology, 102*(5), 342-348.

Han, D. W., Koo, B. N., Chung, W. Y., Park, C. S., Kim, S. Y., Palmer, P. P., et al. (2006). Preoperative greater occipital nerve block in total thyroidectomy patients can reduce postoperative occipital headache and posterior neck pain.*Thyroid, 16*(6), 599-603.

Han, D. W., Koo, B. N., Chung, W. Y., Park, C. S., Kim, S. Y., Palmer, P. P., et al. (2006). Preoperative greater occipital nerve block in total thyroidectomy patients can reduce postoperative occipital headache and posterior neck pain.*Thyroid, 16*(6), 599-603.

Hankey, B. F., Ries, L. A., & Edwards, B. K. (1999). The surveillance, epidemiology, and end results program: A national resource.*Cancer Epidemiology, Biomarkers & Prevention : A Publication of the American Association for Cancer Research, Cosponsored by the American Society of Preventive Oncology, 8*(12), 1117-1121.

Hassan, S. J., & Weymuller, E. A. (1993). Assessment of quality of life in head and neck cancer patients.*Head & Neck, 15*(6), 485-496.

Juul, T., Søgaard, K., Roos, E. M., & Davis, A. M. (2015). Development of a patient-reported outcome: The neck OutcOme score (NOOS)–Content and construct validity.*Journal of Rehabilitation Medicine, 47*(9), 844-853.

Juul, T., Sogaard, K., Davis, A. M., & Roos, E. M. (2016). Psychometric properties of the neck OutcOme score, neck disability index, and short form-36 were evaluated in patients with neck pain.*Journal of Clinical Epidemiology, 79*, 31-40.

Katz, J., & Melzack, R. (1999). Measurement of pain.*The Surgical Clinics of North America, 79*(2), 231-252.

La Vecchia, C., Malvezzi, M., Bosetti, C., Garavello, W., Bertuccio, P., Levi, F., & Negri, E. (2015). Thyroid cancer mortality and incidence: a global overview. *International journal of cancer*, *136*(9), 2187-2195.

Lee, J. S., Kim, J. P., Ryu, J. S., & Woo, S. H. (2018). Effect of wound massage on neck discomfort and voice changes after thyroidectomy. *Surgery*, *164*(5), 965-971.

Mehanna, H. M., & Morton, R. P. (2006). Does quality of life predict long-term survival in patients with head and neck cancer?*Archives of Otolaryngology–Head & Neck Surgery, 132*(1), 27-31.

Moshtaghi, N. M., Khoshnevis, J., Khayamzadeh, M., Shormeij, Z., & Akbari, M. E. (2017). Overall survival and complications of thyroidectomy in patients with thyroid cancer.*International Journal of Cancer Management,*(In Press)

Ortíz, V. M. S., Ornelas, G. E. A., Cantisani, J. A. F., Torres, J. I. R., & Flores, F. C. (2017). Interventional techniques for head and neck cancer pain. *Diagnosis and management of head and neck cancer* () InTech.

Park, C., Choi, J., Lee, Y., Chang, H., Shin, C., Kim, S., et al. (2015). The effect of intra‐operative transcutaneous electrical nerve stimulation on posterior neck pain following thyroidectomy.*Anaesthesia, 70*(4), 434-439.

Rahib, L., Smith, B. D., Aizenberg, R., Rosenzweig, A. B., Fleshman, J. M., & Matrisian, L. M. (2014). Projecting cancer incidence and deaths to 2030: The unexpected burden of thyroid, liver, and pancreas cancers in the united states.*Cancer Research, 74*(11), 2913-2921.

Roerink, S. H., Coolen, L., Schenning, M. E., Husson, O., Smit, J. W., Marres, H. A., ... & Netea–Maier, R. T. (2017). High prevalence of self‐reported shoulder complaints after thyroid carcinoma surgery. *Head & neck*, *39*(2), 260-268.

Sakorafas, G. H. (2010). Historical evolution of thyroid surgery: From the ancient times to the dawn of the 21st century.*World Journal of Surgery, 34*(8), 1793-1804.

Shah, S., Har‐El, G., & Rosenfeld, R. M. (2001). Short‐term and long‐term quality of life after neck dissection.*Head & Neck, 23*(11), 954-961.

Siegel, R., Ma, J., Zou, Z., & Jemal, A. (2014). Cancer statistics, 2014.*CA: A Cancer Journal for Clinicians, 64*(1), 9-29.

Simons, D. G., Travell, J. G., & Simons, L. S. (1999). *Travell & simons' myofascial pain and dysfunction: Upper half of body* Lippincott Williams & Wilkins.

Snaith, R. P. (2003). The hospital anxiety and depression scale.*Health and Quality of Life Outcomes, 1*(1), 29.

Takamura, Y., Miyauchi, A., Tomoda, C., Uruno, T., Ito, Y., Miya, A., et al. (2005). Stretching exercises to reduce symptoms of postoperative neck discomfort after thyroid surgery: Prospective randomized study.*World Journal of Surgery, 29*(6), 775-779.

Talmi, Y. P., Horowitz, Z., Pfeffer, M. R., Stolik-Dollberg, O. C., Shoshani, Y., Peleg, M., et al. (2000). Pain in the neck after neck dissection.*Otolaryngology—Head and Neck Surgery, 123*(3), 302-306.

Terrell, A., Gardner, P., Spanos, W. C., Allard, B., Barth, R., Bhatia, V., et al. (2015). Clinical outcomes of a team approach to thyroidectomy.*South Dakota Medicine : The Journal of the South Dakota State Medical Association, 68*(12), 539-541.

Torres-Chica, B., Nunez-Samper-Pizarroso, C., Ortega-Santiago, R., Cleland, J. A., Salom-Moreno, J., Laguarta-Val, S., et al. (2015). Trigger points and pressure pain hypersensitivity in people with postmeniscectomy pain.*The Clinical Journal of Pain, 31*(3), 265-272.

Van Wilgen, C., Dijkstra, P., Van der Laan, B., Plukker, J. T., & Roodenburg, J. (2004). Shoulder and neck morbidity in quality of life after surgery for head and neck cancer.*Head & Neck, 26*(10), 839-844.

Vecht, C. J., Hoff, A. M., Kansen, P. J., De Boer, M. F., & Andries Bosch, D. (1992). Types and causes of pain in cancer of the head and neck.*Cancer, 70*(1), 178-184.

**Table 1.** Baseline characteristics of the sample per group.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Control group**  **(n=28)** | **Thyroidectomy group**  **(n=28)** | **p** |
| **Mean (SD)** | **Mean (SD)** |
| Sex (women %) | 81.8 | 87.7 | 0.718 |
| Age (years) | 54.45 (7.12) | 50.29 (10.49) | 0.117 |
| BMI (Kg/m2) | 26.9 (5.14) | 27.71 (3.70) | 0.522 |
| Operation time (min) | - | 87.31(24.56) | - |
| Tumor size (cm) | - | 1.63 (0.84) | - |
| HADS | | | |
| Anxiety | 4.73 (3.71) | 5.50 (4.07) | 0.492 |
| Depression | 2 (2.76) | 3.14 (3.46) | 0.212 |
| Total | 6.73 (5.90) | 8.64 (6.85) | 0.303 |

Variables are expressed as mean (standard deviation). BMI: body mass index, HADS: hospital anxiety and depression scale, min: minutes, mm: millimetres, cm: centimeters. \*p<0.05, \*\*p<0.001.

**Table 2.** Musculoskeletal variables in control and thyroidectomy group.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | | **Control group**  **(n=28)** | **Thyroidectomy group**  **(n=28)** | **P** |
| **Active neck mobility** | | | | |
| Flexion (degrees) | | 54.3 (8.23) | 45.74 (9.65) | 0.002\* |
| Extension (degrees) | | 59.5 (15.8) | 47.77 (12.27) | 0.005\* |
| Right lateral-flexion (degrees) | | 39.62 (8.03) | 35.8 (7.73) | 0.095 |
| Left lateral-flexion (degrees) | | 41.79 (9.43) | 37.13 (8.27) | 0.069 |
| Right rotation (degrees) | | 60.6 (8.5) | 58.75 (11.16) | 0.522 |
| Left rotation (degrees) | | 60.7 (9.58) | 60.11 (9.42) | 0.827 |
| **Trigger points** | | | | |
| Scalene | Right | 0.09 (0.29) | 0.63 (0.49) | <0.001\*\* |
| Left | 0.09 (0.29) | 0.63 (0.49) | <0.001\*\* |
| Sternocleidomastoid | Right | 0.73 (0.98) | 3.79 (1.97) | <0.001\*\* |
| Left | 1.36 (1.18) | 3.5 (1.99) | <0.001\*\* |
| Upper trapezius | Right | 1.55 (1.77) | 3.5 (2.72) | 0.005\* |
| Left | 1.64 (1.65) | 3.36 (2.51) | 0.008\* |
| Levator scapulae | Right | 0.36 (0.66) | 1.07 (0.90) | 0.002\* |
| Left | 0.73 (0.77) | 1.14 (0.93) | 0.098 |
| Suboccipital | Right | 0.18 (0.59) | 0.93 (0.90) | 0.002\* |
| Left | 0.27 (0.63) | 1 (0.86) | 0.002\* |
| Total | Right | 2.91 (2.97) | 9.93 (5.49) | <0.001\*\* |
| Left | 4.09 (3.42) | 9.64 (5.17) | <0.001\*\* |

Variables are expressed as mean (standard deviation). \*\*p<0.001, \*p<0.05

**Table 3.** Functional and symptomatic variables in control and thyroidectomy group.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Control group**  **(n=28)** | **Thyroidectomy group**  **(n=28)** | **p** |
| **NPRS** | 0.36 (1.78) | 4 (3.13) | <0.001\*\* |
| **NOOS** | | | |
| Mobility subscore | 94.48 (6.68) | 72.98 (22.38) | <0.001\*\* |
| Symptoms subscore | 85 (20.24) | 61.07 (23.66) | <0.001\*\* |
| Sleep disturbance subscore | 88.64 (16.99) | 71.52 (26.39) | 0.011\* |
| Activity subscore | 89.49 (19.59) | 63.39 (26.53) | <0.001\*\* |
| Participation subscore | 91.36 (9.78) | 73.04 (25.41) | 0.002\* |
| Total subscore | 448.96 (48.31) | 347.3 (104.64) | <0.001\*\* |

NPRS: Numeric Pain Rating Scale, NOOS: Neck OutcOme Scale. Variables are expressed as mean (standard deviation). \*p<0.05, \*\*p<0.001.