Original research

A cadaveric study of surgical landmarks for retrograde parotidectomy

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Highlights

- Three anatomical relationships have been examined but no statistically significant result was found, indicating that these relationships are relatively consistent.
- Surgeons now have more options for use in surgery, which is particularly useful in cases where one landmark has been obscured by the tumor mass.
- The angle of the mandible is the preferred landmark in retrograde parotidectomy, given that this osseous structure can be vividly appreciated by light palpation on the face.

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Abstract

Purpose: Retrograde parotidectomy is employed in situations where tumors or scar tissue obscure the facial nerve trunk, making anterograde parotidectomy hazardous. Hence, the reliability of anatomical landmarks in retrograde parotidectomy is of equal practical importance.

Methods: Distances from soft tissue and osseous landmarks to the corresponding peripheral branches of the facial nerve were measured in 41 half-head specimens. The distances were from: i) the zygomatic arch (Z) to the buccal branch (B); ii) the retromandibular vein (RMV) to the marginal mandibular branch (MM); and iii) the angle of the mandible (A) to MM. These distances were compared in left vs. right sides, male vs. female groups, occlusal vs. nonocclusal sides.

Results: No statistically significant differences were found in any of the three distances between all groups compared, amongst which, the mean distances from A to MM were the shortest and least variable (Male = 8.9 ± 3.0 mm vs. Female = 6.8 ± 3.5 mm; Left = 7.3 ± 2.8 mm vs. Right = 8.8 ± 3.9 mm; Occlusal = 8.6 ± 3.5 mm vs. Nonocclusal = 7.8 ± 3.4 mm).

Conclusion: The findings indicate that all three landmarks are useful for surgeons to locate the facial nerve branches during retrograde parotidectomy. Since all three landmarks were consistent indicators for the corresponding facial nerve branches, the surgeon has more than one option should one landmark be obscured by tumors. The optimal landmark is the distance from A to MM because it is shortest and most reliable, followed by RMV to MM, and Z to B.

1. Introduction

Parotidectomy is a commonly employed surgical procedure to remove parotid gland tumors of certain types. The surgical approach can be anterograde or retrograde in type. The former aims to initially identify the facial nerve main trunk, and then trace it forward to dissect the tumor out, whereas the latter aims at finding the peripheral branches of the facial nerve first, and then trace them backward to remove the tumor.

Landmarks for retrograde parotidectomy vary depending on the chosen facial nerve peripheral branches. The retromandibular vein is a commonly used landmark for the marginal mandibular branch of the facial nerve. The angle of the mandible has also been suggested as a landmark for the marginal mandibular branch in some literature, due to its proximity to the retromandibular vein. The buccal branch is another facial nerve branch used by surgeons. However, anatomical studies in this area are still relatively poor.

Early intra-operative identification and preservation of the nerve is of paramount importance in this surgical practice, because facial nerve injury is an important cause of morbidity.

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2. Materials and methods

This study specifically compares the distances of chosen anatomical landmarks to corresponding facial nerve branches between: male and female specimens; left and right sides of the specimens; sides with occlusal jaws and sides with non-occlusal jaws. If more than one premolar or one molar tooth from the maxilla are lined up with the corresponding teeth from the mandible, the specimen is defined as having an occlusal maxilla and mandible.

The following distances are chosen and specified in Table 1 and Fig. 1:

Data were collected using prosected specimens from the anatomy labs of both the University of New South Wales (UNSW) and the University of Sydney, where all landmarks can be vividly appreciated. In addition, the number and presence of teeth were recorded to determine whether the premolars or molars of the maxillae and mandibles came into contact to form occlusal surfaces. Approval was obtained from the UNSW Human Research and Ethics Committee (HREC09372).

Measurement was taken three times for each specimen using the same digital micrometer (Mitutoyo Digimatic Caliper; Mitutoyo Corp., Kawasaki, Japan), and an average was calculated. Each half head was extended to 120°. This angle is defined as the obtuse angle between the red and blue lines (Fig. 2). The red line is defined from the lateral angle of the eye to the tragus cartilage, and the blue line is down the transverse processes of the cervical vertebrae. The mouths of specimens were closed during measurement. A grand total of 41 superficial dissected half-head specimens were collected for part two. The ethnicity of all specimens is Australian of European descent, and the mean age of the specimens is 81 years old.

Statistical analyses were undertaken using SPSS (20.0) (IBM Corp., Armonk, NY, USA). To determine the differences between the different groups aforementioned, particular tests were applied (Table 2).

3. Result

There is no statistically significant difference found in all three distances when comparing respectively: genders; left/right; amongst different edentulous groups; sides with opposing upper and lower jaws and sides with non-opposing upper and lower jaws. (Tables 3–5.)

4. Discussion

For retrograde parotidectomy, the targets are the peripheral branches of the facial nerve. There are two types of studies concerning the variations of the landmarks to the facial nerve peripheral branches. The first type focused on describing anatomical relationships according to cases. For instance, Hanazawa et al. found 2 cases of anomalous facial nerve relationships after examining 105 surgical specimens of parotid gland tumor in 1988 [1]. In one case the buccal branch and the zygomatic branch of the facial

| Distance | Description | Reason |
|----------|-------------|--------|
| 1        | The point at the distal end of the zygomatic arch just before it becomes the frontal process of the zygoma to the more superior buccal branch just after its emergence from the parotid gland. | This is easily palpated without much surgical exploration. |
| 2        | The most superior point of the retromandibular vein just after its emergence below the parotid gland to the marginal mandibular branch of the facial nerve just after its emergence from the parotid gland. | This is the most commonly used landmarks and is easily found with superficial dissection. |
| 3        | The point at the angle of the mandible just before it becomes the ramus of the mandible to the marginal mandibular branch of the facial nerve just after its emergence from the parotid gland. | This is used by surgeons and can be easily palpated. |
nerve coursed beneath the retromandibular vein; and in the other case the marginal mandibular branch ran beneath the retro-
mandibular vein [1]. Similarly, the study by Kawakami, Tsukada, and Taniguchi in 1994 exposed 26 facial nerves and discovered one anomalous relationship, such that the temporal branch of the facial nerve lay beneath the retromandibular vein [2]. However, the frequency of this type of study has greatly reduced over the past decade, as the possibility of discovering new cases with anomalous relationships has significantly reduced.

The second type of study investigated and analysed anatomical variations by categorizing them. For instance, Laing and McKerrow illustrated their findings by categorizing the patterns of the relationship between the facial nerve branches and the retromandibular vein into 5 different types, and then calculating the percentage of each type [3]. However, this type of study has greatly reduced over the past decade, as the possibility of discovering new cases with anomalous relationships has significantly reduced.

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Retrograde parotidectomy approaches the facial nerve main trunk retrogradely through one of the branches of the facial nerve that may be found at predictable sites, for instance, the marginal mandibular nerve of the facial nerve. While current surgical practice for parotidectomy is dominated by the anterograde approach, the retrograde surgical technique is employed in situations where the position of the tumor may obscure both the facial nerve main trunk and the various landmarks used in anterograde parotidectomy are not easily accessible intraoperatively [4]. Furthermore, in circumstances where reoperation is required, the usual surgical landmarks for the facial nerve main trunk become useless, because scar tissue, inflammation, or even recurrent disease may have distorted the surgical field [5]. In addition, retrograde parotidectomy reduces the amount of normal parotid gland that needs to be removed, and may permit a more conservative approach than standard parotidectomy, while having similar complication rates and surgical effectiveness [6]. Hence, studying the variation of landmarks used in retrograde parotidectomy is as important as studying those used in anterograde parotidectomy.

However, from a surgical point of view data are very poor in the literature concerning the variations of these landmarks. Most analyses are of purely anatomical interest with no clinical application [3].

In the present study, three anatomical relationships have been examined but no statistically significant result was found, indicating that these relationships (the distance of the buccal branch of the facial nerve to the distal end of the zygomatic arch; the distance

| Table 2 | Statistics tests applied for data analysis in this study. |
|------------------|---------------------------------------------------------------|
| Statistics analysis | To test if there is no significant difference in the distance of the chosen anatomical landmarks to the corresponding facial nerve branches between: |
| Two sample T test | • male and female specimens |
| | • left and right specimens |
| | • sides with occlusal jaws and sides with non-occlusal jaws |

| Table 3 | Results from two samples T test comparing the means of these distances (in mm) between genders. M – Male; F – Female. |
|------------------|---------------------------------------------------------------|
| Gender | No. | Mean | Std. deviation | Max. | Min. | Mean difference | P value |
| Distance 1 | M 23 | 35.8 | 6.2 | 54.8 | 26.9 | 0.5 | 0.849 |
| | F 7 | 35.3 | 4.2 | 40.0 | 27.2 | | |
| Distance 2 | M 23 | 10.2 | 5.6 | 19.3 | 1.9 | –2.2 | 0.412 |
| | F 7 | 12.4 | 7.1 | 24.8 | 1.5 | | |
| Distance 3 | M 23 | 8.9 | 3.0 | 17.6 | 4.1 | 2.1 | 0.129 |
| | F 7 | 6.8 | 3.5 | 14.3 | 3.2 | | |

| Table 4 | Results from two samples T tests comparing the means of these distances (in mm) between left and right sides. |
|------------------|---------------------------------------------------------------|
| Half | No. | Mean | Std. deviation | Max. | Min. | Mean difference | P value |
| Distance 1 | L 20 | 35.1 | 6.5 | 54.8 | 26.9 | 0.3 | 0.892 |
| | R 19 | 34.8 | 5.3 | 45.9 | 26.9 | | |
| Distance 2 | L 20 | 11.1 | 5.5 | 24.8 | 14.3 | –0.2 | 0.902 |
| | R 20 | 11.3 | 6.5 | 21.6 | 1.5 | | |
| Distance 3 | L 20 | 7.3 | 2.8 | 14.3 | 3.9 | –1.5 | 0.177 |
| | R 20 | 8.8 | 3.9 | 18.2 | 4.3 | | |

| Table 5 | Results of comparing the means of these distances (in mm) between two groups: sides with occlusal upper and lower jaws and sides with non-occlusal upper and lower jaws. O – occlusal, N – non-occlusal. |
|------------------|---------------------------------------------------------------|
| Group | No. | Mean | Std. deviation | Min | Max | Mean difference | P value |
| Distance 1 | O 11 | 34.8 | 6.0 | 26.9 | 45.7 | –0.3 | 0.891 |
| | N 29 | 35.1 | 5.9 | 26.9 | 54.8 | | |
| Distance 2 | O 12 | 11.7 | 6.1 | 3.4 | 21.4 | 0.9 | 0.687 |
| | N 29 | 10.8 | 6.0 | 1.5 | 24.8 | | |
| Distance 3 | O 12 | 8.6 | 3.5 | 4.1 | 18.2 | 0.8 | 0.501 |
| | N 29 | 7.8 | 3.4 | 3.9 | 17.6 | | |
of the marginal mandibular branch of the facial nerve to the retromandibular vein; the distance of the marginal mandibular branch of the facial nerve to the angle of the mandible) are relatively consistent. More importantly, since three landmarks of different positions have been studied in the present study, the surgeons now have more options for use in surgery, which is particularly useful in cases where one landmark has been obscured by the tumor mass.

In addition, the shortest distance is from the angle of the mandible to the marginal mandibular branch of the facial nerve, followed by the retromandibular vein to the marginal mandibular branch, and the distal end of the zygomatic arch to the buccal branch (Tables 3–5). Therefore, it can be concluded that the angle of the mandible is the preferred landmark in retrograde parotidectomy, given that this osseous structure can be vividly appreciated by light palpation on the face.

5. Conclusion

This cadaveric study has reviewed various anatomical landmarks for retrograde parotidectomy. It added the results of the first quantitative research into this field, which has given surgeons a more accurate reference. Surgeons therefore should be mindful about the variations of some landmarks found this study, not only the variations of them between genders, sides or different levels of dentitions, but also the variations of them at different stages of the surgery.

Ethical approval

Yes. Approval was obtained from the UNSW Human Research and Ethics Committee (HREC09372).

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Author contribution

Wenjie Zhong is the main person who conducted this research, including literature review, data collection, data analysis as well as manuscript completion. Ken Ashwell improvised research topic and assisted in final editing of the manuscript.

Conflict of interest

The authors have no conflict of interest to declare.

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