Localization of cervical branches of facial nerve innervating platysma bands

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A Thesis Submitted in Partial Fulfillment of the Requirements

for the Degree of Master of Science in Medical Sciences

Common Course

Faculty of Medicine

Chulalongkorn University

Academic Year 2018

การหาตำแหน่งของcervical branchesของเส้นประสาทเฟเชี่ยลที่กระตุ้นการทำงานของกล้ามเนื้อ platysma

น.ส.ชาลิสา ทัศนเมธิน

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
สาขาวิชาวิทยาศาสตร์การแพทย์ ไม่สังกัดภาควิชา/เทียบเท่า
คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
ปีการศึกษา 2561

Thesis Title	Localization of cervical branches of facial nerve innervating platysma bands
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Field of Study	Medical Sciences
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ชาลิสา ทัศนเมธิน : การหาตำแหน่งของcervical branchesของเส้นประสาทเฟเชี่ยลที่กระตุ้นการทำงานของกล้ามเนื้อplatysma. (Localization of cervical branches of facial nerve innervating platysma bands) อ.ที่ปรึกษาหลัก : ศ. นพ.ธันวา ตันสถิตย์

การผ่าตัดยกกระชับใบหน้าเป็นการปรับปรุงลักษณะที่ปรากฏของคอ แต่อย่างไรก็ตามการบาดเจ็บที่เส้นประสาทเฟเชี่ยลแขนงcervical และหลอดเลือดดำ retromandibular (RMV)อาจเกิดขึ้นได้จากขั้นตอนการใช้กรรไกรหรือการดูดไขมันที่ใบหน้าซึ่งมีผลทำให้เลือดออกใต้ชั้นผิวหนังและเกิดอัมพาตที่กล้ามเนื้อยกมุมปากล่างได้ งานวิจัยนี้ได้ศึกษาในใบหน้าอาจารย์ใหญ่จำนวน27ข้างเพื่อศึกษาความสัมพันธ์ของเส้นประสาทเฟเชี่ยลแขนงcervical branches และ ตำแหน่งสำคัญบนsoft tissueเพื่อช่วยให้แพทย์มีข้อมูลของเส้นประสาทในการประกอบการตัดสินใจลงมือทำหัตถการและแม่นยำมากขึ้น จากการศึกษาพบว่า BP มักพบในบริเวณ C3มากถึง 96.67% โดยBPในระยะแกนX อยู่ทางด้านนอกต่อขอบหน้ากล้ามเนื้อsternocleidomastoid (SCM)2ซม.และอยู่เหนือthyroid line5ซม. TBP มักพบในบริเวณ C3 มากถึง 73.33% ตำแหน่งTBP1และTBP2 ในระยะแกนX อยู่ทางด้านนอกต่อขอบหน้ากล้ามเนื้อ SCM 5มม. และอยู่เหนือthyroid line4ซม. ตำแหน่ง TBP3 ในระยะแกนX อยู่ทางด้านในต่อขอบหน้ากล้ามเนื้อ SCM 5มม. และอยู่เหนือthyroid line4ซม. ตำแหน่ง TBP4 ในระยะแกนX อยู่ทางด้านในต่อขอบหน้ากล้ามเนื้อ SCM 1ซม. และอยู่ใต้ต่อthyroid line4มม.ผลการศึกษาโดยสรุปพบว่า BP และ TBP วางตัวอยู่ที่พื้นที่C3มากที่สุด ตำแหน่งของBP มีระยะห่างและอยู่ทางด้านในต่อRMV ในเพศชายมากกว่าในเพศหญิง

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การศึกษา		.....

5974115030 : MAJOR MEDICAL SCIENCES

KEYWORD: cervical branch of facial nerve, platysma muscle

Chalisa Tatsanametin : Localization of cervical branches of facial nerve innervating platysma bands . Advisor: Prof. TANVAA TANSATIT, M.D.

The facelift is a traditional surgical procedure to improve the appearance of the neck. However, cervical branch of facial nerve (CN) and retromandibular vein (RMV) injury can occur with scissors or even with a liposuction cannula during dissection. This dissection was performed on 27 hemifaces Thai embalmed cadavers to clarify the detail of CN as it relates to surface landmarks to help surgeons predict the location of CN. Branching point of cervical branch of facial nerve (BP) was frequently on C3 regions (96.67%) and located lateral to anterior border of sternocleidomastoid muscle (SCM) 2cm; along x-axis and the distances above thyroid line estimated 5 cm in distance y. While the cervical terminal branching point of the facial nerve TBP1 and TBP2 frequently supply platysma in C3 regions (73.33%) lateral to the anterior border of the SCM 5 mm; along the x-axis and the distances y above the thyroid line was estimated at a distance of 4 cm. Moreover, TBP3 was frequently found at medial to the anterior border of the SCM 5 mm in distance X. There was estimated at a distance of 4 cm superior to the thyroid line, whereas TBP4 was frequently found at medial to the anterior border of the SCM 1 cm in distance X. There was estimated at a distance of 4 mm inferior to the thyroid line. To summarize our finding, BP and TBP frequently placed on C3 regions. The distance between BP and RMV were greater and more medial to RMV in male than female

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Academic Year:	2018	Advisor's Signature .....

ACKNOWLEDGEMENTS

My research would have been impossible without the aid and support of my advisor, Professor Tanvaa Tansatit for his patience, motivation, enthusiasm, and invaluable help and constant encouragement throughout the course of this research.

I am very much obliged to Professor Vilai Chentanez, Associate Professor Poonlarp Cheepsoonthorn, Dr. Kritsada Leungchavaphongse and Assistant Professor Suwadee Chaunchaiyakul for their valuable suggestions and insightful comments.

I would also like to thanks to all staffs at Department of Anatomy, Faculty of Medicine, Chulalongkorn University for their facilitates and encouragement.

Finally, I must express my very profound gratitude for my family and my friends providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them. Thank you.

Chalisa Tatsanametin

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CHAPTER I

INTRODUCTION

1. Background and Rationale

Age is not the only contributor to facial aesthetic concerns but also aging changes in the neck area. The aging neck is one of the most common cosmetic consultation [1]. It is easy to visible causing bothersome to patients due to lack of confidence. The aging neck demonstrates development of an obtuse cervicomental angle, elimination of the smooth jawline border , accumulation of submental fat ,skin laxity, and platysma bands due to degenerative of connective tissue such as collagen and elastic fibers [2] [3].

Platysma bands are the narrow strips that usually goes anterior or lateral vertical segments from the lower border of mandible to suprasternal region with varied appearance around the neck, which can be found in males and females at aged 55 or over [4] [5]. In people with a thin skin the bands may become visible in an early time [6]. There are many surgical approaches to improve the neck bands.

The facelift is a traditionally surgical procedure to improve the appearance of the neck[7]. The procedure has different techniques such as Superficial Muscular Aponeurotic System (SMAS) platysmal plication and Deep plane rhytidectomy with submental liposuction. Both techniques tighten platysma muscle to preauricular region to tighten the platysma muscle in superolateral direction. These approaches are suitable for people who have mild to moderate platysma band with no or minimal skin laxity but can result in scarring formation, hematoma, temporary leather neck, and band may still persist after surgery [8] [9] [10] [11]. Another technique is extended deep-plane rhytidectomy, which is similar to the techniques mentioned above but added releasing cervical retaining ligament for more lateral motion .This should be combined with corset platysmaplasty, bringing the 2 midline bands of the platysma muscle closer together in case of severe platysma banding and laxity. However, it can lead to complications including scarring and

hardening of tissue in submental region. All of these techniques contribute to tightening skin and platysma muscle to reduce platysma band [9] [12].;however, during these procedures, some complications may occur. For example, pseudoparalysis of the marginal mandibular nerve due to cervical branch injury (1.7 percent) whereas other cosmetic complication (2 percent) [12]. Moreover, marginal mandibular nerve (MM) and retromandibular vein (RMV) injury can occur with scissors or even with a liposuction cannula during dissection in the superficial subcutaneous layer [12] [13] [14] . The injury to these nerves effect on function, aesthetics, and the social that leads to abnormal platysmal movement such as not full denture smile, and asymmetrical lower lips movement [15].

Present study reports that correction of platysma bands which are innervated by cervical branches of facial nerve are associated with deactivating platysma muscle [5]. Botox is the most popular non-surgical cosmetic treatment. It is a presynaptic nerve block relaxing the injected muscle, therefore it can be used to improve appearance of the cervical region. Moreover, it also benefit for medical conditions, especially strabismus and focal dystonias, hemifacial spasm, and various spastic movement disorders. It is fast, non-invasive procedure, and produces significant aesthetic improvement. Nevertheless, duration of effect is last long 4 to 6 months then muscle cords begin to reappear and need to be treated again [16] [17] [18]. Closed Platysmotomy is a treatment that uses steel wire to surround the muscle connected with platysmotome device to cut 3-6 sections along each band through the minimal incision. It is effective in medium to long-term, and the recurrence platysma band is rare. However, this technique could still cause a hematoma, ecchymosis, and the surgeon should concern nearby important structures when cutting the bands in the suprahyoid region such as facial artery and anterior jugular vein[4].

Serial notching technique is undermining and notching the band by little skin incision and ultrasonic scalpel with a function in cutting and coagulation muscle. The surgery technique takes short time, gives quickly recover, but still has multiple visible postoperative scars at the anterior neck that may lead to an infection[11]. While the longest periods of recurrence bands are 2-3 years, the shortest time is 4-6 months.

For various clinical applications, the cervical branch innervation of platysma muscle has recently become point of interest. The cervical branch of the facial nerve has recently been used for the nerve brachial plexus for nerve reconstruction [19]. Moreover, Neurectomy treatments for patients with hyperkinetic motility disorders in cervical regions can relieve patients from difficult swallowing and painful cramps [12]. Furthermore, in specific anatomical location may allow surgeons to denervate the platysma and reduce the amount of banding. However, there are limited studies in the distribution of cervical branches of facial nerve. Therefore, This study aims to describe the details of the cervical branches of facial nerve that relate to surface landmarks as a guideline for surgeons to apply surgical procedures such as facelift, nerve blocking, and neurectomy to operate more safely and better optimized for reducing the risk of nerve injury and retromandibular vein in head and neck areas.

2. Research Questions

2.1 Primary research questions

- Where are the branching point and terminal branching point of cervical branch of facial nerve on platysma muscle?

2.2 Secondary research questions

- Are the locations of branching point and terminal branching point of cervical branches of facial nerve on platysma muscle different between sides and genders?

- What is the distance from external jugular vein to the terminal branching point of cervical branches of facial nerve?

- What is the distance from retromandibular vein to the terminal branching point of cervical branches of facial nerve?

- What are the prevalence of the terminal branching points of cervical branches of facial nerve point on platysma muscle?

- What are the prevalence of anastomosis of cervical branches of facial nerve on platysma muscle?

3. Research objectives

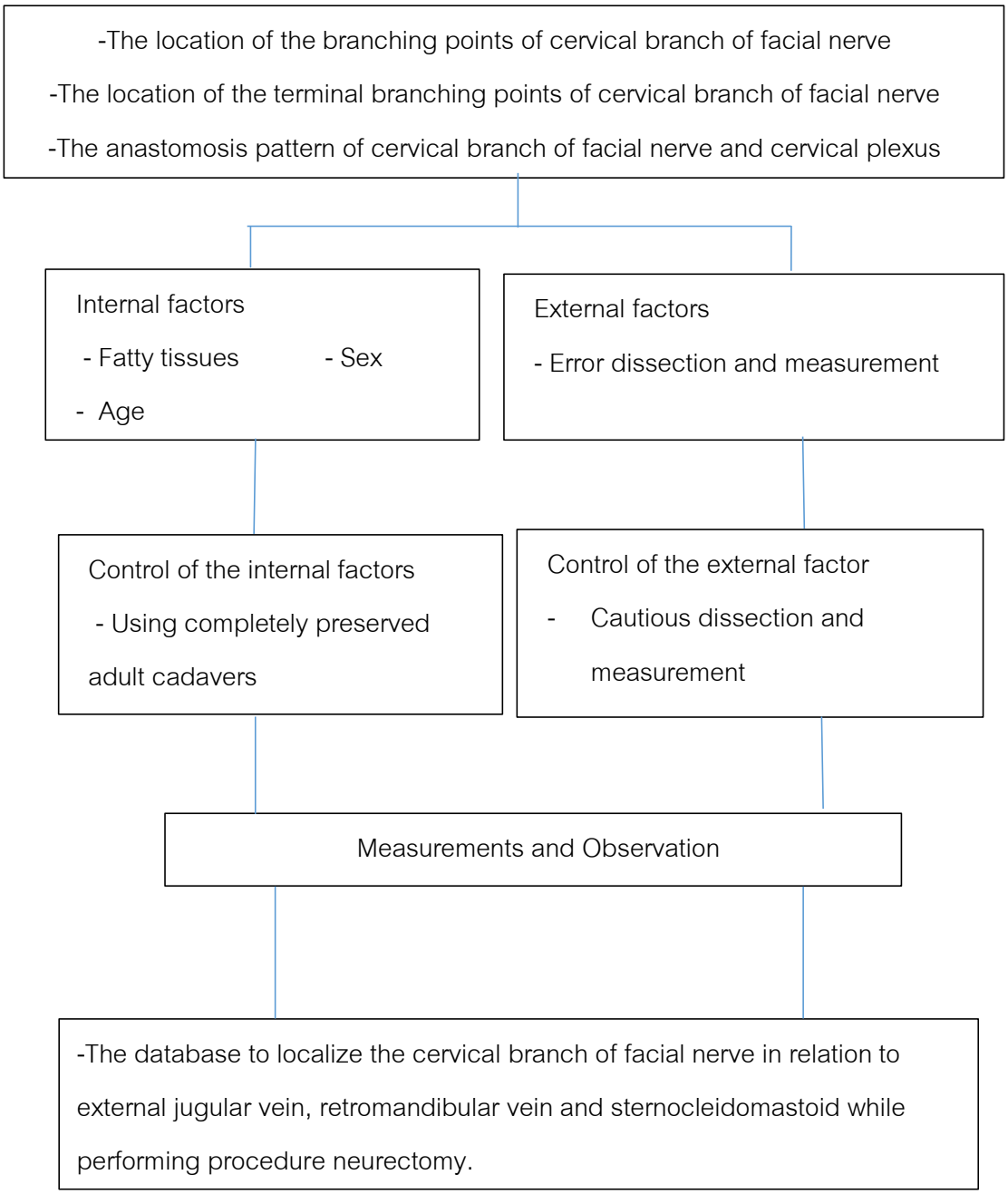
-To determine the location of branching points and terminal branching points of cervical branches of facial nerve on platysma muscle

-To compare the location of branching points and terminal branching points of cervical branch of facial nerve on platysma muscle between sides and genders

-To measure the distances from branching points and terminal branching points of cervical branch of facial nerve to external jugular vein

-To determine the prevalence of the terminal branching point and anastomosis of cervical branches of facial nerve located on the platysma muscle

4. Conceptual framework



5. Assumptions

Most of cervical branches of facial nerve supply platysma muscle around hyoid bone

6. Keywords

Cervical branches, Platysma Muscle, Platysma band

7. Research Design

Descriptive research

8. Obstacles

- The cervical branches of facial nerve are small and very thin. Researcher must be careful and have expert knowledge about the anatomy of the face and neck.

- The platysma muscle is difficult to separate from the skin and fat because some aging cadaver had thin layers of skin and fat; therefore, carefully dissection should be performed.

9. Expected Benefits and Applications

The surgeons could use this study to determine the location of the branching point, terminal branching point, and anastomosis of the cervical branch of the facial nerve to another nerve on the platysma muscle relative to the reference framework; sternocleidomastoid, external jugular vein, and retromandibular vein. This can help to reduce platysma band, movement disorders and the duration of surgical procedures

CHAPTER II

REVIEW OF RELATED LITERATURES

1. Treatments and clinical application of cervical branches of facial nerve

Cervical branches of the facial nerve exit the inferior margin of the parotid gland slightly anterior to the angle of mandible and run forward anteriorly, reach submandibular gland, and finally pass beneath the platysma muscle [15] [20]. Most commonly, platysma is a superficial muscle that overlaps the sternocleidomastoid. It is a broad sheet originated from the upper portion of anterior thorax to clavicle (67.7 %), followed by subcutaneous tissue from subclavicular and acromial regions (22.6 %) and pectoral regions (9.7 %) [23] [24]. The platysma is supplied by cervical branch of the facial nerve. The platysma's most common aging-related change was shortening (70.7 %), followed by thinning (25.2 %). Platysma bands presented with different extensions and appearances in one or two bands along the anterior or lateral neck segment. A number of techniques are applicable to correct the platysma band.

Standard textbook mentioned that cervical branches of facial nerve received much less attention in literatures. The reason for this is there are frequent injuries to the frontal and marginal mandibular branches Moreover, the cervical branches of the facial nerve supply only the platysma muscle corresponding to facial expression [15] [20]. However, these branches of facial nerve particularly relevant to aesthetic facial surgery and clinical application in treating brachial plexus injury, platysma band, and platysma dyskinesia.

Pablo Scolovsky et al (2008) [21] stated that treating brachial plexus injury using nerve transfer from cervical branches of the facial nerve to connect with the medial pectoral nerve giving satisfactory results. This is because the cross-sectional areas of these two nerves are close. The surface area of medial pectoral nerve is about 76% of cervical branches of facial nerve. After surgery, the muscle power of shoulder adduction was improved and was classified as grade 4 after 8 years of follow-up.

Movement disorder of platysma may be associated with both aesthetic and functional problems. Most of movement disorders of platysma is hyperkinesia associated

with synkinesis that accompanies with defective healing such as salivary gland tumor resection, nerve reconstruction after the removal acoustic neuroma or malignant tumors of the parotid gland, trauma, and Bell's palsy. Many patients felt painful cramps, discomfort in the cervical regions, have symptoms of platysma paresis and unfavorable movement and platysma band [12]. They are several options of treatment for both surgical and non-surgical approaches [22]. A number of techniques are applicable to correct the platysma band.

Rhytidectomy cosmetic

Rhytidectomy (facelift) is one of the most commonly performed plastic surgery procedures in the head and neck [9] [23].

Traditional rhytidectomy (facelift), such as superficial musculoaponeurotic system (SMAS), can improve changes in the lower face and in the neck caused by aging. Surgery usually involves suture suspension alone to reverse the vectors of aging. The SMAS of the lower face is drawn vertically in-folding and anchoring it to the more immobile SMAS overlying the parotid

Deep plane rhytidectomy is continuing the flap below the angle of the mandible into the neck with release of the platysma and cervical retaining ligaments. The deep plane entry point was marked on the skin before dissection. This point extends from the angle of the mandible to the lateral canthus and releases zygomatic ligament SMAS-platysmal plication sutures were then placed in a superolateral vector to the deep temporal fascia. T-like incision was made over the submental region, and the skin was elevated off the platysma. Similarly, Jacono et al (2016) was performed on 5 cadaver heads. The lateral distraction of the medial edge of the platysma muscle was measured during tightening of the SMAS platysmal complex. The measurements were taken after the following 3 rhytidectomy techniques: SMAS-platysmal plication, Deep-plane rhytidectomy and Extended deep-plane rhytidectomy were laterally distracted 2.2 mm, 9.4 mm and 12.2 mm respectively. Results are 554% greater lateral distraction of the medial edge of the platysma muscle compared with SMAS platysmal facelift ($P<.001$).

Closed platysmotomy

Platysmotomy was a kind of myectomy that using of a steel wire loop encircles the platysma through two puncture holes in the skin and is connected to a device known as the platysmotome. Platysmotomy will apply three to six sections along each band eliminate the platysma band, leaving no visible marks on the skin. However, the following nearby important structures are worthy of attention: (1) the anterior jugular vein, (2) the external jugular vein (3) the mentonian nerve, emerges at the mental foramen in the mandible. From platysmotomy technique, Dahler JC (2011) [4] performed closed platysmotomy in 11 patients for correct platysma bands and avoiding submental or cervical incision. This technique is suitable for patients who have visible platysma bands and no skin flaccidity, patients with recurring bands after face-lifting and no cervical skin flaccidity.

Serial notching of platysma band

Serial notching was a kind of myectomy that underminined and dissected on both sides of the muscle band. The muscle bands were delivered from the wound with the help of the Small Mosquito Clamp and Colorado needle was used for notching muscle.
Saylan Z (2001) [11] performed serial notching of the platysma bands to 51 patients, including 5 men (9.8%) and 46 women (90.2%). The average patient age was 61 years. Incision of 1 to 1.5 cm horizontal to the platysma band. Each incision was made with a distance 3 to 4 cm. multiple incisions gave a good results. .All patients were satisfied with the results. The time for surgery is less than 20 minutes. The recovery period is quick (5 to 7 days) compared with lower-face lift (14 to 21 days) but this technique did not improve skin laxity.

Botox (Botulinum toxin A)

Botulinum toxin is the most popular non-invasive technique cosmetics but complication was bruising and temporary. A decision to treat neck bands was made, the

patients were requested to pull the depressor angulus oris muscle descending and when they couldn't do it well, they were requested to vocalize "e" sound instead to keep the platysma muscle contracted. The most visible segment of the muscle was received between 3U and 5U. The points lateral to this main point received at least 1 U. The distance between injections was 1.5 cm. Ordinarily, The injection focus on under the mandible and the weakest parts of the band, close to the clavicle. The injections were performed in an intramuscular layer.

Neurectomy

Nakamura et al (1994) [22] reported that two patients with synkinesis was used neurectomy at the anastomosis of nerve that supply the muscle of the orbicularis oculi and oris. First patient had a right facial paralysis and when she whistled, she complained about high-grade synkinesis between the orbicularis oris and the orbicularis oculi muscles. Another patient who was speaking and contracting the platysma while whistling had an involuntary shoulder contraction. Each branch of the cervical branch of facial nerve was firstly investigated by electrostimulation. Neurectomy of the cervical branch of facial nerve branches was then performed to stop synkinesis. Moreover, Henstrom et al (2011) [24] reported that twenty-four patients (20 females and 4 males) with platysmal synkinesis and hypertonicity were removed platysma band with bipolar hemostasis. Patients were requested to complete another FaCE survey after surgery. There was 47 days (range 12-204 days) between the procedure and the postoperative FaCE survey. Before surgery, the mean overall FaCE score was 46.7 and the mean FaCE score after surgery was 55.2 (P=.02). Therefore, bipolar hemostasis can make patients satisfied with reducing platysma band

2. Locations of cervical branches of facial nerve

The Location of cervical branch of facial nerve has been well described by the previous studies. The cervical branch of facial nerve (CN) emerged from antero-inferior border of parotid glands. Then, it runs forward beneath the platysma and forms a series

at the greater cornu of hyoid bone. However, the several previous studies represented that the location of cervical branch of facial nerve had numerous variations in locations.

Ziarah HA. and Atkinson ME.(1981) [20] suggested that the cervical branches of facial nerve in 110 embalmed cadavers were laid an average horizontal distance to be 0.83 ± 0.37cm (0.2 – 1.4 cm) posterior to the gonion. Moreover, In bilateral 5 embalmed cadavers, Plabo Scolovsky et al. (2008) [21] described that the cervical nerve had an average distance of 8 mm (range 4-11 mm) between the gonion and the platysma motor branch and a mean distance of 18.5 mm (12-23) from the platysma branch to the gonion. Additionally, Salinas et al (2009)[25] stated that marginal mandibular divided before reaching the angle of mandible. The cervical branches exiting parotid gland to submandibular gland within 10 mm. Most inferior cervical branches are below inferior border of the mandible distance 45 mm. Therefore, incision should be placed at least 2 cm posterior to mandibular angle. Furthermore, Chowdhry et al (2010) [26]studied the cervical branches of facial nerve in 16 fresh heminecks cadavers. The branching point of cervical branch of the facial nerve was identified to lower the mandible in every specimens and was consistently found 1.75 ± 0.26 cm directly perpendicular to a line from the angle of mandible to the mastoid-mentum line. Dividing the mastoid-mentum line by the length of the ramus gave the ratio of 1.83±0.17 cm.

3. Locations of anastomosis of cervical branches of facial nerve and other nerve

The cervical branch of facial nerve (CN) is the little-known communications with transverse cervical nerve (TCN). However, The study of Ziarah et al (1981) [20] showed that cervical branches of facial nerve (CN) in 110 embalmed cadaver anastomose with the ascending transverse cervical nerve (TCN) at the greater cornu of the hyoid bone and continues into the skin. The diameter of cervical nerve distal to the anastomosis will thicker and penetrates deep to the platysma muscle, Similarly, Bertelli et al. (2007) [19] expressed that the cervical branches descended behind the ramus of the mandible, emerged from the lower part of the parotid gland and run anteroinferiorly under the platysma to the front of the neck to supply the platysma and associated with the transverse

cutaneous cervical nerve at the suprahyiod region. While, Domet et al (2005) [27] studied in 22 hemifacial human cadavers (n=11) discovered that the anastomosis between cervical branches of facial nerve and transverse cervical cutaneous nerve occurs in 2 positions 1.inferior border of the submandibular gland from the inferior border of the mandible average distance of 28 mm 2.posterior to the submandibular gland from the inferior border of the mandible, at an average distance of 20 mm.. Moreover, Pablo Scolovsky et al.(2008) [21] stated that anastomosis between the cervical branch of facial nerve and the cervical plexus were at the level of the anterior border of the sternocleidomastoid muscle and the number of cervical branches anastomosed with the transverse cervical cutaneous nerve via an average of 5 branches (3-9 branches) in 5 cadaveric dissections. In addition, Rao sirasinagandla et al.(2013) [28] encountered an anatomical variation during dissection class to the first year medical students that one branch of transverse cervical cutaneous nerve(TCN) gave a communicating branch to cervical branches (CN) of facial nerve posterior to the submandibular gland and the another TCN was noted to be communicated with the CB of facial nerve within the parenchyma of the parotid gland.

4. Anastomosis pattern of cervical branches and cervical plexus

Ziarah et al.(1981)[20] considered that cervical branches of facial nerve anastomose with the ascending transverse cervical nerve at the greater cornu of the hyoid bone in 110 hemifaces. The transverse cervical nerve continues into the skin. The diameter cervical nerve distal to the anastomosis will thicker and penetrates deep to the platysma muscle. Moreover, Woltmann et al (2006) [29] performed in 27 hemifacial human cadavers (45 hemi-faces).They found that the marginal mandibular branch anastomosed with the cervical branch in 10 cases (22.22%) and the buccal branch in 19 cases (42.22%). No anastomoses among facial branches were found In 16 cases (35.55%). Additionally, Salinas et al (2009) [25] described that the great auricular nerve(GA) and the transverse cervical nerve(TCN) joined together and then communicated with the main cervical branch(CB) was found in one specimen.

Furthermore, Rao et al. (2012) [28]founded that an anatomical variant of the anterior division of the great auricular nerve(GA) with the cervical branch of the facial nerve(CN) outside the parotid gland was found in the 60-year-old South Indian male cadaver.

5. Patterns of cervical branches of facial nerve

Ziarah et al.(1981) [20] found that the cervical nerve emerged from the parotid as a single branch in 80 percents of 110 facial halves. When nerve reaches superficial surface of submandibular gland is divided into fine plexus above the level of the hyoid bone. In other 20 percents of cases, two branches ran parallel to each other and divided into fine plexus anterior to hyoid bone. Moreover, Salinas et al (2009) [25] reported from 20 facial dissections that single branch was found in 3 dissections, two branches were found in 11 dissections and three branches were identified in 6 dissections, while Plabo Scolovski et al.(2008) [21] explained that single branch innervated the platysma muscle in four out of ten dissections. In five dissections, there was two branches to the muscle. Three branches have only one dissection. Moreover, Chowdhry et al.(2010) [26] described that total of 16 fresh heminecks in this study had only one main branch. Therefore, the number of cervical branch of facial nerve might be vary depending on races or genetics differences

6. Bony landmarks and corresponding spinal levels

Surgical Exposures in Orthopedics 4th Edition textbooks (2009) recommend to use the midline palpable anterior neck structures as a landmarks represent the spinal levels: Angle of the mandible [C2 body], Hyoid bone [C3 body], Thyroid cartilage [C4–C5 disc] and Cricoid cartilage [C6 body] to determine the approximate level for skin incisions (Fig 1.)

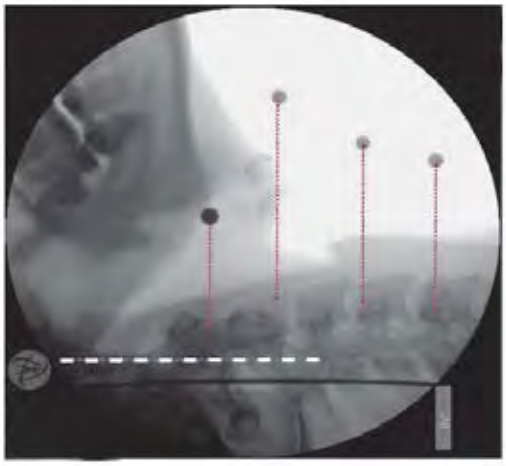


Figure 1. Radiographic measurements were performed in a supine position with a slightly extended necks to achieve normal cervical lordosis. Each of the radiographs had vertical lines drawn from four markers to the cervical vertebral body. Bony landmarks corresponding spinal levels; Angle of the mandible [C2 body], Hyoid bone [C3 body], Thyroid cartilage [C4–C5 disc] and Cricoid cartilage [C6 body]. (Ref: Koopong et al, 2018)

CHAPTER III
RESEARCH METHODOLOGY

1. Target Population and Sample Population

This study will use the donor cadaver for study at the Department of Anatomy. Faculty of Medicine Chulalongkorn University.

2. Inclusion Criteria

Hard embalmed cadavers with no damage occurs to the face and neck.

3. Exclusion Criteria

Hard embalmed cadavers which no damage with fungi or occurs to the face and neck.

4. Sample Size Determination

Based on research articles of Chowdhry et al (2011) [26]. The study was performed in all 8 cadavers (16 heminecks) and found that the branching point was located perpendicular from angle of mandible to mastoid-mentum line average 1.75 cm. The standard deviation of branching point are 0.26 cm. The values are calculated for the population using the Cochran's formula. This formula is used in case of unknown size of population and needs to predict sample population.

Determine the confidence level is 95%

$$N=z^2_{\alpha/2}\sigma^2 / d^2$$

Z = Z value at confidence level or significance level.

If the confidence level of 95% or the significance level of 0.05 is Z = 1.96

If the confidence level of 99% or the significance level 0.01 is Z = 2.58

$$Z\alpha_{/2} = Z_{0.05/2} = 1.96 \text{ (two tail)}$$

$$\sigma^2 = \text{Variance} = (0.26)^2$$

$$d = \text{Acceptable error} = 0.1 \text{ mm}$$

$$N = z^2 \alpha_{/2} \sigma^2 / d^2$$

$$n = (1.96)^2 (0.26)^2 / (0.1)^2$$

$$n = 25.97$$

Therefore, the population must be studied at least 26 sample. This study will be performed in 27 sample (n=19). The number will be used more than calculate for reliable information.

5. Materials

1. Operative scissors, Operative knife, Surgical blade, Probe, Forceps, Cramps Holder
2. Vernier caliper
3. Measurement tape
4. Pins
5. Markers pen
6. Angle ruler
7. Camera

6. Methods

6.1 Dissection

1. The dissection was performed layer by layer. Set the anatomical reference point at oral commissure, ear lobule, acromion process, clavicle, sternal notch and lower vermillion border after that draw line and open the skin through the reference point. Firstly, the skin incision was done following the vertical line from lower vermillion border to sternal notch, following horizontal line from gnathion to ear lobule. Next, An incision was made from oral commissure to ear lobule after that draw line pass through acromion process continue to clavicle until sternal notch. After that, the skin was superficially removed along the incision from the medial to the lateral side. After completing the skin dissection, the subcutaneous tissue layer will be seen (Fig 2.)

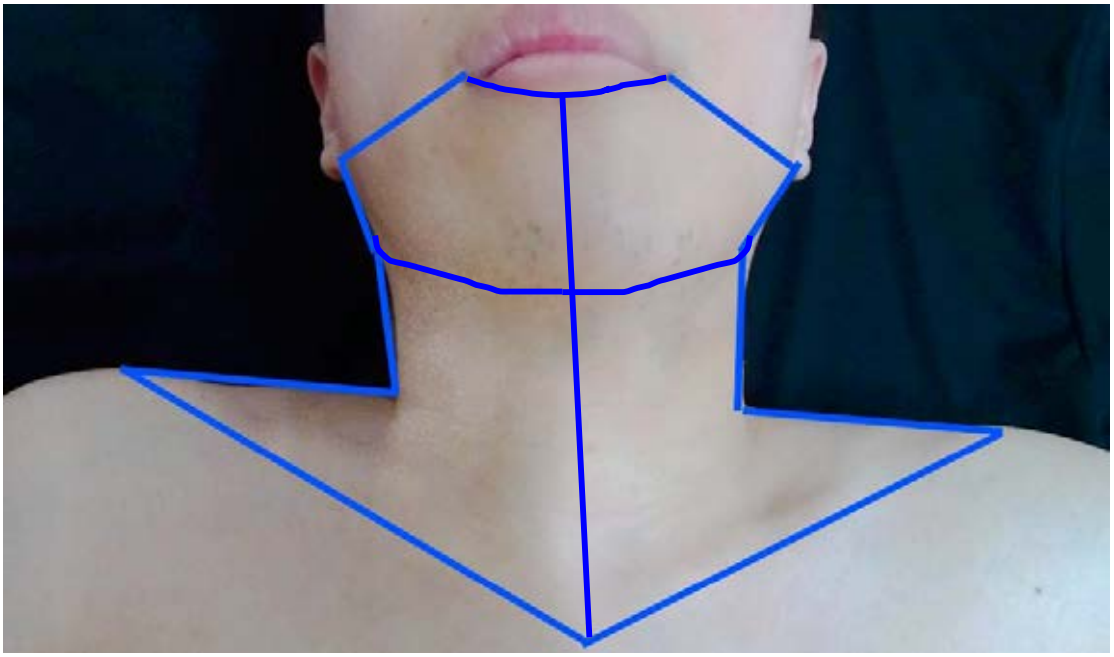


Figure 2. Skin incision and dissection: An incision was made following the vertical line from lower vermillion border to sternal notch, following horizontal line from gnathion to ear lobule. Next, skin incision was performed from oral commissure to ear lobule after that draw line pass through acromion process continue to clavicle until sternal notch. The skin was removed superficially from the medial side to the lateral side.

2. The subcutaneous tissue layer will be seen after the skin dissection has been completed. Then, the subcutaneous fat carefully removed. The platysma muscle will be found (Fig 3.)

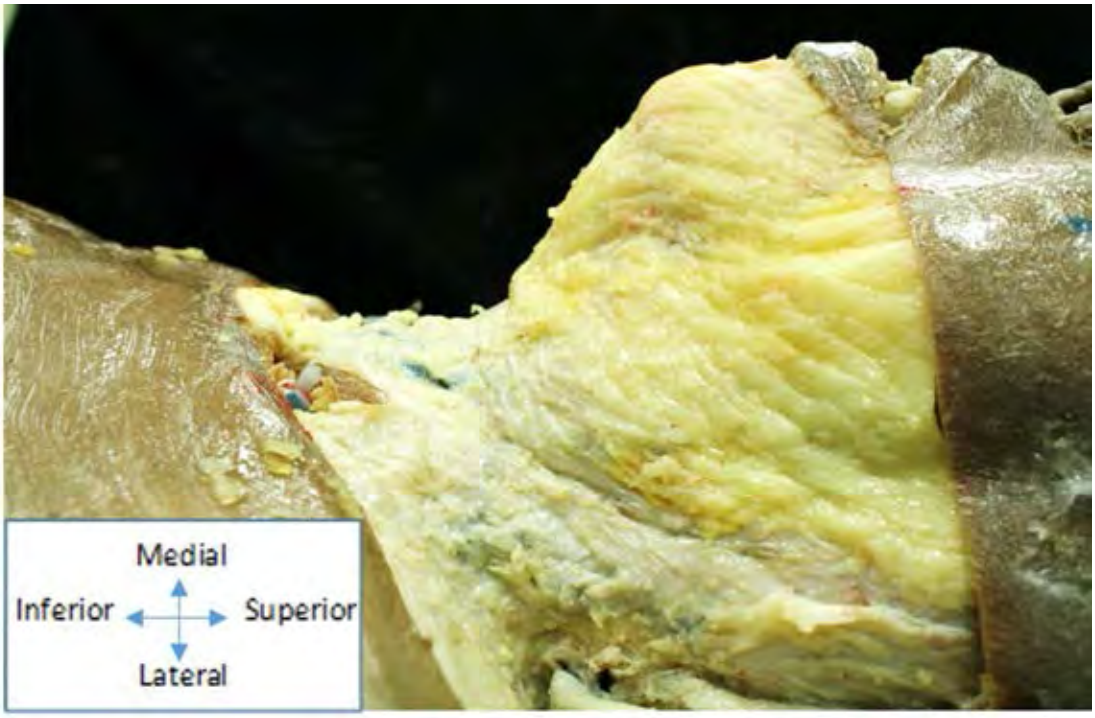


Figure 3. After completing the skin dissection, the subcutaneous tissue layer will be seen and continue carefully removed.

3. Mark the reference point at the most prominence part of hyoid bone, thyroid cartilage and cricoid cartilage .Draw horizontal line from hyoid bone through greater cornu of hyoid bone and draw horizontal line from thyroid cartilage and cricoid cartilage on platysma muscle (Fig 4.)

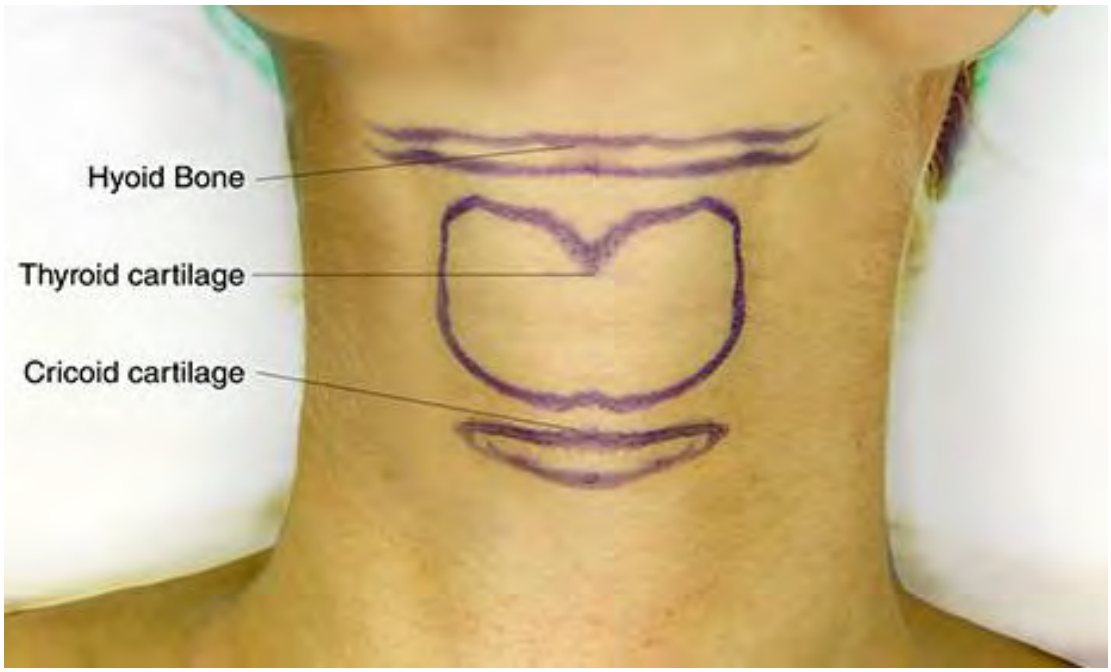


Figure 4. Anterior cervical bone landmarks regarding three parallel horizontal line to evaluated location of cervical branch of facial nerve. (Above)Hyoid bone, (Middle)Thyroid cartilage and (Lower)Cricoid cartilage (Ref.:https://www.nysora.com/regional-and-topical-anesthesia-for-awake-endotracheal-intubation)

4. Draw a vertical line at intersection of anterior border of sternocleidomastoid muscle and horizontal line that draw pass through thyroid cartilage on platysma muscle. (Fig 5.)

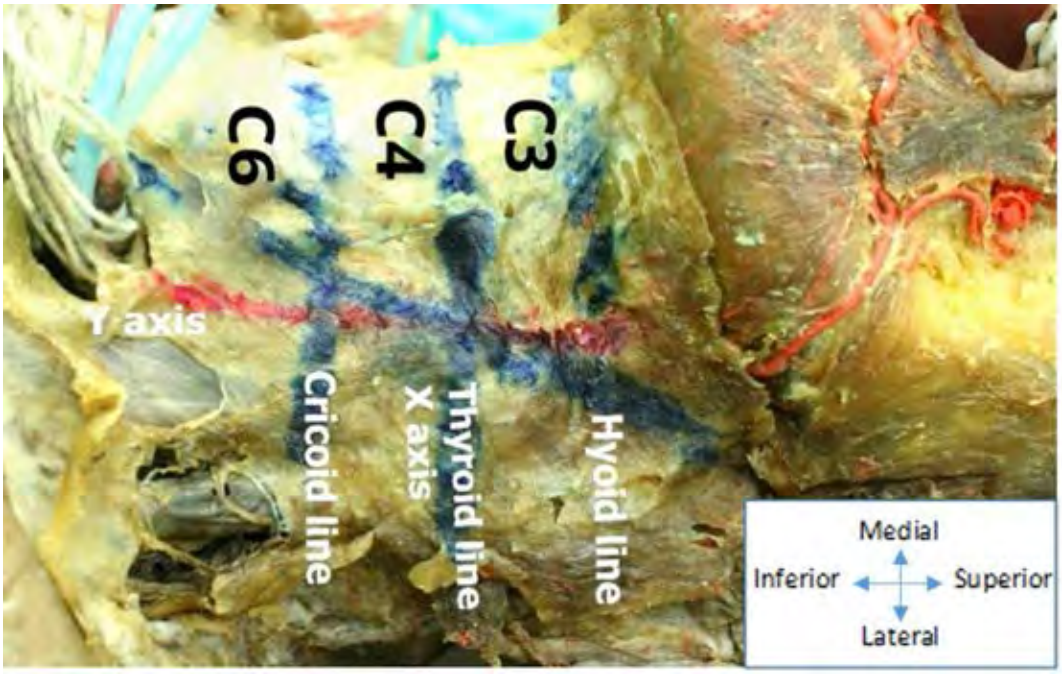


Figure 5. Reference line frameworks showed to evaluated location of cervical branch of facial nerve; three parallel horizontal lines through hyoid bone, thyroid cartilage and cricoid cartilage and a vertical line at intersection of anterior border of sternocleidomastoid muscle and thyroid cartilage line on platysma muscle.

5. Reflect platysma muscle from superiomedial to infererolateral along the mandible towards its origin. This allowed access to subcutaneous fat and underlying structures such as external jugular vein, cervical branch of facial nerve of facial nerve, transverse cervical nerve, and great auricular nerve (Fig 6.)

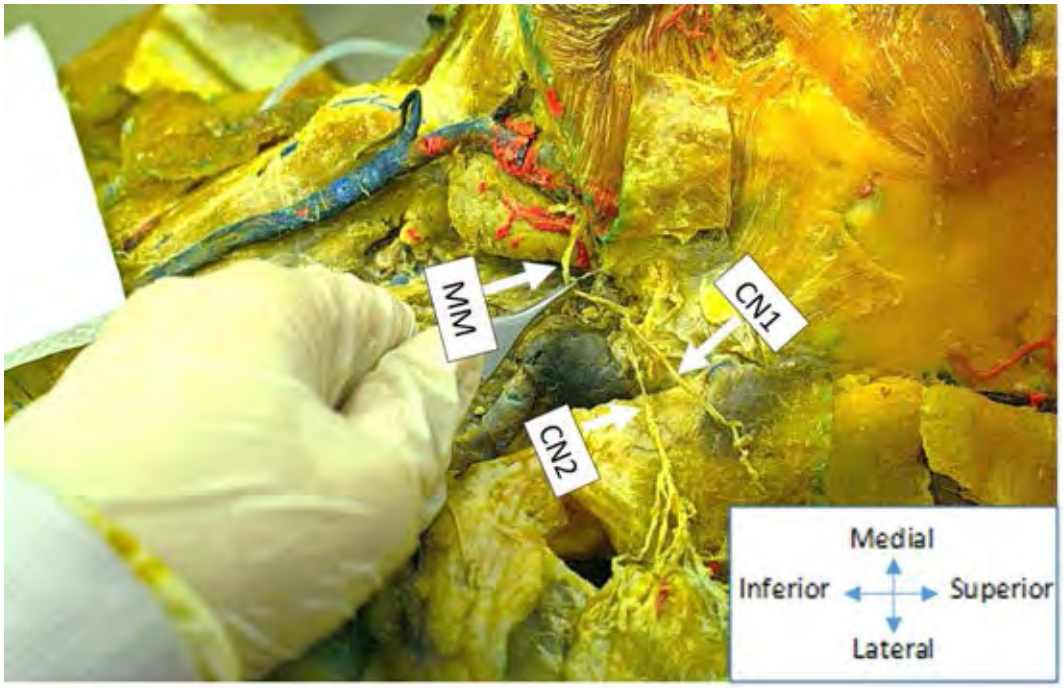


Figure 6 Platysma muscle was opened to demonstrate the emerging Marginal mandibular nerve and Cervical branch of facial nerve; (MM) Marginal mandibular nerve, (CN1) 1st Cervical branch of facial nerve and (CN2) 2nd Cervical branch of facial nerve

6.2 Observation

Record the appearance of cervical branch and transverse cervical branch of facial nerve.

6.3 Measurement

- To study the coordinates of branching points, terminal branches and anastomosis of cervical branches of facial nerve on reference frame (Y axis = the vertical line drawn through intersection of anterior border of sternocleidomastoid and X axis)(X axis =horizontal line that draw from thyroid cartilage)

- To study the distance from branching points of cervical branch of facial nerve to external jugular vein

7. Data analysis

Statistical analysis was undertaken with SPSS version 22. The data were analyzed to get averaged value (Mean), Minimum value (Min), Maximum value (Max) and Standard deviation. Mode will be used in characterize locating of branching point, locating of Terminal branching point and locating of anastomosis. All data will be tested for a normality test. Significance value of Shapiro-Wilk is used in case of number of sample less than 50. If $p > 0.05$, It is estimated that the distribution of data is normal. If $p < 0.05$, It is estimated that the distribution of data is distribution free or nonparametric. To compare the difference between genders. If the distribution is normal, the student's t test is selected. If the distribution is independent or nonparametric statistics. Mann-Whitney U is tested. The data were statistically significant at $p < 0.05$. To compare the difference between sides. If the distribution is normal distribution, Paired Samples Test is selected. If the distribution is independent (distribution free) or Nonparametric statistics. Wilcoxon signed rank test is tested.

CHAPTER IV
RESULTS

Nineteen human cadavers [9 males (13 sides) and 10 female (14sides)] were studied at the Department of Anatomy in Faculty of Medicine Chulalongkorn University. Overall Mean ages were 78.15 years (range, 59-94 years). Mean ages were 74.21 years (range, 57-93 years) for males and 80.57 years (range 54-94 years) for females (Table1).

Table 1. Ages of cadavers

Gender	Age(years)			Total
	Max	Min	Average	
Male	93	57	75.5	13
Female	94	54	80.6	14
Total	94	54	78.15	27

The branching patterns of the facial nerve from 19 cadavers (27 sides) were classified into four pattern: one branch (8 of 27 sides, 29.62%), two branches (8 of 27 sides, 29.62%), three branches (8 of 27 sides, 29.62%) and four branches (3 of 27 sides, 11.11%). Therefore, the prevalence of branching of the nerve of one branch, two branches and three branches are similar (8 of 27 sides, 29.62%). The branching of the nerve of four branches has found the least.

This research studied the topography of cervical branch of facial nerve (CN) based on reference framework: the sternocleidomastoid muscle and three parallel horizontal lines pass through hyoid bone, thyroid cartilage and cricoid cartilage on superficial platysma muscle. By studying the location of cervical branch of facial nerve and the relationship of the course of cervical branch of the facial nerve to soft tissue, the following measurements will be performed.

1. Distance between branching points and retromandibular vein

From the study, we found that the distances between 1st branching point (BP1) and retromandibular vein (RMV) were 0.50±3.97 mm; laterally to RMV. The distances between 2nd branching point (BP2) and retromandibular vein (RMV) were 3.00±1.30mm; medial to RMV. The distances between 3rd branching point (BP3) and retromandibular vein (RMV) were 3.43±1.25mm; medial to RMV. The distances between 4th branching point (BP4) and retromandibular vein (RMV) were 0.17±5.00 mm; medial to RMV.

When comparing distances between males and females of the sample groups, it was found that there was no significant difference ($P > 0.05$) between males and females except the distances between BP2 to RMV (Table 2). Moreover, no statistical significance was found ($p>0.05$) when comparing the distances between sides. There was statistical significance ($p<0.05$) when comparing the distances of 4th branching point (BP4) to retromandibular vein (RMV) between sides. The distances between BP4 to RMV were 3.05±0.49mm; medial to RMV on right sides, and the distances between BP4 to RMV were 5.60 mm on left sides; laterally to RMV. (Table 3) (Fig 6.)

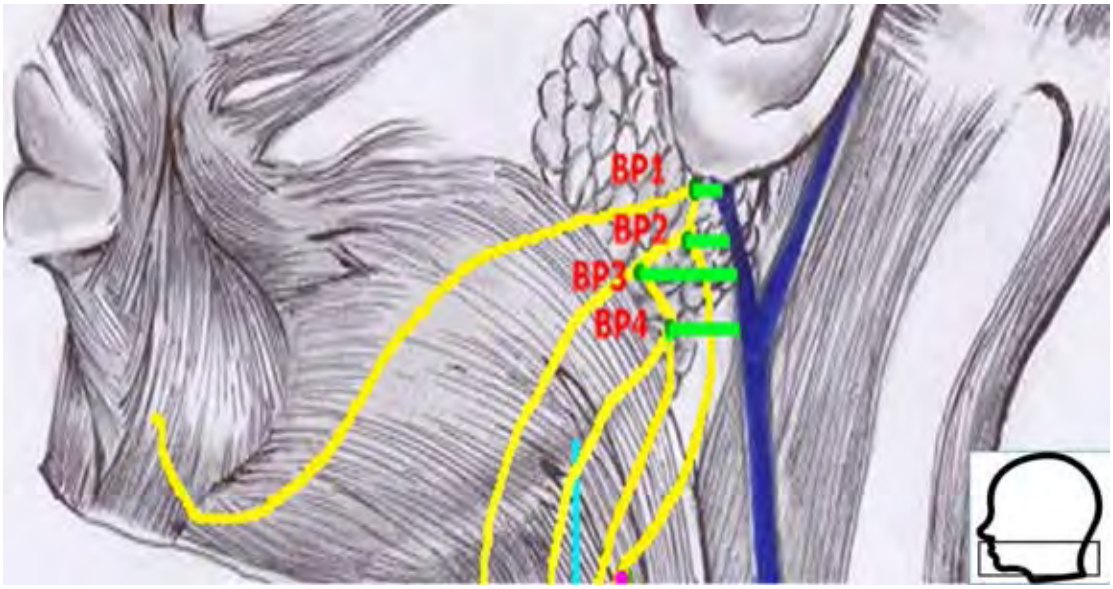


Figure 7. Measurements of the distance from the branching point of cervical branch of facial nerve (BP) to the external jugular vein (EJV); (Green) distances between BP and RMV

Table 2. Comparison of distance between branching points and retromandibular vein among male and female

	gender	N	Distance(mm)				P value
			Min	Max	Mean	Std. Deviation	
BP1-RMV	Male	13	-4.20	4.70	-0.90	2.99	0.240
	Female	14	-6.20	10.80	0.97	4.80	
	Total	27	-3.20	4.70	0.50	3.97	
BP2-RMV	Male	10	-7.50	0.00	-2.89	2.28	**0.007***
	Female	9	-3.30	8.40	2.10	4.13	
	Total	19	-3.30	8.40	-0.53	4.10	
BP3-RMV	Male	5	-8.50	-2.20	-5.00	2.46	0.069
	Female	6	-7.70	8.40	1.03	6.26	
	Total	11	-4.70	-2.20	-3.43	1.25	
BP4-RMV	Male	3	-3.40	5.60	-0.17	5.00	-
	Female	-	-	-	-	-	
	Total	3	-3.40	5.60	-0.17	5.00	

[-] represent the branching point (BP) is placed medially to the retromandibular vein (RMV).

Table 3. Comparison of distance between branching points and retromandibular vein among right and left

	Sides	N	Distance(mm)				P value
			Min	Max	Mean	Std.	
BP1-RMV	Right	13	-4.00	4.70	-2.30	3.11	0.200
	Left	14	-6.20	10.80	1.05	4.69	
	Total	27	-3.2	4.7	0.50	3.97	
BP2-RMV	Right	10	-4.20	4.20	-1.20	2.96	0.465
	Left	9	-7.50	8.40	0.22	5.16	
	Total	19	-4.5	-2.20	-3.00	1.30	
BP3-RMV	Right	5	-6.20	-2.00	-3.56	1.82	0.323
	Left	6	-8.50	8.40	-0.18	7.41	
	Total	11	-4.7	-2.20	-3.43	1.25	
BP4-RMV	Right	2	-3.40	-2.70	-3.05	0.49	**0.045***
	Left	1	-	-	5.60	-	
	Total	3	-3.40	5.60	-0.17	5.00	

[-] represent the branching point (BP) is placed medially to the retromandibular vein (RMV).

2. Distance between terminal branching points and external jugular vein

From the study found that the distances between 1st terminal branching point (TBP1) and external jugular vein (EJV) were 6.83±15.01 mm; medial to RMV. The distances between 2nd terminal branching point (TBP2) and external jugular vein (EJV) were 7.94±14.51mm; medial to RMV. The distances between 3rd terminal branching point (TBP3) and external jugular vein (EJV) were 4.45±13.32 mm; medial to RMV. The distances between 4th terminal branching point (TBP4) and external jugular vein (EJV) were 27.33± 13.50mm; medial to RMV.

From the study, when comparing distances of the terminal branching points (TBP) and external jugular vein (EJV) between males and females of the sample, It was found that there was no significant difference (P> 0.05) between males and female except the distances between TBP1 to EJV (P<0.05).The distances between TBP1 to EJV were 15.25±14.09mm; medial to EJV in male. The distances between TBP1 to EJV were 0.99±11.43mm; lateral to RMV in female (Table 4). In addition, no statistical significance was found (p>0.05) when comparing the distances of the terminal branching points (TBP) and external jugular vein (EJV) between sides. (Table 5) (Fig 7.)

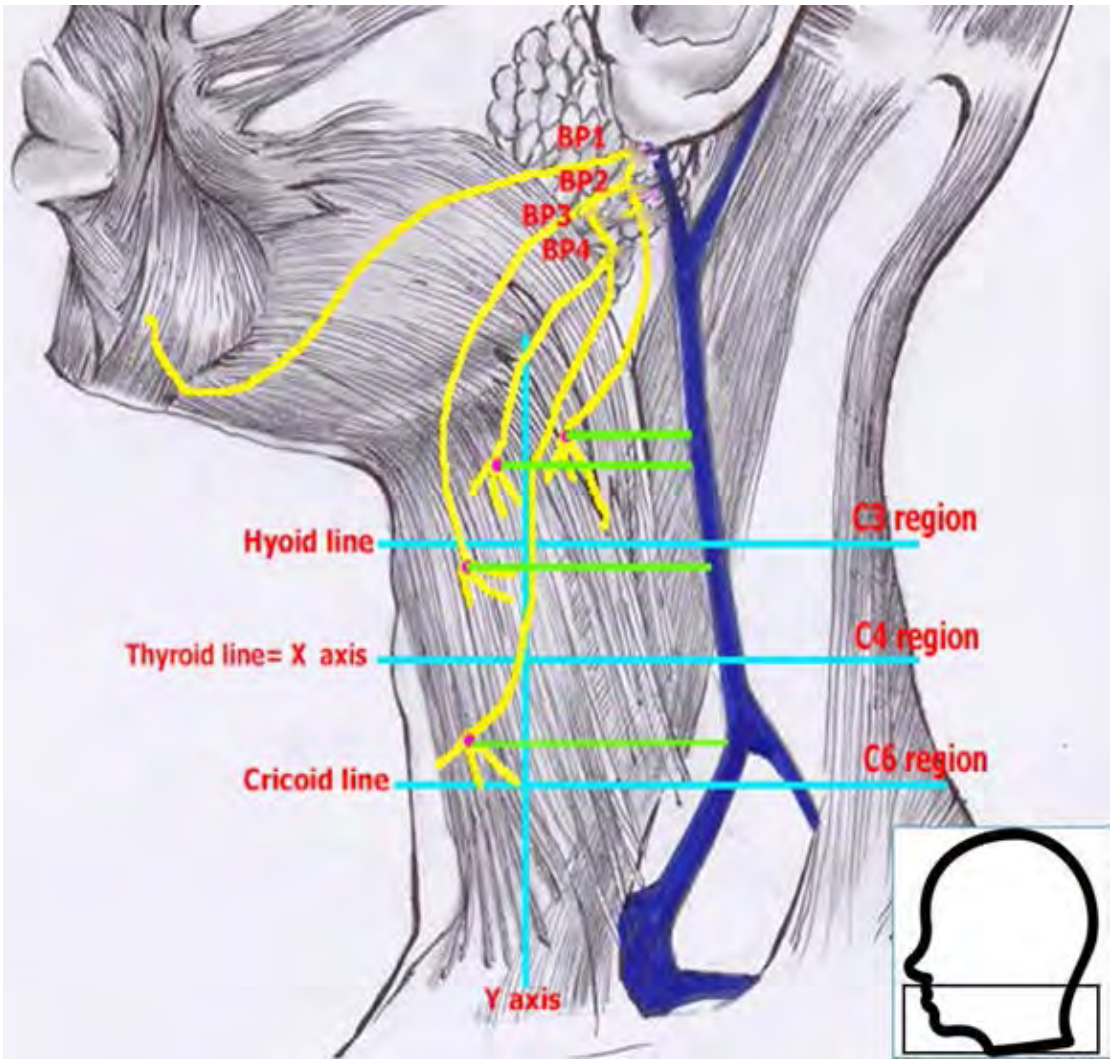


Figure 8. Measurements of the distance from the terminal branching point (TBP) to the external jugular vein (EJV); (Green) distances between TBP and RMV, (Pink) terminal branching point on C3, C4 and C6 regions

Table 4. Comparison of distance between terminal branching points and external jugular vein among male and female

	Sides	N	Distance(mm)				P value
			Min	Max	Mean	Std.	
TBP1-EJV	Right	13	-38.00	3.70	-15.25	14.09	0.003*
	Left	14	-15.40	24.90	0.99	11.43	
	Total	27	-38.00	24.90	-6.83	15.01	
TBP2-EJV	Right	10	-36.70	11.50	-13.67	16.07	0.068
	Left	9	-11.60	18.40	-1.58	9.83	
	Total	19	-36.70	18.40	-7.94	14.51	
TBP3-EJV	Right	5	-34.50	8.20	-7.34	16.73	0.054
	Left	6	-16.80	12.50	-2.05	10.75	
	Total	11	-34.50	12.50	-4.45	13.32	
TBP4-EJV	Right	2	-38.90	-12.50	-27.33	13.50	-
	Left	1	-	-	-	-	
	Total	3	-38.90	-12.50	-27.33	13.50	

[-] represent the terminal branching point (TBP) is placed medially to the external jugular vein (EJV).

Table 5. Comparison of distance between terminal branching points and external jugular vein among right and left

	Sides	N	Distance(mm)				P value
			Min	Max	Mean	Std. Deviation	
TBP1-EJV	Right	13	-33.10	24.90	-3.85	17.28	0.329
	Left	14	-38.00	9.30	-9.60	11.43	
	Total	27	-38.00	24.90	-6.83	15.01	
TBP2-EJV	Right	10	-31.30	-36.70	-4.50	12.03	0.287
	Left	9	11.50	18.40	-11.78	16.71	
	Total	19	-36.70	18.40	-7.94	14.51	
TBP3-EJV	Right	5	-10.30	12.50	3.34	8.57	0.073
	Left	6	-34.50	4.80	-10.95	13.59	
	Total	11	-34.50	12.50	-4.45	13.32	
TBP4-EJV	Right	2	-38.90	-12.50	-25.70	18.67	-
	Left	1	-	-	5.60	-	
	Total	3	-38.90	-12.50	-27.33	13.50	

[-] represent the terminal branching point (TBP) is placed medially to the external jugular vein (EJV).

3. Locations of branching points on platysma muscle

3.1 Single branch

From the study found that the locations of branching points in distances X and Y were 18.48±1.20mm and 51.71±4.60 mm, respectively. When comparing locations of BP1 (single branch) between right and left sides of the sample. In distance X, it was found that there was no significant difference ($P > 0.05$) between right and left sides (Table 6). The locations of branching points in distances X on right and left sides were 19.07±1.42mm and 18.12±1.05mm, respectively. In distance Y, It was found that there was no significant difference ($P > 0.05$) between right and left sides (Table 6). The locations of branching

points in distances Y on right and left sides were 50.43±0.91mm and 52.48±5.89, respectively. In addition, when comparing locations of BP1 (single branch) between male and female. In distance X, it was found that there was no significant difference (P> 0.05) between male and female (Table 7). The locations of branching points in distances X in male and female were 18.00±0.62mm and 18.76±1.43mm, respectively. In distance Y, It was found that there was no significant difference (P> 0.05) between male and female (Table 7).The locations of branching points in distances Y on male and female were 54.43±5.06mm and 50.08±3.91mm ,respectively.(Table 7) (Fig 8.).

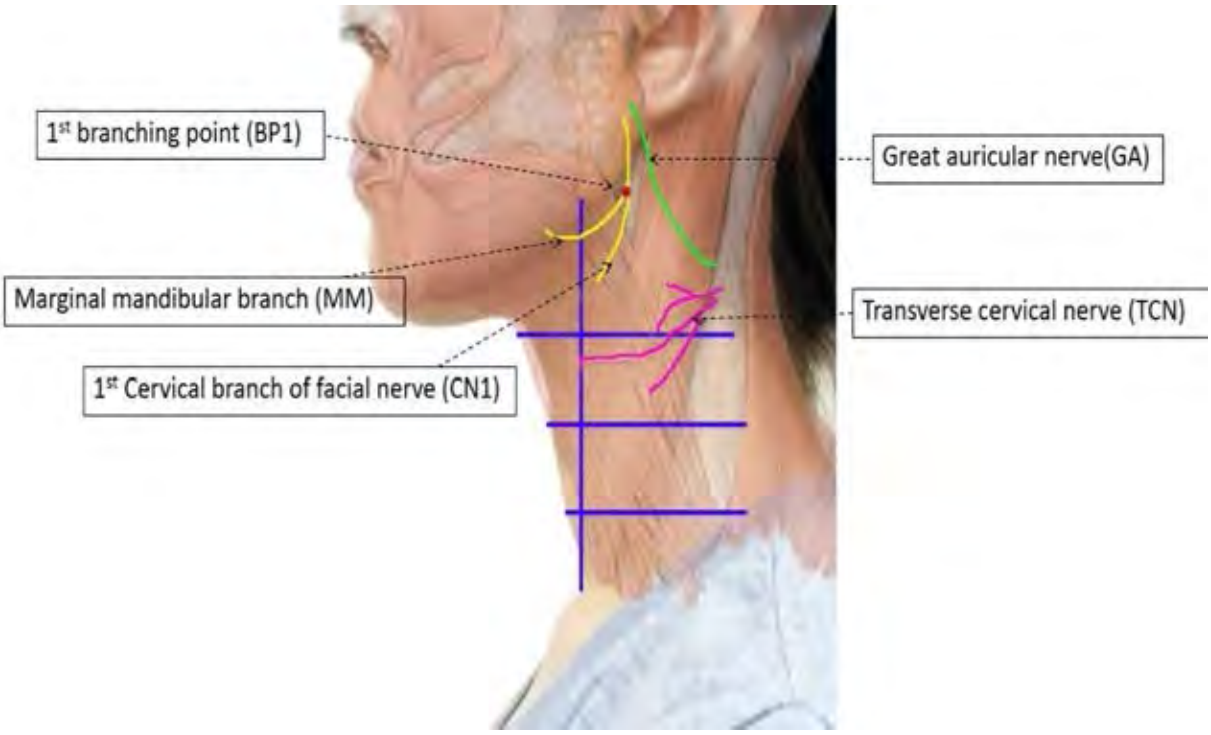


Figure 9. Schematic drawing of single branch of cervical branch of facial nerve; (BP1) 1st branching point of cervical branch of facial nerve diverged into (MM) Marginal mandibular branch and (CN1) 1st cervical branch of facial nerve.

Table 6. Comparison locations of branching point (single branch) between Right and Left

Distance	Mean distances(mm)						P value
	Total		Right		Left		
	N (%)	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	
Distance X	8 (100)	18.48 ±1.20	3 (37.5)	19.07 ±1.42	5 (62.5)	18.12 ±1.05	0.316
Distance Y		51.71 ±4.60		50.43 ±0.91		52.48 ±5.89	0.485

Table 7. Comparison locations of branching point (single branch) between Male and Female

Distance	Mean distances(mm)						P value
	Total		Male		Female		
	N (%)	Mean distance X±SD (Range) (mm)	N (%)	Mean distance X±SD (Range) (mm)	N (%)	Mean distance X±SD (Range) (mm)	
Distance X	8 (100)	18.48 ±1.20	3 (37.5)	18.00 ±0.62	5 (62.5)	18.76 ±1.43	0.429
Distance Y		51.71 ±4.60		54.43 ±5.06		50.08 ±3.91	0.218

3.2 Two branches

In this scenario, we found that the locations of the first branching point (BP1) in distances X and Y were 21.25±1.43mm and 50.74±4.83mm, respectively. Moreover, the locations of second branching point (BP2) in distances X and Y were 19.89±2.20mm and 49.44±6.42mm, respectively.

When comparing locations of BP1 between right and left sides of the samples with two branches, the locations of BP1 in distances X on right and left sides were 21.40±0.78mm and 21.00±1.43mm, respectively. Moreover, the locations of branching points in distances Y on right and left sides were 50.40 ±5.99mm and 51.30±3.01mm, respectively. There was no significant difference ($P > 0.05$) on both distance X and Y between right and left sides (Table 8). In addition, when comparing locations of BP2 between right and left sides of the samples with two branches. The locations of BP2 in distances X on right and left sides were 18.76±1.83 and 21.77±1.29mm, respectively. Moreover, in distance Y, the locations of branching points in distances Y on right and left

sides were 47.28±7.51mm and 53.03±0.57mm, respectively. There was no significant difference (P> 0.05) on both distance X and Y between right and left sides (Table 8).

When comparing locations of BP1 between male and female of the samples with two branches. The locations of branching points in distances X on male and female were 20.86±1.54mm and 21.90±1.21mm, respectively. The locations of branching points in distances Y in male and females were 48.90±5.34 and 53.76±1.58mm, respectively. There was no significant difference (P> 0.05) between male and female sides (Table 9) (Fig 10.).

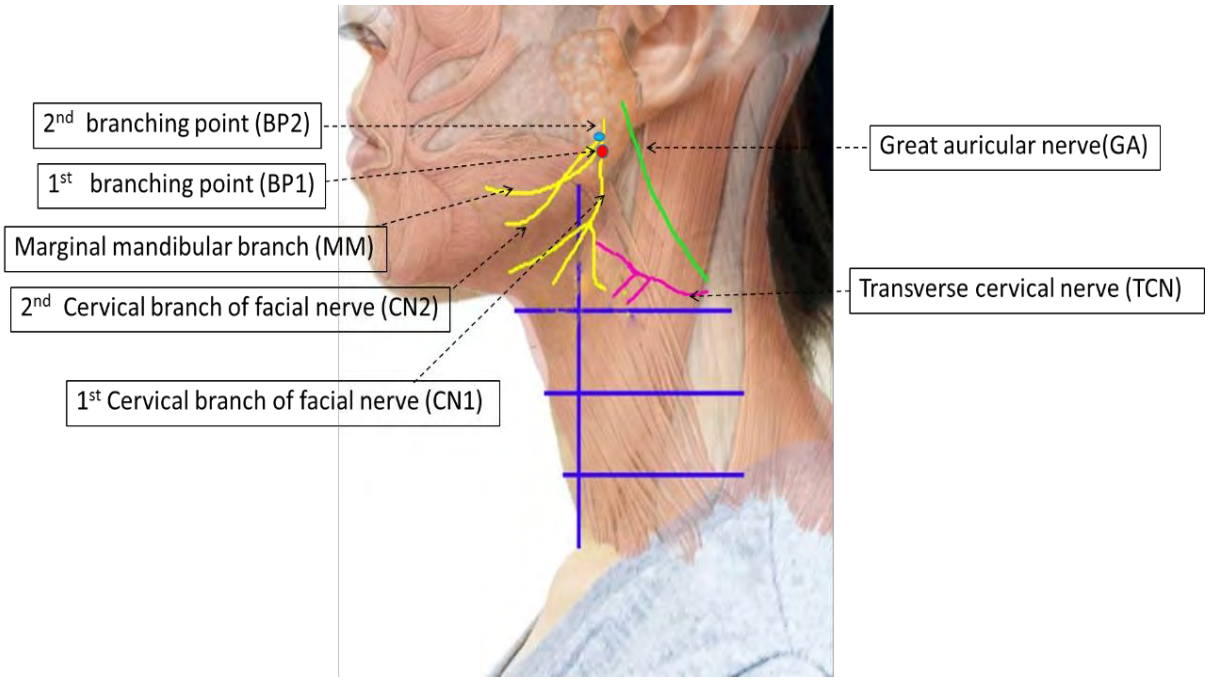


Figure 10. Schematic drawing of two branches of cervical branch of facial nerve; (BP1) 1st branching point of cervical branch of facial nerve diverged into (MM) Marginal mandibular branch and (CN1) 1st cervical branch of facial nerve. (BP2) 2nd branching point of cervical branch of facial nerve diverged from (CN1) 1st or main cervical branch of facial nerve into (CN2) 2ndcervical branch of facial nerve.

Table 8. Comparison locations of branching points (Two branches) between Right and Left

	Distance	Mean distances(mm)						P value
		Total		Right		Left		
		N (%)	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	
BP1	Distance X	8 (100)	21.25 ±1.43	5 (62.5)	21.40 ±0.78	3 (37.5)	21.00 ±1.43	0.734
	Distance Y		50.74 ±4.83		50.40 ±5.99		51.30 ±3.01	0.820
BP2	Distance X		19.89 ±2.20		18.76 ±1.83		21.77 ±1.29	0.490
	Distance Y		49.44 ±6.42		47.28 ±7.51		53.03 ±0.57	0.247

Table 9. Comparison locations of branching points (Two branches) between Male and Female

	Distance (mm)	Mean distances(mm)						P value
		Total		Right		Left		
		N (%)	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	
BP1	Distance X	8 (100)	21.25 ±1.43	5 (62.5)	20.86 ±1.54	3 (37.5)	21.90 ±1.21	0.60
	Distance Y		50.74 ±4.83		48.90 ±5.34		53.76 ±1.58	0.23
BP2	Distance X		19.89 ±2.20		20.08 ±1.22		19.57 ±3.70	0.14
	Distance Y		49.44 ±6.42		47.82 ±7.95		52.13 ±0.73	0.10

3.3 Three branches

In this scenario, we found that the locations of the 1st branching point (BP1). in distances X and Y were 18.34±8.70mm and 45.15±19.74mm, respectively. Moreover, the locations of second branching point (BP2) in distances X and Y were 17.19±8.25mm and 44.26±19.58mm, respectively. The locations of branching points (BP3) in distances X and Y were 15.13±9.27mm and 41.55±19.12mm, respectively.

When comparing locations of BP1 between right and left sides of the samples with three branches, the locations of BP1 in distances X on right and left sides were 20.53 ±0.09mm and 17.02±11.04mm, respectively. Moreover, the locations of branching points in distances Y on right and left sides were 54.57±3.44mm and 39.50±23.86mm, respectively. There was no significant difference (P> 0.05) on both distance X and Y between right and left sides (Table 8). In addition, when comparing locations of BP2

between right and left sides of the samples with three branches. The locations of BP2 in distances X on right and left sides were 20.00±2.56mm and 15.50±10.32mm, respectively. Moreover, in distance Y, the locations of branching points in distances Y on right and left sides were 49.27±5.94mm and 39.52±24.33mm, respectively. There was no significant difference (P> 0.05) on both distance X and Y between right and left sides (Table 8). Furthermore, When comparing locations of BP3 between right and left sides of the samples with three branches. The locations of branching points in distances X in right and left sides were 20.23±3.07and 17.02±11.04mm, respectively. Moreover, the locations of branching points in distances Y on right and left sides were 49.27±5.95mm and 39.50±23.86mm, respectively. There was no significant difference (P> 0.05) on both distance X and Y between right and left sides (Table 10) (Fig11).

When comparing locations of BP1 between male and female of the sample with three branches. The locations of branching points in distances X on male and female were 22.35±0.64mm and 17.00±9.86mm, respectively. Moreover, the locations of branching points in distances Y on right and left sides were 53.95±3.33and 42.22±22.40mm, respectively. It was found that there was no significant difference (P> 0.05) between male and females (Table 11). In addition, when comparing locations of BP2 between male and female with three branches. The locations of branching points in distances X in male and female were 21.35±1.48mm and 15.80±9.25mm, respectively. The locations of branching points in distances Y on male and female were 53.05± 1.77mm and 41.33±22.25mm, respectively. It was found that there was no significant difference (P> 0.05) between male and female (Table 11).

Furthermore, When comparing locations of BP3 between male and female with three branches. The locations of branching points in distances X in male and female were 21.00± 3.81and 13.17±9.95mm, respectively. The locations of branching points in distances Y on male and female were 51.50±1.70mm and 38.23±21.41mm, respectively. It was found that there was no significant difference (P> 0.05) between male and female (Table 11) (Fig 11.)

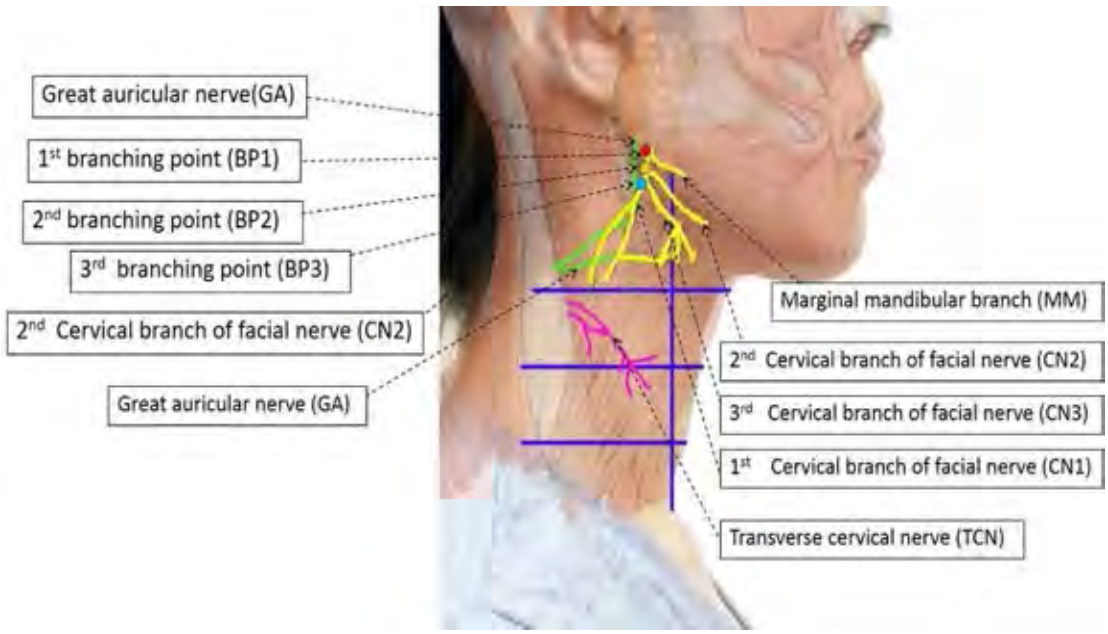


Figure 11. Schematic drawing of three branches of cervical branch of facial nerve; (BP1) 1st branching point of cervical branch of facial nerve diverged into (MM) Marginal mandibular branch and (CN1) 1st cervical branch of facial nerve. (BP2) 2nd branching point of cervical branch of facial nerve diverged from (CN1) 1st or main cervical branch of facial nerve into (CN2) 2nd cervical branch of facial nerve. (BP3) 3rd branching point of cervical branch of facial nerve diverged from (CN1) 1st or main cervical branch of facial nerve into (CN2) 2nd cervical branch of facial nerve

Table 10. Comparison locations of branching points (Three branches) between Right and Left

	Distance	Mean distances(mm)						P value
		Total		Right		Left		
		N (%)	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	
BP1	Distance X	8 (100)	18.34 ±8.70	3 (37.5)	20.53 ±0.09	5 (62.5)	17.02± 11.04	0.619
	Distance Y		45.15 ±19.74		54.57 ±3.44		39.50± 23.86	0.333
BP2	Distance X		17.19 ±8.25		20.00 ±2.56		15.50± 10.32	0.498
	Distance Y		44.26 ±19.58		49.27 ±5.94		39.52± 24.33	0.418
BP3	Distance X		15.13 ±9.27		20.23 ±3.07		17.02± 11.04	0.256
	Distance Y		41.55 ±19.12		49.27 ±5.95		39.50± 23.86	0.419

Table 11. Comparison locations of branching points (Three branches) between Male and Female

	Distance	Mean distances(mm)						P value
		Total		Male		Female		
		N (%)	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	
BP1	Distance X	8 (100)	18.34 ±8.70	2 (25)	22.35 ±0.64	6 (75)	17.00 ±9.86	0.619
	Distance Y		45.15 ±19.74		53.95 ±3.33		42.22 ±22.40	0.333
BP2	Distance X		17.19 ±8.25		21.350 ±1.48		15.80 ±9.25	0.498
	Distance Y		44.26 ±19.58		53.05 ± 1.77		41.33 ±22.25	0.418
BP3	Distance X		15.13 ±9.27		21.00 ± 3.81		13.17 ±9.95	0.256
	Distance Y		41.55 ±19.12		51.50 ±1.70		38.23 ±21.41	0.419

3.4 Four branches

In this scenario, we found that the locations of the 1st branching point (BP1). In distances X and Y were 20.67±1.10mm and 54.47±3.53mm, respectively. Moreover, the locations of 2nd branching point (BP2) in distances X and Y were 20.30 ±3.62mm and 52.70±2.19mm, respectively. Furthermore, the locations of 3rd branching points (BP3) in distances X and Y were 15.13±9.27mm and 41.55±19.12mm, respectively. In addition,

the locations of 4th branching points (BP4) in distances X and Y were 18.00±1.30mm and 51.30±3.58mm.

When comparing locations of 1st branching point (BP1) with four branches between right and left sides of the sample. The locations of branching points in distances X on right and left sides were 20.30±1.27mm and 21.4mm, respectively. Furthermore, the locations of branching points in distances Y on right and left sides were 56.50 ±0.42mm and 50.4mm, respectively. It was found that there was no significant difference (P> 0.05) between right and left sides (Table 12). When comparing locations of 2nd branching point (BP2) with four branches between right and left sides of the sample. The locations of branching points in distances X in right and left sides were 18.60 ± 2.97mm and 23.7mm, respectively. The locations of branching points in distances Y on right and left sides were 51.90 ± 2.40mm and 54.3mm, respectively. It was found that there was no significant difference (P> 0.05) between right and left sides (Table 12). Furthermore, When comparing locations of 3rd branching point (BP3) between right and left sides with four branches. The locations of 3rd branching points in distances X in right and left sides were 18.00 ± 2.12mm and 19.7mm, respectively. The locations of branching points in distances Y on right and left sides were 50.45 ± 0.35mm and 55.3mm. It was found that there was no significant difference (P> 0.05) between right and left sides (Table 12). When comparing locations of BP4 (four branches) between right and left sides. The locations of branching points in distances X in right and left sides were 17.65 ± 1.62mm and 18.7mm, respectively. In distance Y, It was found that there was no significant difference (P> 0.05) between right and left sides.

To compare the locations of BP1 between male and female of the sample with for branches cannot be computed because female group is empty. The locations of 1st branching points (BP1) in distances X and distance Y in male were 20.67±1.10mm and 54.47±3.53mm. The locations of 2nd branching points (BP2) in distances X and distance Y in male were 20.30±3.62mm and 52.70±2.19mm. The locations of 3rd branching points (BP3) in distances X and distance Y in male were 18.57±1.79mm and 52.07±2.81mm. The

locations of 4th branching points (BP4) in distances X and distance Y in male were 18.00±1.30mm and 51.30±3.58mm. (Table 13) (Fig 12.)

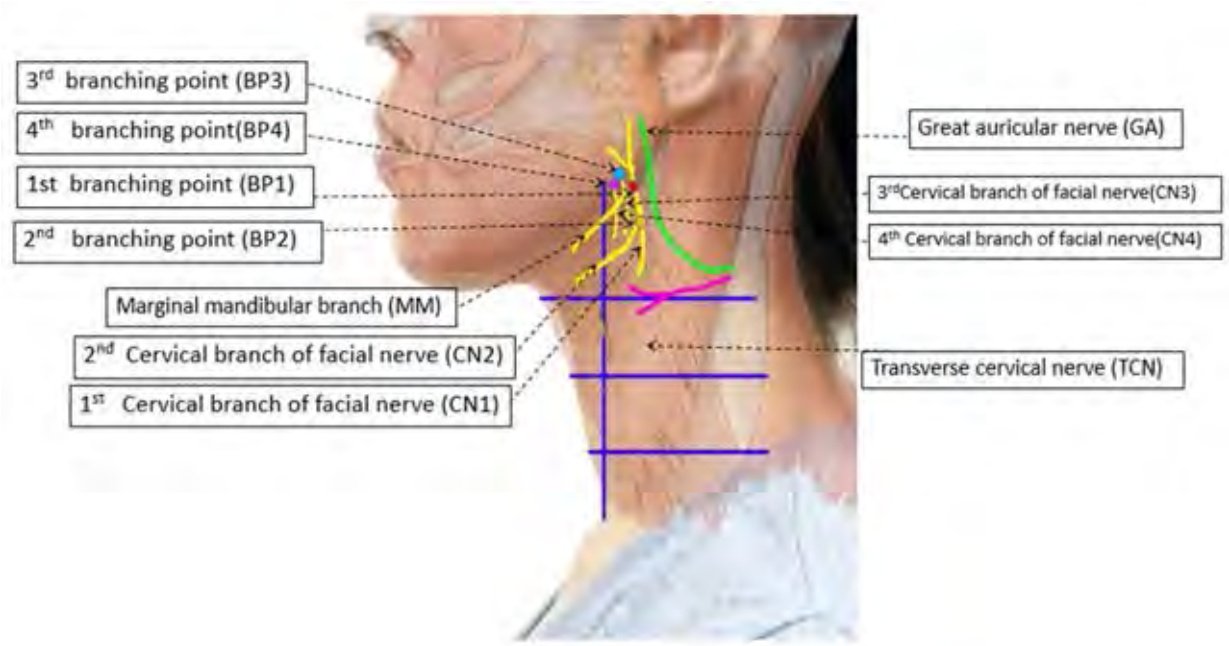


Figure 12. Schematic drawing of four branches of cervical branch of facial nerve; (BP1) 1st branching point of cervical branch of facial nerve diverged into (MM) Marginal mandibular branch and (CN1) 1st cervical branch of facial nerve. (BP2) 2nd branching point of cervical branch of facial nerve diverged from (CN1) 1st or main cervical branch of facial nerve into (CN2) 2ndcervical branch of facial nerve. (BP3) 3rd branching point of cervical branch of facial nerve and (BP4) 4th branching point of cervical branch of facial nerve left from inferior pole of parotid and gave a single branch to supply platysma muscle.

Table 12. Comparison locations of branching points (Four branches) between Right and Left

	Distance (mm)	Mean distances(mm)					
		Total		Right		Left	
		N (%)	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)
BP1	Distance X	3 (100)	20.67 ±1.10	2 (66.67)	20.30 ±1.27	1 (33.33)	21.4
	Distance Y		54.47 ±3.53		56.50 ±0.42		50.4
BP2	Distance X		20.30 ±3.62		18.6 ± 2.97		23.7
	Distance Y		52.70 ±2.19		51.9 ± 2.40		54.3
BP3	Distance X		18.57 ±1.79		18.0 ± 2.12		19.7
	Distance Y		52.07 ±2.81		50.45 ± 0.35		55.3
BP4	Distance X		18.00 ±1.30		17.65 ± 1.62		18.7
	Distance Y		51.30 ±3.58		49.30 ± 1.27		55.3

Table 13. Comparison locations of branching points (Four branches) between Male and Female

	Distance (mm)	Mean distances(mm)					
		Total		Male		Female	
		N (%)	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)
BP1	Distance X	3 (100)	20.67±1.10	3 (100)	20.67±1.10	0 (0)	-
	Distance Y		54.47±3.53		54.47±3.53		-
BP2	Distance X		20.30 ±3.62		20.30 ±3.62		-
	Distance Y		52.70±2.19		52.70±2.19		-
BP3	Distance X		18.57±1.79		18.57±1.79		-
	Distance Y		52.07±2.81		52.07±2.81		-
BP4	Distance X		18.00±1.30		18.00±1.30		-
	Distance Y		51.30±3.58		51.30±3.58		-

3.5 Summarize

We categorized our data to relate with cervical regions for practical use. Single cervical branch was found in 8 dissections consisting of 1st cervical branching point (BP1) 8 sites. Branching points of one branch of cervical branch of facial nerve on the platysma muscle at C3 position 8 sites (13.33%), consisting of 1st cervical branching point (BP1) 8 sites (Table14). Moreover, two cervical branches was found in 8 dissections consisting of 1st cervical branching point (BP1) 8 sites and 2nd cervical branching point (BP2) 8 sites. Branching points of two branches of cervical branch of facial nerve placed on the platysma muscle at C3 position 16 sites(26.67%) consisting of 1st cervical branching point (BP1) 8 sites and 2nd cervical branching point (BP2) 8 sites. Furthermore, three cervical branches was found in 8 dissections consisting of 1st cervical branching point (BP1) 8 sites, 2nd cervical branching point (BP2) 8 sites and 3rd cervical branching point (BP3) 8 sites. Branching points of three cervical branches placed on the platysma muscle at C3 position 22 sites (91.67%) consisting of BP1 8sites, BP2 7 sites, BP3 7 sites. The location of branching points on C4 1 site (4.17%) and C6 1 site (4.17%).In addition, four cervical branches was found in 3 dissections. Branching points of four cervical branches on the platysma muscle at C3 position 12 sites (20%) consisting of 1st cervical branching point (BP1) 3 sites, 2nd cervical branching point (BP2) 3 sites, 3rd cervical branching point (BP3) 3 sites and 4th cervical branching point (BP4) 3 sites. (Table14).

The data from the previous 3.1-3.4 can be summarized as shown in (Table 15) and (Table 16). In order to find the average locations of each branching points, we can be summarized as shown in (Table 17).

This research studied the branching of cervical branch of facial nerves (CN) ranging from one branches to four branches. The location of BP1, BP2, BP3 and BP4 in distance X were 19.56±7.74mm, 18.68±6.86mm, 17.32±7.48mm and 18.00±1.30mm, respectively. In distance Y, The location of BP1, BP2, BP3 and BP4 were 49.27±3.85, 49.03±11.93, 47.28±10.41 and 51.30±3.60mm (Table 14).

To study the location of branching points in single branch. When comparing between males and females, it was found that there is no significant difference. Comparing between the left and right sides, it was also found that there is no significant difference. The average distance X of the location of BP1 in one branch was 18.48 ± 1.20 mm, distance Y was 51.71 ± 4.60 mm.

In two branches, the mean distance X of BP1 was 21.25 ± 1.43 mm, distance Y was 50.74 ± 4.83 mm. The average distance X of BP2 was 19.89 ± 2.20mm, distance Y was 49.44 ± 6.42 mm. When comparing between males and females, it was found that there is no significant difference. Comparing between the left and right sides, it was also found that there is no significant difference.

Three branches, The average distance X in BP1 was 18.34 ± 8.70mm, distance Y was 45.15 ± 19.74mm. The average distance X in BP2 was 17.19 ± 8.25 mm. distance Y was 44.26 ± 19.58 mm. The average distance X in BP3 is 15.13 ± 9.27mm. Distance Y is on average 41.55 ± 19.12 mm. When comparing between males and females, it was found that there is no significant difference. Comparing between the left and right sides, it was also found that there is no significant difference

Four branches, the average distance X in BP1 was 20.67±1.10mm, Distance Y was 54.47±3.53mm. The average distance X in BP2 was 54.47±3.53mm, Distance Y was 52.70±2.19 mm. The average distance X in BP3 was 18.57±1.79mm, Distance Y was 52.17±2.81mm. The average distance X in BP4 was 18.00±1.30mm. Distance Y is 51.30±3.60 mm. (Table 15) (Table 16).

Table 14 Locations of branching points on the platysma muscle zone

	N	C3	C4	C6	BelowC6
One branch	8 (13.33)	8 (13.33)	-	-	-
Two branches	16 (26.67)	16 (26.67)	-	-	-
Three branches	24 (40)	22 (36.67)	1 (4.17)	1 (4.17)	-
Four branches	12 (20)	12 (20)	-	-	-
Total	60 (100)	58 (96.67)	1 (1.67)	1 (1.67)	

Table 15. The average distance X of the location of branching point

	Single	Two	Three	Four
BP1	18.48±1.20	21.25±1.43	18.34±8.70	20.67±1.10
BP2	-	19.89±2.20	17.19±8.25	20.30 ±3.62
BP3	-	-	15.13±9.27	18.57±1.79
BP4	-	-	-	18.00±1.30

Table 16. The average distance Y of the location of branching point

	Single	Two	Three	Four
BP1	51.71±4.60	50.74±4.83	45.15±19.74	54.47±3.53
BP2	-	49.44±6.42	44.26±19.58	52.70±2.19
BP3	-	-	41.55±19.12	52.17±2.81
BP4	-	-	-	51.30±3.60

Table 17. The average distance X and distance Y of the location of branching point

	Distance X (mm)	Distance Y (mm)
BP1	19.56±7.74	49.27±3.85
BP2	18.68±6.86	49.03±11.93
BP3	17.32±7.48	47.28±10.41
BP4	18.00±1.30	51.30±3.60

4. Locations of terminal branching points on platysma muscle

4.1 Single branch

From the study found that the locations of terminal branching points (TBP1) in distances X and Y were 6.25±11.00 mm and 31.71±25.78 mm, respectively. When comparing locations of TBP1 (single branch) between right and left sides of the sample. In distance X, It was found that there was no significant difference ($P > 0.05$) between right and left sides (Table 18). The locations of terminal branching points (TBP1) in distances X on right and left sides were 1.20±15.21mm; medial to y-axis and 10.72±5.43mm, respectively. In distance Y, It was found that there was no significant difference ($P > 0.05$) between right and left sides (Table 18).The locations of terminal branching points (TBP1) in distances Y on right and left sides were 21.47±43.33mm and 37.86±9.57mm, respectively. In addition, When comparing locations of TBP1 (single branch) between male and female. In distance X, It was found that there was no significant difference ($P > 0.05$) between male and female (Table 19). The locations of terminal branching points (TBP1) in distances X in male and female were 1.37±13.97mm and 9.19±9.25mm, respectively. In distance Y, It was found that there was no significant difference ($P > 0.05$) between male and female (Table 19).The locations of branching points (TBP1) in distances Y on male and female were 9.00±32.67mm and 9.18±3.18mm, respectively .(Table 19)

Table 18. Comparison locations of terminal branching points (One branch) between Right and Left

Distance	Mean distances(mm)						P value
	Total		Right		Left		
	N (%)	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	
Distance X	8 (100)	6.25 ±11.00	3 (40)	-1.20± 15.21	5 (60)	10.72 ±5.43	0.316
Distance Y		31.71 ±25.78		21.47± 43.33		37.86 ±9.57	0.583

[-]= In distance x, represent medial to y-axis. In distance Y, represent inferior to x-axis

Table 19. Comparison locations of terminal branching points (One branch) between Male and Female

Distance	Mean distances(mm)						P value
	Total		Male		Female		
	N (%)	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	
Distance X	8 (100)	6.25± 11.00	3 (40)	1.37 ±13.97	5 (60)	9.19 ±9.25	0.370
Distance Y		31.71± 25.78		9.00 ±32.67		9.18 ±3.18	0.040

4.2 Two branches

The locations of terminal branching points (TBP1) (two branches) in distances X and Y were 21.25±1.43mm and 50.74±4.83mm, respectively. The locations of terminal branching points (TBP2) in distances X and Y were 19.89±2.20mm and 49.44±6.42mm, respectively.

When comparing locations of TBP1 (two branches) between right and left sides of the sample. In distance X, It was found that there was no significant difference ($P > 0.05$) between right and left sides (Table 20).The locations of terminal branching points (TBP1) in distances X on right and left sides were 3.04±16.93mm and 5.13±13.37mm, respectively. In distance Y, It was found that there was no significant difference ($P > 0.05$) between right and left sides (Table 20).The locations of terminal branching points (TBP1) in distances Y on right and left sides were 42.26±4.72mm and 37.53±4.48mm, respectively. In addition, When comparing locations of TBP2 (two branches) between right and left sides of the sample. In distance X, It was found that there was no significant difference ($P > 0.05$) between right and left sides (Table 20).The locations of terminal branching points (TBP1) in distances X on right and left sides were 8.18±11.18mm and 0.57±16.19mm, respectively. In distance Y, It was found that there was no significant difference ($P > 0.05$) between right and left sides (Table 20).The locations of terminal branching points (TBP1) in distances Y on right and left sides were 38.4±6.62mm and 27.5±16.12mm, respectively

When comparing locations of TBP1 (two branches) between male and female. In distance X, It was found that there was no significant difference ($P > 0.05$) between male and female (Table 21). The locations of terminal branching points (TBP1) in distances X in male and female were 2.18±16.05mm; medial to y-axis and 13.83±0.45mm, respectively. In distance Y, It was found that there was no significant difference ($P > 0.05$) between male and female (Table 21).The locations of branching points (TBP1) in distances Y on male and female were 39.08±5.11mm and 42.83 ± 4.51mm ,respectively.(Table 21). When comparing locations of TBP2 (two branches) between

male and female of the sample. In distance X, It was found that there was no significant difference (P> 0.05) between male and female (Table 21).The locations of terminal branching points (TBP1). In distances X in male and female were 2.14±15.49mm and 10.63±4.39mm, respectively. In distance Y, It was found that there was no significant difference (P> 0.05) between male and female (Table 21).The locations of terminal branching points (TBP1) in distances Y in male and female sides were 29.86±11.94mm and 41.73±6.44mm, respectively. (Table 21)

Table 20. Comparison locations of terminal branching points (two branches) between Right and Left

	Distance (mm)	Mean distances(mm)						P value
		Total		Right		Left		
		N (%)	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	
TBP1	Distance X	8 (100)	21.20 ±1.43	5 (62.5)	3.04 ±16.93	3 (37.5)	5.13± 13.37	0.734
	Distance Y		50.70 ±4.83		42.26 ±4.72		37.5± 4.48	0.820
TBP2	Distance X	8 (100)	19.89 ±2.20	5 (62.5)	8.18 ±11.18	3 (37.5)	0.57± 16.19	0.490
	Distance Y		49.44 ±6.42		38.4 ±6.62		27.5± 16.12	0.247

[-]= In distance x, represent medial to y-axis. In distance Y, represent inferior to x-axis

Table 21. Comparison locations of terminal branching points (two branches) between Male and Female

	Distance	Mean distances(mm)						P value
		Total		Male		Female		
		N (%)	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	
TBP1	Distance X	8 (100)	21.25 ±1.43	5 (62.5)	-2.18± 16.05	3 (37.5)	13.83 ±0.45	0.734
	Distance Y		50.74 ±4.83		39.08 ±5.11		42.8 ±4.51	0.820
TBP2	Distance X	8 (100)	19.89 ±2.20	5 (62.5)	2.14± 15.49	3 (37.5)	10.63 ±4.39	0.490
	Distance Y		49.44 ±6.42		29.86± 11.94		41.73 ±6.44	0.247

[-]= In distance x, represent medial to y-axis. In distance Y, represent inferior to x-axis

4.3 Three branches

The locations of branching points (TBP1) (three branches) in distances X and Y were 7.61±12.50and 39.81±5.41mm, respectively. The locations of terminal branching points (TBP2) in distances X and Y were 5.29±20.28mm and 36.28±10.44mm, respectively. The locations of terminal branching points (TBP3) in distances X and Y were 0.14±14.49mm; medial to y-axis and 35.91±5.23mm, respectively.

. When comparing locations of TBP1 (three branches) between right and left sides of the sample. In distance X, It was found that there was no significant difference (P> 0.05) between right and left sides (Table 22).The locations of terminal branching points (TBP1) in distances X on right and left sides were 13.13±4.50mm; medial to RMV

and 4.30±15.06mm, respectively. In distance Y, It was found that there was no significant difference (P> 0.05) between right and left sides (Table 22).The locations of terminal branching points (TBP1) in distances Y on right and left sides were 43.27±5.10mm and 37.73±4.89mm, respectively. In addition, When comparing locations of TBP2 (three branches) between right and left sides of the sample. In distance X, It was found that there was no significant difference (P> 0.05) between right and left sides (Table 22). The locations of terminal branching points (TBP2) in distances X on right and left sides were 7.67±16.21mm and 3.86±24.12mm, respectively. In distance Y, It was found that there was no significant difference (P> 0.05) between right and left sides (Table 22).The locations of terminal branching points (TBP3) in distances Y on right and left sides were 43.33±3.55mm and 32.04±11.17mm, respectively. Furthermore, When comparing locations of TBP3 (three branches) between right and left sides of the sample. In distance X, It was found that there was no significant difference (P> 0.05) between right and left sides (Table 22).The locations of terminal branching points (TBP3) in distances X on right and left sides were 3.13±14.19mm and 1.66±16.00mm, respectively. In distance Y, It was found that there was no significant difference (P> 0.05) between right and left sides (Table 22).The locations of terminal branching points (TBP3) in distances Y on right and left sides were 36.67±5.40mm and 35.46±5.71mm, respectively (Table 22).

When comparing locations of TBP1 (three branches) between male and female of the sample. In distance X, It was found that there was no significant difference (P> 0.05) between male and female (Table 23).The locations of terminal branching points (TBP1) in distances X in male and female were 4.30±15.06mm and 7.38±14.45mm, respectively. In distance Y, It was found that there was no significant difference (P> 0.05) between male and female (Table 23).The locations of terminal branching points (TBP1) in distances Y in male and female were 37.73±4.89mm and 41.01±5.70mm, respectively. In addition, When comparing locations of TBP2 (three branches) between male and female of the sample. In distance X, It was found that there was no significant difference (P> 0.05) between right and left sides (Table23).The locations of terminal branching points (TBP2) in distances X on male and female were

3.86±24.12mm and 0.15±21.16mm, respectively. In distance Y, It was found that there was no significant difference (P> 0.05) between male and female (Table 23).The locations of terminal branching points (TBP2) in distances Y on male and female were 32.04±11.17mm and 35.53±11.84mm, respectively. Furthermore, When comparing locations of TBP3 (three branches) between male and female of the sample. In distance X, It was found that there was no significant difference (P> 0.05) between male and female (Table 23).The locations of terminal branching points (TBP2) in distances X in male and female were 1.66±16.00mm and 3.13±14.99mm; medial to RMV respectively. In distance Y, It was found that there was no significant difference (P> 0.05) between male and female (Table 23).The locations of terminal branching points (TBP3) in distances Y on right and left sides were 35.46±5.71mm and 37.65±4.55mm, respectively. (Table 23)

Table 22. Comparison locations of terminal branching points (three branches) between Right and Left

[-]= In distance x, represent medial to y-axis. In distance Y, represent inferior to x-axis

	Distance (mm)	Mean distances(mm)						P value
		Total		Right		Left		
		N (%)	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	
TBP1	Distance X	8 (100)	7.61± 12.50	2 (37.5)	13.13 ±4.50	6 (62.5)	4.30 ±15.06	0.619
	Distance Y		39.81 ±5.41		43.27 ±5.10		37.73 ±4.89	0.333
TBP2	Distance X		5.29 ±20.28		7.67 ±16.21		3.86 ±24.12	0.498
	Distance Y		36.28 ±10.44		43.33 ±3.55		32.04 ±11.17	0.418
TBP3	Distance X		-0.14 ±14.49		-3.13 ±14.19		1.66 ±16.00	0.256
	Distance Y		35.91 ±5.23		36.67 ±5.40		35.46 ±5.71	0.419

Table 23. Comparison locations of terminal branching points (three branches) between Male and Female

	Distance (mm)	Mean distances(mm)						P value
		Total		Right		Left		
		N (%)	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	
TBP1	Distance X	8 (100)	7.61 ±12.50	3 (37.5)	4.30 ±15.06	5 (62.5)	7.38 ±14.45	0.619
	Distance Y		39.81 ±5.41		37.73 ±4.89		41.01 ±5.70	0.333
TBP2	Distance X		5.29 ±20.28		3.86 ±24.12		0.15 ±21.16	0.498
	Distance Y		36.28 ±10.44		32.04 ±11.17		35.53 ±11.84	0.418
TBP3	Distance X		-0.14 ±14.49		1.66 ±16.00		-3.13 ±14.99	0.256
	Distance Y		35.91 ±5.23		35.41 ±5.71		37.65 ±4.55	0.419

4.4 Four branches

The locations of branching points (TBP1) (Four branches) in distances X and Y were 0.77±17.27; medial to y-axis and 45.43±11.13mm, respectively. The locations of terminal branching points (TBP2) in distances X and Y were 2.83±16.86mm and 42.6±10.16mm, respectively. The locations of terminal branching points (TBP3) in distances X and Y were 7.83±16.80mm; medial to y-axis and 39.27±10.26mm, respectively. The locations of terminal branching points (TBP4) in distances X and Y were 10.60±14.51mm; medial to y-axis and 4.63±44.67mm, inferiorly to x-axis respectively. (Table24)

In 3 cases found four branches of cervical branch of facial nerve, 2 cases found on right side and 1 case found on left side. The locations of terminal branching points (TBP1) in distances X were 9.00±4.95mm on right side and 20.30mm on left side; medial to y-axis. TBP1 in distances Y were 47.00±15.27mm on right side and 42.30mm on left side. The locations of terminal branching points (TBP2) in distances X were 12.50±2.83mm and 16.50mm; medial to y-axis. TBP2 in distances Y were 44.05±13.93mm on right side and 39.70mm on left side. The locations of terminal branching points (TBP3) in distances X were 6.00±23.33mm on right side; medial to y-axis and 11.5mm on left side; medial to y-axis. TBP3 in distances Y were 39.05±14.50mm on right side and 39.7mm on left side; inferiorly to x-axis. The locations of terminal branching points (TBP4) in distances X were 4.55±14.21mm on right side; medial to y-axis and 22.7mm; medial to y-axis on left side. TBP4 in distances Y were 7.25±56.07mm and 28.4mm; inferiorly to x-axis on right and left sides, respectively. (Table25)

In 3 cases found four branches of cervical branch of facial nerve. All of 3 cases are males. The locations of terminal branching points (TBP1) in distances X and Y were 0.77±17.27mm; medial to y-axis and 45.43±11.13mm, respectively. The locations of terminal branching points (TBP2) in distances X were 2.83±16.86mm and 42.6±10.16mm, respectively. The locations of terminal branching points (TBP3) in distances X and Y were 7.83±16.80mm; medial to y-axis and 39.27±10.26mm, respectively. The locations of

terminal branching points (TBP4) in distances X and Y were 10.60±14.51mm; medial to y-axis and 4.63±44.67mm, inferiorly to x-axis respectively. (Table26)

Table 24. Comparison locations of terminal branching points (Four branches) between Right and Left

	Distance	Mean distances(mm)					
		Total		Right		Left	
		N (%)	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)
TBP1	Distance X	3 (100)	-0.77 ±17.27	2 (66.67)	9.00 ±4.95	1 (33.33)	-20.30
	Distance Y		45.43 ±11.13		47.00 ±15.27		42.30
TBP2	Distance X		2.83 ±16.86		12.50 ±2.83		-16.50
	Distance Y		42.6 ±10.16		44.05 ±13.93		39.70
TBP3	Distance X		-7.83 ±16.80		-6.00± 23.33		-11.50
	Distance Y		39.27 ±10.26		39.05 ±14.50		-39.70
TBP4	Distance X		-10.60 ±14.51		-4.55 ±14.21		-22.70
	Distance Y		-4.63 ±44.67		7.25 ±56.07		-28.40

[-]= In distance x, represent medial to y-axis. In distance Y, represent inferior to x-axis

Table 25. Comparison locations of terminal branching points (Four branches) between Male and Female

	Distance	Mean distances(mm)					
		Total		Male		Female	
		N (%)	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)	N	Mean distance X±SD (Range) (mm)
TBP1	Distance X	3 (100)	-0.77 ±17.27	3 (100)	-0.77 ±17.27	0 (0)	-
	Distance Y		45.43 ±11.13		45.43 ±11.13		-
TBP2	Distance X		2.83 ±16.86		2.83 ±16.86		-
	Distance Y		42.6 ±10.16		42.6 ±10.16		-
TBP3	Distance X		-7.83 ±16.80		-7.83 ±16.80		-
	Distance Y		39.27 ±10.26		39.27 ±10.26		-
TBP4	Distance X		-10.60 ±14.51		-10.60 ±14.51		-
	Distance Y		-4.63 ±44.67		-4.63 ±44.67		-

[-]= In distance x, represent medial to y-axis. In distance Y, represent inferior to x-axis

5. Anastomosis pattern of cervical branch of facial nerve

The communicating branch of the facial nerve was evaluated in 27 adult embalmed cadaveric heminecks in 19 cadavers. This study found variant in 3 neck dissections. One branch group, CN anastomose with GA was found in one specimen and no anastomosis were found in seven specimens. Two branches groups, CN anastomose with CN was found in one specimen and no anastomosis were found in seven specimens. Three branches groups, no anastomosis was found in 8 specimens. Four branches groups TCN anastomose with CN was found in 1 specimens. The others were no anastomosis (Table26.)(Fig.13)(Fig.14) (Fig.15)

Table 26. Anastomosis pattern of the nerve

	N	CN-CN	CN-TCN	CN-GA	No anastomosis
One branch	8	-	-	1	7
Two branches	8	1	-	-	7
Three braches	8	-	-	-	8
Four branches	3	-	1	-	2

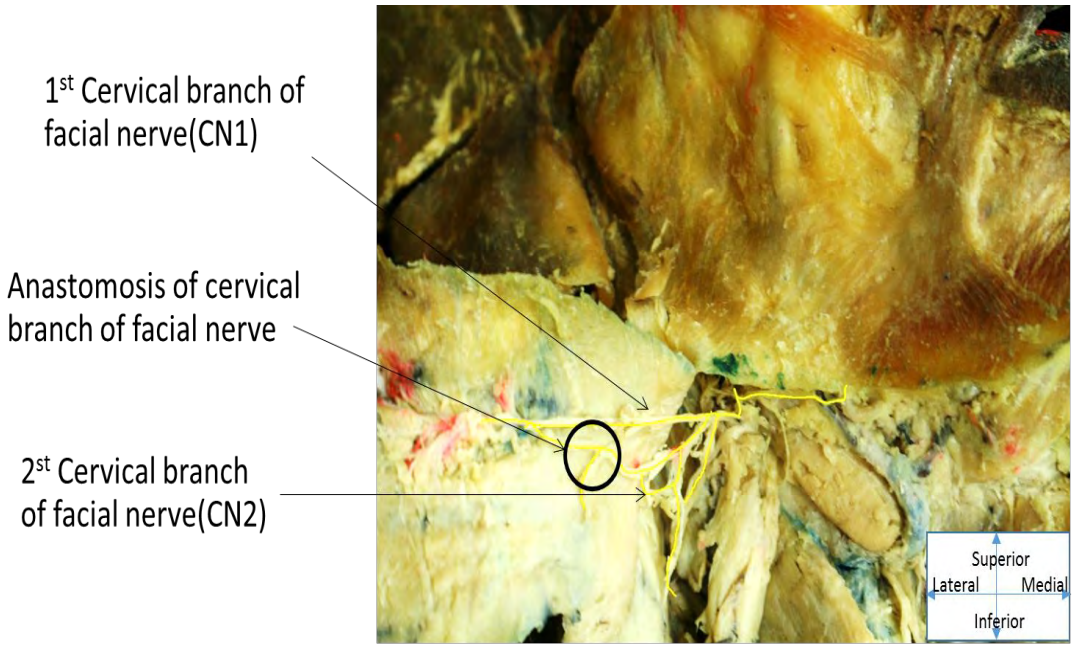


Figure 13. Photograph of a right dissected neck demonstrating the anastomosis of cervical branch of facial nerve with itself.

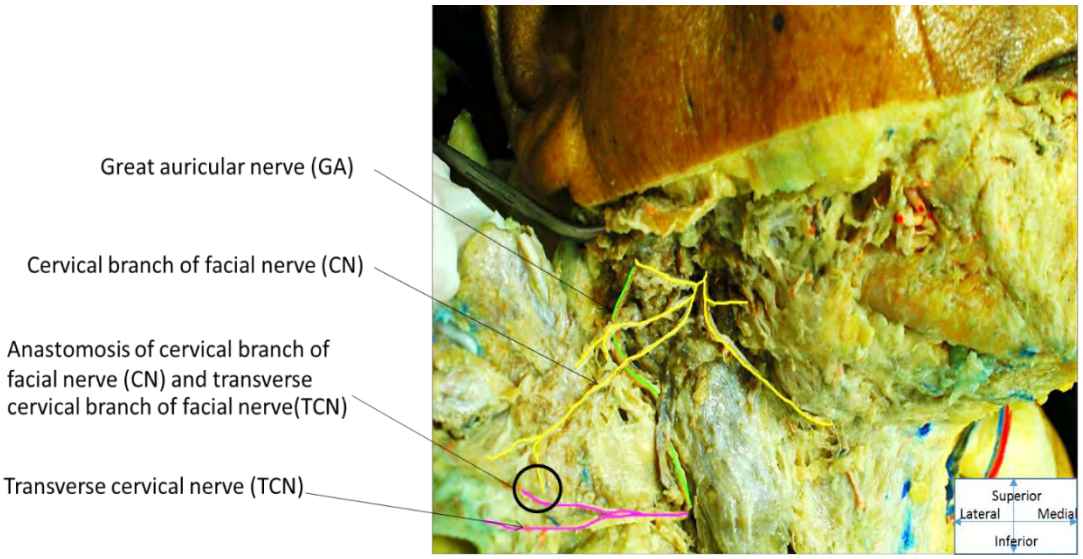


Figure 14. Photograph of a right dissected neck demonstrating the anastomosis of cervical branch (CN) of facial nerve with transverse cervical nerve (TCN)

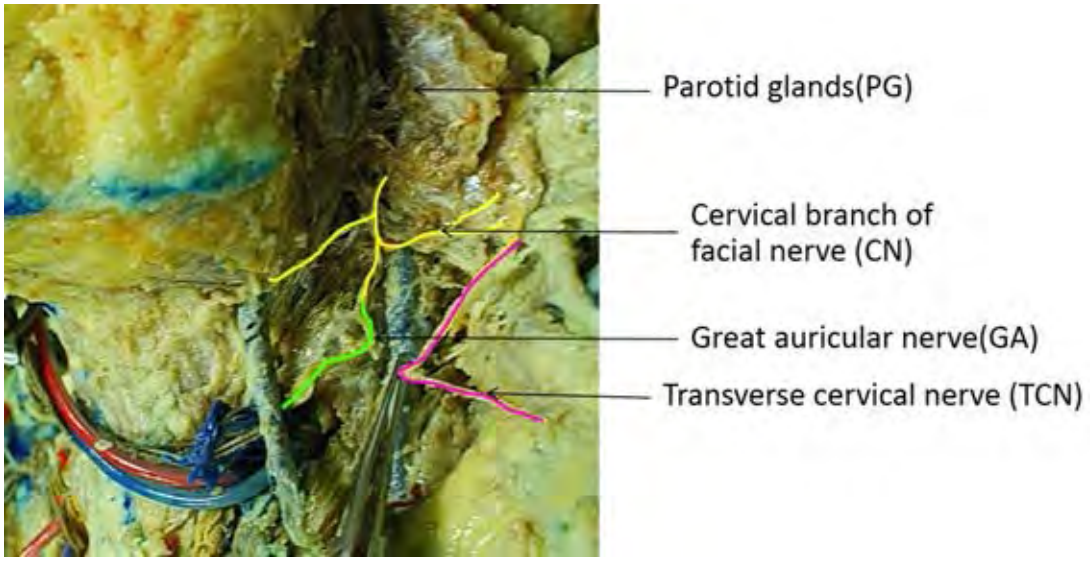


Figure 15. Photograph of a left dissected neck demonstrating the anastomosis of cervical branch (CN) of facial nerve with great auricular nerve (GA) within parotid gland

6. Summarize

We categorized our data to relate with cervical regions for practical use. we studied the prevalence of locations of the terminal branching points located on the platysma muscle. We discovered that Single cervical branch was found in 8 dissections. Terminal branching points placed on the platysma muscle at C3 position 4 sites (6.67%), C4 position 3 sites (5%) and C6 position 1 site(1.67%) consisting of TBP1 8 sites (Table27).Two cervical branch was found in 8 dissections. Terminal branching points placed on the platysma muscle at C3 position 15 sites (25%) consisting of TBP1 8 sites, TBP2 7 sites. At C4 position 1 site (1.67%) consisting of TBP2 1 sites (Table27). Three cervical branch was found in 8 dissections. Terminal branching points placed on the platysma muscle at C3 position 16 sites (26.67%) consisting of TBP1 6 sites, TBP2 5 sites, TBP3 5 sites. The location of terminal branching points placed on C4 8 sites (13.33%) consisting of TBP1 2 sites, TBP2 3 sites, TBP3 3 sites (Table27).Four cervical branch was found in 3 dissections. Terminal branching points placed on the platysma muscle at C3 position 9 sites (15%) consisting of TBP1 1 sites, TBP2 3 sites, TBP3 3 sites and TBP4 2 sites. At C4 position, TBP was found 1 sites (1.67%) consisting of TBP1 1 sites. At C6 position, TBP was found 2 sites (3.33%) consisting of TBP1 1 site and TBP4 1 site (Table27).

The data from the previous 4.1-4.4 can be summarized as shown in (Table 28) and (Table 29). In order to find the average locations of each branching points, we can be summarized as shown in (Table 30)

This research studied the location of the terminal branching of cervical branch of facial nerves (CN) This study found that, the distances between TBP1, TBP2, TBP3 and TBP4 in distance X were 4.93±14.34mm, 5.03±14.26mm, 4.82±37.72mm; medial to y-axis and 10.60±14.51mm; medial to y-axis, respectively. The distances between TBP1, TBP2, TBP3 and TBP4 in distance Y were 49.27±3.85, 49.03±11.93, 47.28±10.41 and 51.30±3.60mm. (Table 30).

To study the location of terminal branching points (TBP) in single branch. When comparing between males and females, it was found that there is no significant difference.

Comparing between the left and right sides, it was also found that there is no significant difference. The average distance X of the location of TBP1 in one branch was 6.25±11.00 mm, distance Y was 31.71±25.78mm.

In two branches, the mean distance X of TBP1 was 3.83±14.70mm, distance Y was 40.49±4.95mm. The average distance X of TBP2 was 5.94±9.74mm, distance Y was 34.13±11.45mm. When comparing between males and females, it was found that there is no significant difference. Comparing between the left and right sides, it was also found that there is no significant difference.

Three branches, the average distance X in TBP1 was 7.61±12.50mm, distance Y was 39.81±5.41mm. The average distance X in TBP2 was 5.29±20.28mm. Distance Y was 36.28±10.44mm. The average distance X in TBP3 is 0.14±14.49mm. Distance Y is on average 35.91±5.23mm. When comparing between males and females, it was found that there is no significant difference. Comparing between the left and right sides, it was also found that there is no significant difference

Four branches, the average distance X in BP1 was 0.77±17.27mm; medial to y-axis, Distance Y was 45.43±11.13mm. The average distance X in BP2 was 2.83±16.86mm, Distance Y was 42.6±10.16mm. The average distance X in BP3 was 7.83±16.80mm; medial to y-axis, Distance Y was 39.27±10.26mm. The average distance X in BP4 was 10.60±14.51mm; medial to y-axis. Distance Y is 4.63±44.67mm. (Table 28) (Table 29)

Table 27. Terminal branching points that located on the platysma muscle

	N	C3	C4	C6	BelowC6
One branch	8 (13.33)	4 (6.67)	3 (5)	1 (1.67)	-
Two branches	16 (26.67)	15 (25)	1 (1.67)	-	-
Three branches	24 (40)	16 (26.67)	8 (13.33)	-	-
Four branches	12 (20)	9 (15)	1 (1.67)	2 (3.33)	-
Total	60 (100)	44 (73.33)	23 (21.67)	3 (5)	

Table 28. The average distance X of the location of terminal branching point

	Single	Two	Three	Four
TBP1	6.25±11.00	3.83±14.70	7.61±12.50	-0.77±17.27
TBP2	-	5.94±9.74	5.29±20.28	2.83±16.86
TBP3	-	-	-0.14±14.49	-7.83±16.80
TBP4	-	-	-	-10.60±14.51

[-]= In distance x, represent medial to y-axis. In distance y, represent inferior to x axis

Table 29. The average distance Y of the location of terminal branching point

	Single	Two	Three	Four
TBP1	31.71±25.78	40.49±4.95	39.81±5.41	45.43±11.13
TBP2	-	34.13±11.45	36.28±10.44	42.6±10.16
TBP3	-	-	35.91±5.23	39.27±10.26
TBP4	-	-	-	-4.63±44.67

[-]= In distance x, represent medial to y-axis. In distance y, represent inferior to x axis

Table 30. The average distance X and distance Y of the location of terminal branching point

	Distance X(mm)	Distance Y (mm)
TBP1	4.93±14.34	39.67±16.5
TBP2	5.03±14.26	39.87±4.72
TBP3	-4.82±37.72	37.28±8.44
TBP4	-10.60±14.51	-4.63±44.67

[-]= In distance x, represent medial to y-axis. In distance y, represent inferior to x axis

CHAPTER V
DISCUSSION AND CONCLUSION

There is limited interest in studying the anatomy and distribution of the cervical branch of the facial nerve[20], nevertheless, the cervical branch of the facial nerve has a useful cosmetic and functional impact. Submandibular gland excision on a transcervical approach and SMAS facelifts procedure erroneously resulted in the prevalence of cervical branch lesion reported at 1.7% [15] [30]. Moreover, the cervical branch of facial nerve was recently used to reconstruct of the brachial plexus injuries[19]. In addition, neurectomy of this nerve in patients with hyperkinetic motility disorders can relieve patients in cervical regions from difficult swallowing, painful cramps, and synkinesis[21] [22].Furthermore, the specific anatomical location of cervical branch of facial nerve may allow surgeons to denervate the platysma and reduce the amount of banding[12]. Therefore, the precise location of cervical branches of facial nerve and its anatomic variation should be identified.

In the previous studies, Ziara, et al. (1981) [20] found that the cervical branch of facial nerve emerged as a single branch in 88 facial halves from the parotid gland and two branches diverged from each other in 22 facial halves at a variable distance from the gland. Furthermore, Salinas, NL et al (2009) [25] reported from 20 facial dissections that single branch was found in 3 dissections, two branches were found in 11 dissections and three branches were identified in 6 dissections, while Plabo, et al. (2008) [21] explained that single branch innervated the platysma muscle in four out of ten dissections. In five dissections, there was two branches to the muscle. Three branches have only one dissection. Moreover, Chowdhry S, et al. [26]described that total of 16 fresh heminecks in this study had only one main branch.

Compared with these studies, in our work, the cervical branch of facial nerve was identified in 27 adult embalmed cadaveric heminecks in 19 cadavers. We discovered that cadavers have 4 branching patterns of nerves: one branch, two branches, three branches, and four branches. The first three patterns of cervical branch of facial nerve supplying platysma muscle were found in most cases (8 of 27 sides, 29.62%), while the

least common was four branches (3 of 27 sides, 11.11%). Therefore, the number of cervical branch of facial nerve might be vary depending on races or genetics differences.

1. Distance between branching point and retromandibular vein

The distance between branching point and retromandibular vein were investigated in this study. The distances between BP1, BP2, BP3 and RMV were 0.50 ± 3.97mm, 3.00±1.30mm; medial to RMV and 0.17±5.00 mm; medial to RMV, respectively.

No similar study has measured the closest distances between branching point (BP) and retromandibular vein (RMV).The nearest distances from branching point (BP) to retromandibular vein (RMV) were BP4-RMV with the distances of 0.17± 5.00mm; medial to RMV. The farthest distances from branching point (BP) to retromandibular vein (RMV) were BP3-RMV with the distances of 3.43± 1.25mm; medial to RMV (Table2).

Therefore, in most cases, the distance between BP and RMV were greater in males than females and greater in right side than left side. In other words, BP in male and on right side was located more medial to RMV than female and left side.

2. Distance between terminal branching point and retromandibular vein

This study found that, the distances between TBP1, TBP2 and RMV were 6.83± 15.01mm; medial to RMV and 7.94±14.51mm; medial to RMV, respectively. There was no study similar to our study to measure the distances from terminal branching point (TBP) to retromandibular vein (RMV) in the nearest vein investigation term. TBP3-RMV with distances of 4.45±13.32 mm ; medial to RMV were the closest distances from terminal branching point (TBP) to retromandibular vein (RMV).The farthest distances from terminal branching point (TBP) to retromandibular vein (RMV) were TBP4-RMV with the distances of 27.33±13.50mm; medial to RMV (Table4).

The distances between TBP and RMV were greater and more medial to RMV in males than female in most cases. In addition, the distances between TBP1, TBP2, TBP3 and RMV were greater and more medial to RMV on left than right sides (Table4) (Table5)

Consequently, in most cases, the distance between TBP and RMV were greater and more medial to RMV in male than female and greater on left side than right side except

the distances between TBP4 and RMV were greater and more medial to RMV on right than left sides. In other words, TBP in male and on left side was located more medial to RMV than female and right side.

3. The Location of the branching point on the platysma muscle

This research studied the location of branching of cervical branch of facial nerves (CN) ranging from one branches to four branches. Our study represent that the distances between BP1, BP2, BP3 and BP4 in distance X were 19.56±7.74mm, 18.68±6.86mm, 17.32±7.48mm and 18.00±1.30mm, respectively. The distances between BP1, BP2, BP3 and BP4 in distance Y were 49.27±3.85, 49.03±11.93, 47.28±10.41 and 51.30±3.60mm (Table14). As mentioned above, the branching point of cervical branch of facial nerve was usually located 2 cm posterior to anterior border of sternocleidomastoid muscle or lateral to y-axis and averaged on 5 cm placed above the thyroid line(X axis). Additionally, there is no significant difference when comparing between the genders and sides. In other words, the location of cervical branch of facial nerve which investigated in this population were often symmetry both sides and genders. Following the study, Ziarah et al.(1981) [20] discovered that the cervical branch of facial nerve was 0.83 ± 0.37 cm (0.2 – 1.4 cm) posterior to the gonion. Moreover, Pablo Scolovski et al.(2008) [21] described that mean distances were 18.5 mm (12-23 mm) from the cervicofacial trunk to the gonion. The mean distances of 8 mm (4-11 mm) from the nearest part of the platysma branch of facial nerve to the gonion. similarly, Salinas et al.(2009) [25] expressed that cervical branches were posterior to angle of mandible with an average 7.5 mm (1-15mm). Most inferior cervical branches are below inferior border of the mandible distance 45mm, while the study of Chowdhry et al. (2010) [26] reported that the branching point of the CN found 1.75 ± 0.26 cm directly perpendicular to a line from angle of the mandible to the mastoid-mentum line.

The prevalence of locations of branching points on the platysma muscle

In most cases, 58 of 60 sites (96.67 percent) of the branching points of facial nerve cervical branch located in C3 regions on platysma muscle. However, there was no study measuring the incidence of locations of branching points on the platysma muscle similar

to our study. On C4 regions, only one branching point was found from three cervical branches of facial nerve (1.67 %). Similarly, only one branching point was found in C6 regions from four cervical branches of facial nerve (1.67 %) (Table17).

4. The Locations of the terminal branching points on the platysma muscle

The finding of our study was associated with the terminal branching point of cervical branch of facial nerve and soft tissue reference framework. This research studied the terminal branching of cervical branch of facial nerves (TBP) ranging from one branches to four branches. This study found that, the distances between TBP1, TBP2, TBP3 and TBP4 in distance X were 4.93±14.34mm, 5.03±14.26mm, 4.82±37.72mm; medial to y-axis and 10.60±14.51mm; medial to y-axis, respectively. The distances between TBP1, TBP2, TBP3 and TBP4 in distance Y were 49.27±3.85, 49.03±11.93, 47.28±10.41 and 51.30±3.60mm. (Table26).

As mentioned above, the 1st terminal branching point of cervical branch of facial nerve 1 (TBP1) and the terminal branching point of cervical branch of facial nerve 2nd (TBP2) were usually located 5 mm lateral to anterior border of sternocleidomastoid muscle or lateral to y-axis and 4 cm above the thyroid line(X axis). Additionally, the 3rd terminal branching point of cervical branch of facial nerve (TBP3) were usually located 5 mm medial to anterior border of sternocleidomastoid muscle or medial to y-axis and 4 cm superior to the thyroid line (X axis). Furthermore, the 4th terminal branching point of cervical branch of facial nerve 4 (TBP4) were usually located 4 mm medial to anterior border of sternocleidomastoid muscle or medial to y-axis and averaged on 1 cm inferior to the thyroid line(X axis).In addition, there is no significant difference when comparing between the genders and sides. In other words, the location of cervical branch of facial nerve which investigated in this population were often symmetry both sides and genders.

The prevalence of locations the terminal branching points located on the platysma muscle

In most cases, the terminal branching points of cervical branch of facial nerve located on platysma muscle in C3 regions (44 from 60 sites, 73.33%). Nevertheless, no study was conducted to measure the incidence of terminal branching points on platysma muscle similar to our study. Terminal branching points were located on platysma muscle in C4 regions 23 from 60 sites (21.67%). The terminal branching points of cervical branch of facial nerve rarely located on platysma muscle in C6 regions (3 from 60 sites, 5%) (Table29).

5. **Anastomosis pattern of nerve**

The communicating branch of the facial nerve was evaluated in 27 adult embalmed cadaveric heminecks in 19 cadavers. This study found variant in 3 neck dissections. There are cervical branch of facial nerve (CN) anastomose with transverse cervical nerve (TCN) (1 specimen), CN anastomose with CN (1 specimen).Interestingly, this study found that cervical nerve (CN) anastomose with great auricular nerve (GA) within parotid gland (1 specimen), while the others were no anastomosis among the facial branches (Table30.). Similarly, Ziara et al.(1981) found that [20] cervical nerve(CN) anastomoses with not only the transverse cervical(TCN) of the cervical plexus at greater cornu of hyoid bone but also great auricular nerve(GA) within parenchyma of parotid glands. Moreover, Woltmann et al. (2006) [29] performed in 27 hemifacial human cadavers (45 hemi-faces).They found that cervical branch(CB) anastomosed with the marginal mandibular branch (MM) the in 10 cases (22.22%) and the buccal branch in 19 cases (42.22%). No anastomoses among facial branches were found In 16 cases (35.55%) Furthermore, Salinas et al.(2009) [25] described that the great auricular nerve(GA) and the transverse cervical nerve(TCN) joined together and then communicated with the main cervical branch(CB) was found in one specimen. In addition, Rao et al. (2012) [28] expressed that an anterior division of the great auricular nerve(GA) with the cervical branch of the facial nerve(CN) outside the parotid gland was found in the 60-year-old South Indian male cadaver.

However, this study has some limitations due to anatomical destruction of platysma muscle from cadaver preservative procedure. Two large holes were drilled at both sides of the neck; then, latex and a gelling agent were injected through the internal carotid arteries and external jugular veins in order to differentiate arteries from veins. Therefore, in some cadavers, the hole is too large and destruct platysma muscle that lead to less numbers.

In conclusion, this study showed that branching point of cervical branch of facial nerve was frequently on C3 region and located 2 cm lateral to anterior border of sternocleidomastoid muscle and above thyroid line 5 cm. The 1st and 2nd cervical terminal branching points of the facial nerve TBP1 and TBP2 were frequently found in C3 regions (73.33%) and 5 mm laterally to the anterior border of the sternocleidomastoid muscle; along the x-axis and the distances above the thyroid line were estimated at a distance of 4 cm. Moreover, the 3rd cervical terminal branching point of the facial nerve (TBP3) was frequently found 5 mm medially to the anterior border of the sternocleidomastoid muscle in distance X .There was estimated at a distance of 4 cm superior to the thyroid line. Furthermore, the 4th cervical terminal branching point of the facial nerve (TBP4) was frequently found 1 cm medially to the anterior border of the sternocleidomastoid muscle in distance X, and there was estimated at a distance of 4 mm inferior to the thyroid line.

BP4-RMV with distances of 0.17± 5.00 mm; medial to RMV were the closest distances from branching point (BP) to retromandibular vein (RMV).The distances between BP and RMV were greater in male than female and greater in right side than left side. Moreover, BP in male and on right side was located more medial to RMV than female and left side.

The nearest distances from terminal branching point (TBP) to retromandibular vein (RMV) were TBP3-RMV with the distances of 4.45±13.32mm; medial to RMV .The distance between TBP and RMV were greater and more medial to RMV in male than female and greater on left side than right side except the distances between TBP4 and RMV were greater and more medial to RMV on right than left sides.

The surgeons could use this study to determine the location of the branching point, terminal branching point, and anastomosis of the cervical branch of the facial nerve to another nerve on the platysma muscle relative to the reference framework; sternocleidomastoid, external jugular vein, and retromandibular vein. This can help to reduce risk of nerve injury, denervate the platysma and reduce the amount of banding, operate neurectomy to relieve patient from difficulty swallowing and painful cramps in cervical regions and reducing the risk of nerve injury and retromandibular vein in head and neck areas for operating more safely and better optimized.

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APPENDICES

1. **Ages of cadavers**

Gender	N	Age(years)			P-value
		Max	Min	Average ± SD	
Male	13	93	57	75.5±12.01	0.255
Female	14	94	54	80.6±10.41	
Total	27	93	57	78.15±11.29	-

2. Comparison of distance between branching points and retromandibular vein

2.1 Male and Female

	Sex	N	Distance(mm)				Tests of Normality		Test Statistics	
			Min	Max	Mean	Std.	Kolmogorov-Smirnov (sig.)	Shapiro- Wilk (sig.)	T-Test	Man Whitney
BP1-RMV	Male	13	-4.20	4.70	-0.90	2.99	0.038	0.039*	-	-1.205
	Female	14	-6.20	10.8	0.97	4.80	0.057	0.400		
BP2-RMV	Male	10	-7.50	0.00	-2.89	2.28	0.200	0.576	-3.211	-
	Female	9	-6.20	-3.30	2.10	4.13	0.200	0.643		
BP3-RMV	Male	5	-8.50	-2.20	-5.00	2.46	0.200	0.924	-2.166	-
	Female	6	-7.70	8.40	1.03	6.26	0.200	0.671		
BP4-RMV	Male	3	-3.40	5.60	-0.17	5.01	0.000*	0.134	-	-
	Female	-	-	-	-	-.	-	-		

2.2 Right and Left

	Sex	N	Distance(mm)				Tests of Normality		Test Statistics	
			Min	Max	Mean	Std.	Kolmogorov-Smirnov (sig.)	Shapiro-Wilk (sig.)	T-Test	Man Whitney
BP1-RMV	Right	7	-4.00	4.70	-2.30	3.11	0.134	0.017	-	0.220
	Left	6	-6.20	10.80	1.05	4.69	0.034	0.167		
BP2-RMV	Right	10	-4.20	4.20	-1.20	2.96	0.106	0.030	-	0.549
	Left	9	-7.50	8.40	0.22	5.16	0.200	0.847		
BP3-RMV	Right	5	-6.20	-2.00	-3.56	1.82	0.200	0.255	-1.081	-
	Left	6	-8.50	8.40	-0.18	7.41	0.200	0.312		
BP4-RMV	Right	2	-3.40	-2.70	-3.05	0.49	-	-	-	-
	Left	-	-	-	5.60	-.	-	-		

3.Distance between terminal branching point and retromandibular vein among

3.1 Male and female

	Sides	N	Distance(mm)				Tests of Normality		Test Statistics	
			Min	Max	Mean	Std.	Kolmogorov-Smirno (sig.)	Shapiro- Wilk (sig.)	T-Test	Man Whitney
TBP1-RMV	Male	13	-38.00	-15.25	3.70	14.09	0.134	0.017	-	0.006
	Female	14	-15.40	24.90	0.99	11.43	0.034	0.167		
TBP2-RMV	Male	10	-36.70	11.50	-13.67	16.07	0.129	0.233	-1.950	
	Female	9	-11.60	18.40	-1.58	9.83	0.036	0.133		
TBP3-RMV	Male	5	-34.50	8.20	-7.34	16.73	0.200	0.401	-0.636	-
	Female	6	-16.80	12.50	-2.05	10.75	0.200	0.946		
TBP4-RMV	Male	3	-38.90	-12.50	-27.33	13.50	-	0.597	-	-
	Left	1	-	-	5.60	-	-	-.		

3.2 Right and Left

	Sides	N	Distance(mm)				Tests of Normality		Test Statistics	
			Min	Max	Mean	Std.	Kolmogorov-Smirno (sig.)	Shapiro- Wilk (sig.)	T-Test	Man Whitney
TBP1-RMV	Right	13	-33.10	24.90	-3.85	17.28	0.200	0.319	0.995	-
	Left	14	-38.00	9.30	-9.60	11.43	0.148	0.116		
TBP2-RMV	Right	10	-31.30	-36.70	-4.50	12.03	0.144	0.283	0.585	-
	Left	9	11.50	18.40	-11.78	16.71	0.067	0.159		
TBP3-RMV	Right	5	-10.30	12.50	3.34	8.57	0.200	0.540	2.029	-
	Left	6	-34.50	4.8	-10.95	13.59	0.200	0.637		
TBP4-RMV	Right	2	-38.90	-12.50	-25.70	18.71	5	-	-	-
	Left	1	-	-	5.60	-	-	-.		

4. Comparison locations of branching points (single branch)

4.1 Right and Left

Distance (mm)	Mean distances(mm)								Test of Normality		Test Statistics	
	Right				Left				Kolmogorov Smirnov (sig.)	Shapiro-Wilk (sig.)	T-Test	Man Whitney
	N	Min	Max	Mean ±SD	N	Min	Max	Mean ±SD				
Distance X	3	18.20	20.70	19.07 ±1.42	5	16.80	19.40	18.12 ±1.05	0.000 ,0.20	0.067, 0.677	1.093	-
Distance Y		49.60	51.40	50.43 ±0.91		44.70	59.70	52.48 ±5.89	0.000 ,0.20	0.756, 0.894	-0.763	-

4.2 Male and Female

Distance (mm)	Mean distances(mm)								Test of Normality		Test Statistics	
	Male				Female				Kolmogorov-Smirnov (sig.)	Shapiro- Wilk (sig.)	T-Test	Man Whitney
	N	Min	Max	Mean ±SD	N	Min	Max	Mean ±SD				
Distance X	3	17.30	18.50	18.00 ±0.62	5	16.8	44.7	18.76 ±1.43	0.00, 0.200	0.463, 0.978	-0.848	-
Distance Y		49.60	59.70	54.43 ±5.06		20.7	55.4	50.08 ±3.91	0.00, 0.200	0.858, 0.981	1.377	-

5. Comparison locations of branching points (Two branches)

5.1 Male and Female

Branching point	Distance (mm)	Mean distances(mm)								Test of Normality		Test Statistics	
		Right				Left				Kolmogorov Smirnov (sig.)	Shapiro-Wilk (sig.)	T-Test	Man Whitney
		N	Min	Max	Mean ±SD	N	Min	Max	Mean ±SD				
BP1	Distance X	5	20.4	22.3	21.40 ±0.78	3	18.4	23.2	21.00 ±1.43	0.200, 0.000	0.630 0.073	0.356	-
	Distance Y		40.5	55.5	50.40 ±5.99		47.9	53.6	51.30 ±3.01	0.190 ,0.000	0.167 0.384	-0.238	-
BP2	Distance X		15.8	20.4	18.76 ±1.83		20.7	23.2	21.77 ±1.29	0.177, 0.000	0.234 0.525	-2.456	-
	Distance Y		34.5	52.7	47.28 ±7.51		52.4	53.5	53.03 ±0.57	0.148, 0.000	0.051 0.510	-1.283	-

5.2 Male and Female

Branching point	Distance (mm)	Mean distances(mm)								Test of Normality		Test Statistics	
		Male				Female				Kolmogorov-Smirnov (sig.)	Shapiro - Wilk (sig.)	T-Test	Man Whitney
		N	Min	Max	Mean ±SD	N	Min	Max	Mean ±SD				
BP1	Distance X	5	18.4	22.3	20.86 ±1.54	3	20.8	23.2	21.90 ±1.21	0.200 0.000	0.424 0.726	-0.99	-
	Distance Y		40.5	53.6	48.90 ±5.34		52.4	55.5	53.76 ±1.58	0.200 0.000	0.325 0.614	-1.49	-
BP2	Distance X		18.2	21.4	20.08 ±1.22		15.8	51.3	19.57 ±3.70	0.200 0.000	0.732 0.940	0.30	-
	Distance Y		34.5	53.5	47.82 ±7.95		23.2	52.7	52.13 ±0.73	0.200 0.000	0.084 0.391	-0.91	-

6. Comparison locations of branching points (Three branches)

6.1 Right and Left

Branching point	Distance (mm)	Mean distances(mm)								Test of Normality		Test Statistics	
		Male				Female				Kolmogorov Smirnov (sig.)	Shapiro-Wilk (sig.)	T-Test	Man Whitney
		N	Min	Max	Mean ±SD	N	Min	Max	Mean ±SD				
BP1	Distance X	2	21.9	22.8	22.35 ±0.64	6	-2.7	22.7	17.00 ±9.86	0.000, 0.036	-, 0.002	-	0.881
	Distance Y		51.6	56.3	53.95 ±3.33		-2.9	56.8	42.22 ±22.40	0.000, 0.002,	-, 0.002	-	0.101
BP2	Distance X		20.3	22.4	21.35 ±1,48		-2.9	21.2	15.80 ±9.25	0.000, 0.004	-, 0.001	-	0.549
	Distance Y		51.8	54.3	53.05 ±1.77		-3.4	55.2	41.33 ±22.25	0.000, 0.004	-, 0.002	-	0.297
BP3	Distance X		18.3	23.7	21.00 ±3.81		-6.8	18.8	13.17 ±9.95	0.000, 0.013	-, 0.002	-	0.101
	Distance Y		50.3	52.7	51.50 ±1.70		-4.5	52.7	38.23± 21.41	0.000, 0.002	-, 0.004	-	0.294

6.2 Male and Female

Branching point	Distance (mm)	Mean distances(mm)								Test of Normality		Test Statistics	
		Right				Left				Kolmogorov Smirnov (sig.)	Shapiro- Wilk (sig.)	T-Test	Man Whitney
		N	Min	Max	Mean ±SD	N	Min	Max	Mean ±SD				
BP1	DistanceX	3	17.0	22.7	20.53 ±0.09	5	-2.70	22.80	17.02± 11.04	0.000, 0.001	0.248, 0.001	-	
	DistanceY		50.6	56.8	54.57 ±3.44		-2.90	53.80	39.50± 23.86	0.000, 0.004	0.139, 0.004	-	
BP2	DistanceX		17.3	22.4	20.00 ±2.56		-2.90	21.20	15.50± 10.32	0.000, 0.002	0.806, 0.001	-	
	DistanceY		49.5	55.2	49.27 ±5.94		-3.40	54.30	39.52± 24.33	0.000, 0.016	0.788, 0.009	0.869	
BP3	DistanceX		18.2	23.7	20.23 ±3.07		-6.80	18.40	12.06± 10.70	0.000, 0.025	0.190, 0.008	1.256	
	DistanceY		42.4	52.7	49.27 ±5.95		-4.50	51.70	36.92± 23.46	0.000, 0.011	0.000, 0.009	-	

7. Comparison locations of branching points (Four branches)

7.1 Right and Left

Branching point	Distance (mm)	Mean distances(mm)								Test of Normality		Test Statistics	
		Male				Female				Kolmogorov Smirnov (sig.)	Shapiro-Wilk (sig.)	T-Test	Man Whitney
		N	Min	Max	Mean ± SD	N	Min	Max	Mean ±SD				
BP1	DistanceX	2	19.40	21.2	20.30 ±1.27	1	-	-	21.4	0.000,-	-,-	-	-
	DistanceY		56.20	56.8	56.50 ±0.42		-	-	50.4	0.000,-	-,-	-	-
BP2	DistanceX		16.50	20.7	18.6 ±2.97		-	-	23.7	0.000,-	-,-	-	-
	DistanceY		50.20	53.6	51.9 ±2.40		-	-	54.3	0.000,-	-,-	-	-
BP3	DistanceX		16.50	19.5	18.0 ±2.12		-	-	19.7	0.000,-	-,-	-	-
	DistanceY		50.20	50.7	50.45 ±0.35		-	-	55.3	0.000,-	-,-	-	-
BP4	DistanceX		16.5	18.8	17.65 ±1.62		-	-	18.7	0.000,-	-,-	-	-
	DistanceY		48.4	50.2	49.30 ±1.27		-	-	55.3	0.000,-	-,-	-	-

7.2 Male and Female

Branching point	Distance (mm)	Mean distances(mm)								Test of Normality		Test Statistics	
		Male				Female				Kolmogorov Smirnov (sig.)	Shapiro-Wilk (sig.)	T-Test	Man Whitney
		N	Min	Max	Mean ± SD	N	Min	Max	Mean ±SD				
BP1	DistanceX	3	19.4	21.4	20.67 ±1.10	-	-	-	-	0.000, -	0.174,-	-	-
	DistanceY		50.4	56.8	54.47 ±3.53		-	-	-	0.000, -	0.162,-	-	-
BP2	DistanceX		16.5	23.7	20.30 ±3.62		-	-	-	0.000, -	0.817,-	-	-
	DistanceY		50.2	54.3	52.70 ±2.19		-	-	-	0.000, -	0.306,-	-	-
BP3	DistanceX		50.2	55.3	18.57 ±1.79		-	-	-	0.000, -	0.107,-	-	-
	DistanceY		16,5	19.7	52.07 ±2.81		-	-	-	0.000, -	0.170,-	-	-
BP4	DistanceX		50.2	55.3	18.00 ±1.30		-	-	-	0.000, -	0.073,-	-	-
	DistanceY		48.4	55.3	51.30 ±3.58		-	-	-	0.000, -	0.485,-	-	-

8. Comparison locations of terminal branching points (One branch)

8.1 Right and Left

Distance (mm)	Mean distances(mm)								Test of Normality		Test Statistics	
	Right				Left				Kolmogo rovSmirn ov(sig.)	Shapir o- Wilk (sig.)	T-Test	Man Whitn ey
	N	Min	Max	Mean ±SD	N	Min	Max	Mean ±SD				
DistanceX	2	-13.8	15.7	-1.20 ±15.21	3	4.2	15.7	10.72 ±5.43	0.000, 0.135	0.528, 0.113	1.093	-
DistanceY		-28.6	49.2	21.47 ±43.33		25.9	47.2	37.86 ±9.57	0.000, 0.200	0.119, 0.331	-0.580	-

8.2 Male and Female

Distance (mm)	Mean distances(mm)								Test of Normality		Test Statistics	
	Male				Female				Kolm ogor ovS mirn ov (sig.)	Shapir o- Wilk (sig.)	T-Test	Man Whit ney
	N	Min	Max	Mean ±SD	N	Min	Max	Mean ±SD				
DistanceX	3 (37.5)	17.30	18.50	18.00 ±0.62	5 (62.5)	16.8	44.7	18.76 ±1.43	0.00, 0.200	0.463, 0.978	-0.848	-
DistanceY		49.60	59.70	54.43 ±5.06		20.7	55.4	50.08 ±3.91	0.00, 0.200	0.858, 0.981	1.377	-

9. Comparison locations of terminal branching points (Two branches)

9.1 Right and Left

Branching point	Distance (mm)	Mean distances(mm)								Test of Normality		Test Statistics	
		Right				Left				Kolmogorov Smirnov(sig.)	Shapiro-Wilk (sig.)	T-Test	Man Whitney
		N	Min	Max	Mean ±SD	N	Min	Max	Mean ±SD				
BP1	DistanceX	5	-20.5	17.8	3.04 ±16.93	3	-10.2	14.3	5.13± 13.37	0.800, 0.000	0.163, 0.215	-0.181	-
	DistanceY		38,4	47.4	42.26 ±4.72		34.8	42.7	37.53± 4.48	0.745, 0.000	0.027, 0.064	1.394	-
BP2	DistanceX		-11.3	16.4	8.18 ±11.18		-17.6	13.5	0.57± 16.19	0.763, 0.000	0.039, 0.458	0.798	-
	DistanceY		30.7	45.3	38.4 ±6.62		14.7	45.6	27.5± 16.12	0.871, 0.000	0.271, 0.448	1.387	-

9.2 Male and Female

Branching point	Distance (mm)	Mean distances(mm)								Test of Normality		Test Statistics	
		Male				Female				Kolmogorov Smirnov (sig.)	Shapiro- Wilk (sig.)	T-Test	Man Whitney
		N	Min	Max	Mean ±SD	N	Min	Max	Mean ±SD				
BP1	Distance X	5	-20.5	17.8	-2.18± 16.05	3	13.4	14.30	13.83 ±0.45	0.800, 0.000	0.163, 0.215	-0.181	-
	Distance Y		37.8	47.4	39.08 ±5.11		38.4	47.4	42.83 ±4.51	0.745, 0.000	0.027, 0.064	1.394	-
BP2	Distance X		-17.6	16.4	2.14 ±15.49		5.80	14.40	10.63 ±4.39	0.763, 0.000	0.039, 0.458	0.798	-
	Distance Y		14.7	45.3	29.86 ±11.94		34.3	45.6	41.73 ±6.44	0.871, 0.000	0.271, 0.448	1.387	-

10. Comparison locations of terminal branching points (Three branches)

10.1 Right and Left

Branching point	Distance (mm)	Mean distances(mm)								Test of Normality		Test Statistics	
		Right				Left				Kolmogorov Smirnov (sig.)	Shapiro-Wilk (sig.)	T-Test	Man Whitney
		N	Min	Max	Mean ±SD	N	Min	Max	Mean ±SD				
BP1	DistanceX	3	8.6	17.6	13.13 ±4.50	5	-20.3	17.6	4.30 ±15.06	0.000, 0.200	0.975 0.264	0.962	-
	DistanceY		38.20	48.4	43.27 ±5.10		31.20	43.20	37.3 ±4.89	0.000, 0.200	0.978 0.602	1.528	-
BP2	DistanceX		-9.8	22.2	7.67 ±16.21		-29.7	31.4	3.86± 24.12	0.000, 0.200	0.699 0.904	0.239	-
	DistanceY		39.7	46.8	43.33 ±3.55		13.7	42.1	32.04 ±11.17	0.000, 0.200	0.922 0.298	1.654	-
BP3	DistanceX		-13.7	13.0	-3.13± 14.19		-19.3	20.5	1.66± 16.00	0.000, 0.200	0.338 0.907	-0.426	-
	DistanceY		33.5	42.9	36.67± 5.40		27.9	42.5	35.46 ±5.71	0.000, 0.200	0.018 0.763	0.295	-

10.2 Male and Female

Branching point	Distance (mm)	Mean distances(mm)								Test of Normality		Test Statistics	
		Male				Female				Kolmogorov Smirnov (sig.)	Shapiro-Wilk (sig.)	T-Test	Man Whitey
		N	Min	Max	Mean ±SD	N	Min	Max	Mean ±SD				
BP1	DistanceX	2	3.4	13.2	6.83 ±13.27	6	-20.3	17.6	7.38 ±14.45	0.000, 0.159	0.032		-
	DistanceY		34.20	38.2	36.20 ±2.82		31.20	48.40	41.01 ±5.70	0.000, 0.200	0558		-
BP2	DistanceX		19.2	22.2	20.70 ±2.12		-29.7	31.4	0.15±21.16	0.000, 0.200	0.890		-
	DistanceY		33.5	43.5	38.50 ±7.07		13.7	46.9	35.53± 11.84	0.000, 0.087	0.147		-
BP3	DistanceX		-13.7	12.6	-0.55 ±18.60		-19.3	20.5	0.00± 14.99	0.000, 0.200	0.770		
	DistanceY		27.9	33.5	30.70 ±3.95		33.6	42.9	37.65 ±4.55	0.000, 0.079	0.042		

11. Comparison locations of terminal branching points (Four branches)

11.1 Right and Left

Branching point	Distance (mm)	Mean distances(mm)								Test of Normality		Test Statistics	
		Right				Left				Kolmogorov Smirnov (sig.)	Shapiro-Wilk	T-Test	Man Whitney
		N	Min	Max	Mean ±SD	N	Min	Max	Mean ±SD				
BP1	Distance X	2	5.5	12.5	9.00 ±4.95	1	-	-	-20.3	0.000,-	0.390,-	-	-
	Distance Y		36.2	57.8	47.00 ±15.27		-	-	42.3	0.000,-	0.530,-	-	-
BP2	Distance X		10.5	14.5	12.50 ±2.83		-	-	-16.5	0.000,-	0.227,-	-	-
	Distance Y		34.2	53.9	44.05 ±13.93		-	-	39.7	0.000,-	0.523,-	-	-
BP3	Distance X		-22.5	10.5	-6.00 ±23.33		-	-	-11.5	0.000,-	0.637,-	-	-
	DistanceY		28.8	49.3	39.05± 14.50		-	-	39.7	0.000,-	0.930,-	-	-
BP4	DistanceX		-14.6	5.5	-4.55 ±14.21		-	-	-22.7	0.000,-	0.540,-	-	-
	DistanceY		-32.4	46.9	7.25± 56.07		-	-	-28.4	0.000,-	0.086,-	-	-

11.2 Male and Female

Branching point	Distance (mm)	Mean distances(mm)								Test of Normality		Test Statistics	
		Right				Left				KolmogorovSmirnov (sig.)	Shapiro-Wilk (sig.)	T-Test	Man Whitney
		N	Min	Max	Mean ±SD	N	Min	Max	Mean ±SD				
BP1	DistanceX	3	-20.3	12.5	-0.77 ±17.27	0	-	-	-	-	-	-	-
	Distance Y		-22.5	10.5	45.43 ±11.14		-	-	-	-	-	-	-
BP2	Distance X		-16.5	14.5	2.83 ±16.86		-	-	-	-	-	-	-
	Distance Y		34.2	53.9	42.60 ±10.1		-	-	-	-	-	-	-
BP3	Distance X		-22.5	10.5	-7.83 ±16.81		-	-	-	-	-	-	-
	Distance Y		28.8	49.3	39.27 ±10.26		-	-	-	-	-	-	-
BP4	DistanceX		-22.7	5.5	-10.60 ±14.5		-	-	-	-	-	-	-
	DistanceY		-32.4	46.9	-4.63 ±44.67		-	-	-	-	-	-	-

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