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ORIGINAL ARTICLE

Nerve to Anterior Belly of Digastric Muscle as a Donor for Facial Re-innervation: A Cadaveric Feasibility Study

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Abstract

Background: ***Cadaveric anatomical investigations are used to develop new surgical procedures. Surgeons all around the globe could benefit from publishing some cadaveric feasibility studies and using the results to enhance patient care. There have been further advancements in the surgical treatment of facial paralyzes.***

Aim and objectives: ***To investigate the feasibility of using the part of the digastric muscle connected to the anterior belly as a new donor option for facial re-innervation through a cadaveric dissection study.***

Patients and Methods: ***This cadaveric dissection feasibility study utilized five (10 sides) formalin-preserved cadavers of adults. The research was performed at Al-Azhar University's Faculty of Medicine in the Anatomy and Embryology Department.***

Results: ***This research showed that six cadavers (60%) were needed to dissect the parotid gland, four cadavers (40%) were needed to dissect the submandibular gland, 80% of cadavers needed superior running of marginal mandibular nerve to lower border of the mandible. The present study showed that the mean diameter of the nerve that connects the anterior belly of the digastric was 1.03mm, ranging from 0.8mm to 1.3mm. In the current study, two cadavers (20%) nerve's length to the front of the abdomen till the mandible was three centimeters and (80%) were four centimeters.***

Conclusion: ***Facial re-innervation operations can now include the nerve located in the digastric muscle in the anterior belly as a potential donor choice.***

Keywords: Facial paralysis; Anterior Belly of digastric Muscle; Facial Re-innervation

1. Introduction

Facial muscles have evolved to serve not just as a means of communication through expression but also as an organ of vision, respiration, smell, and digestion. [1]

Facial paralysis is a complicated disorder with many facets, including severe impairments in function, terrible aesthetic effects, and fatal mental health implications. [2]

As this multifaceted area of study develops and new, more effective treatment options become available, surgical repair of facial paralyzes constantly improves. [3]

Nerve transplants, static slings, muscle transfers, nerve repair, and nerve grafting are current surgical options for restoring face nerve function. Additionally, several new combinations have been unveiled. [1]

A highly efficient way to preserve nerve function and muscle activation for potentially reinnervated facial musculature was the introduction of nerve transfers. [4]

FaceFace nerve reanimation has been accomplished using a variety of regional nerves using various regional nerves. However, some researchers have found disappointing outcomes even with tried-and-true nerves like the hypoglossal and spinal accessory nerves. [5]

So far as we are aware, no one has investigated reanimating facial nerves via the nerve located in the digastric muscle in the anterior belly. For several reasons, the nerve that goes to the digastric muscle's anterior belly is a better option than these re-innervation techniques.

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The Mylohyoid and the digastric muscles are located in the anterior belly. Some researchers have utilized them for muscle transposition procedures without glaring functional loss or deformity. The mylohyoid nerve often does not have a cutaneous distribution; it is a motor branch of the trigeminal nerve. Like the facial nerve's extracranial branches, it is both easily accessible and of good quality. The facial nerve and the trigeminal nerve both innervate muscles that move the jaw and cheeks, and both groups of muscles originate from the same embryological place: the second and first pharyngeal arches, respectively. [6]

This work aimed to investigate the feasibility of using the nerve to the anterior belly of the digastric muscle as a new donor option for facial re-innervation through a cadaveric dissection study.

2. Patients and methods

This cadaveric dissection feasibility study utilized five (10 sides) formalin-preserved cadavers of adults. The research was performed at Al-Azhar University's Faculty of Medicine, specifically at the Anatomy & Embryology Department.

Search question: Can the nerve to digastric muscle's anterior belly be a new donor option for facial re-innervation?

2.1.Inclusion criteria: Formalin preserved cadavers, adult male and female cadavers, intact head and neck region.

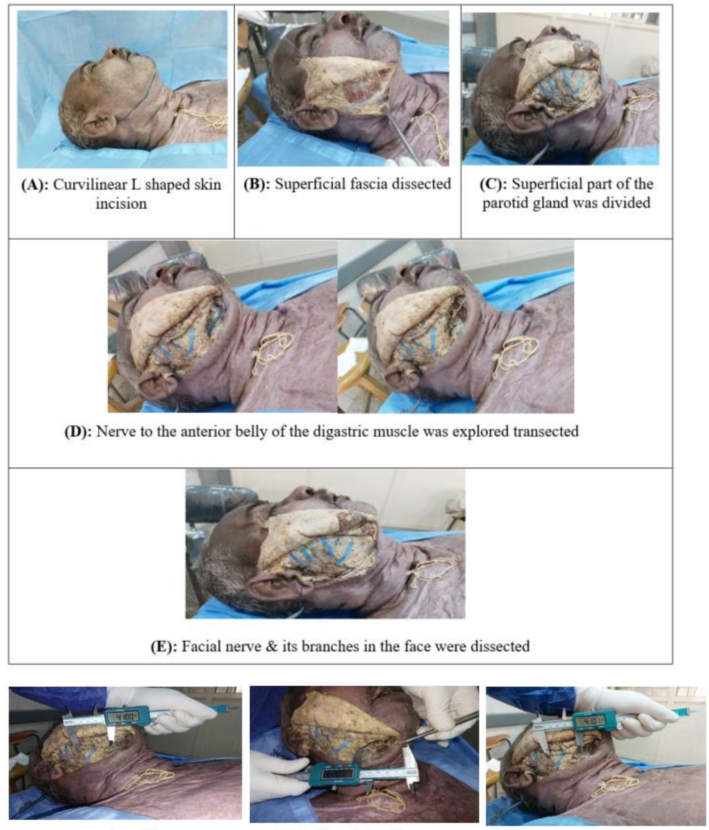
Exclusion criteria: Paediatric cadavers, injured head and neck region (trauma, tumors, previously dissected).

2.2.Study Design

Technique:

Photographic documentation of all steps is essential throughout the work. All measurements were made with calipers.

The corpse was prepared and positioned in a supine position. A curved L-shaped incision is made in the skin, starting directly in front of the ear and extending downwards to the submental region. The outer layer of connective tissue and the platysma muscle were carefully separated. The outermost section of the parotid gland was separated. It was looked at and cut where the nerve goes into the muscle to reach the front belly of the diaphragmatic muscle. The facial nerve and its branches in the face were cut open. The nerve to the anterior belly of the digastric muscle was investigated for length, caliber, variations, branching, relations to vital structures, relativity to the facial nerve proper, trunks, and terminal branches. Dissection of any of the cadavers did not uncover any obvious signs of disease, prior surgeries, or damage to the face or neck.



(A): Curvilinear L shaped skin incision **(B):** Superficial fascia dissected **(C):** Superficial part of the parotid gland was divided

(D): Nerve to the anterior belly of the digastric muscle was explored transected

(E): Facial nerve & its branches in the face were dissected

(F): The nerve to anterior belly of the digastric muscle was investigated

Figure 1. Photos of the right side of the third cadaver:

2.3.Statistical analysis

Statistical Package for the Social Sciences (IBM SPSS) version 20 was utilized for data entry after data collection, coding, and revision. For qualitative data, we used numbers and percentages. We used mean, SD, and range for quantitative data with parametric distribution. For non-parametric distribution, we used median with IQR. With a margin of error of five percent, the confidence interval was set at 95 percent. This led to the conclusion that the p-value was statistically significant: Highly significant (HS) is denoted by a P-value less than 0.01 and non-significant (NS) by a P-value up to 0.05.& $P < 0.05$: Significant (S)

3. Results

100% of studied group was adult male and 100% of them had intact head & neck, intact facial nerve, intact Trunks & amp, branches of facial nerve, intact Ant. Belly of digastric m and intact Nerve to ant. Belly of digastric (Table 1).

Table 1. Demographic data among studied group

		NO	%
SEX	Male	10	100.0%
AGE	Adult	10	100.0%
HEAD AND NECK	Intact	10	100.0%
FACIAL NERVE	Intact	10	100.0%
TRUNKS&BRANCHES OF FACIAL NERVE	Intact	10	100.0%
ANT. BELLY OF DIGASTRIC M.	Intact	10	100.0%
NERVE TO ANT. BELLY OF DIGASTRIC	Intact	10	100.0%

Six cadavers (60%) were needed to dissect parotid gland, 4 cadavers (40%) were needed to dissect submandibular gland, 80% of cadavers need to superior running of marginal mandibular nerve to lower border of mandible. (Table 2)

Table 2. Parotid gland, submandibular gland, reflection of super facial fascia and platysma and running of marginal mandibular nerve to lower border of mandible.

		NO	%
PAROTID GLAND	Dissect	6	60.0%
	Removed	4	40.0%
SUBMANDIBULAR GLAND	Dissect	4	40.0%
	Down word retraction	6	60.0%
REFLECTION OF SUPER FACIAL FASCIA AND PLATYSMA	Done	10	100.0%
RUNNING OF MARGINAL MANDIBULAR NERVE TO LOWER BORDER OF MANDIBLE	2 branches: superior and inferior	1	10.0%
	3 branches: superior and inferior	1	10.0%
	Superior	8	80.0%

Mean of diameter of the nerve to ant were 1.03mm with range from 0.8mm to 1.3mm. Table 3

Table 3. Diameter of the nerve to ant. belly of digastric muscle.

	MIN	MAX	MEAN	SD
DIAMETER OF THE NERVE TO ANT. BELLY OF DIGASTRIC M	0.8	1.3	1.03	0.16

Two cadavers (20%) their Length of the nerve to ant till the mandible were three centimeters and 4 cadavers (80%) were four centimeters. Table 4

Table 4. Length of the nerve to ant till the mandible among studied cadavers in centimeters.

		NO	%
LENGTH OF THE NERVE TO ANT. BELLY OF DIGASTRIC TILL THE MANDIBLE	3	2	20.0%
	4	8	80.0%

4. Discussion

The use of cadavers in anatomical research leads to the creation of novel surgical techniques. Surgeons all around the globe could benefit from publishing some cadaveric feasibility studies and using the results to enhance patient care. Surgeons should know anatomical feasibility studies using cadavers. Clinical anatomists could work with them if they think it is a good idea and could benefit patient treatment. Disciplines generate fresh perspectives, which may lead to the creation of ground-breaking surgical techniques. 7

Facial paralysis is a complex disorder with many facets, including severe functional impairments and catastrophic cosmetic consequences. As this multifaceted area of study expands and new, more effective treatment options become available, surgical repair of facial paralysis constantly improves.8

The introduction of nerve transfers was a highly efficient way to sustain nerve function and muscle activation for potentially reinnervated facial musculature. FaceFace nerve reanimation has been accomplished using various regional nerves using a variety of regional nerves.9 Since a cross-facial nerve graft may simultaneously activate the facial muscles on both the paralyzed and healthy sides, it has long been utilized to create spontaneous smiles.10

In this cadaveric study, we tested the hypothesis that the part of the digastric muscle connected to the anterior belly can be a new donor option when planning facial re-innervation procedures.

This study involved dissecting cadavers in order to study the facial nerve and its branches. It is crucial to take photographs of each step throughout the process. A skin incision shaped like a curving L that began just above the ear and extended below it to the submental area. A hole was cut across the parotid gland's surface. We looked at the digastric muscle's nerve supply to the anterior belly. Here, the nerve is severed just where it enters a portion of the digastric muscle that is located anteriorly. It was decided to remove some of the facial nerve and their branches.

The nerve to the anterior belly of the digastric muscle was investigated for length, caliber, variations, branching, relations to vital structures, and relativity to the facial nerve proper, its trunks, and its terminal branches.

Similarly, Tubbs et al. 6 used the nerve that leads to the mylohyoid for facial nerve reanimation in cadaveric research.

For numerous reasons, we made use of this nerve. For muscle transposition surgeries, prior research has shown that both the mylohyoid muscle and the area of the digastric muscle that is located anteriorly can be utilized without causing visible loss of function or disfigurement.7 The mylohyoid nerve often does not have a cutaneous distribution; it is a motor branch of the trigeminal nerve. Like the facial nerve's extracranial branches, it is both easily accessible and of good quality.11 Last but not least, the pharyngeal arches (the second and first pharyngeal arches, respectively) are the embryological ancestors of the facial expression muscles innervated by the facial nerve and the trigeminal nerve. Researchers believe that establishing connections between the trigeminal and facial nerves in the face may be responsible for the partial recovery of facial muscle function after facial nerve transection. The trigeminal nerve contains similar central connections to the face nucleus and the trigeminal motor nuclei's mesencephalic nucleus, suggesting that it could be a good candidate for reinnervation of facial muscles.12

Because of its tiny size, the masseteric nerve—the trigeminal motor branch to the masseter—could not anastomose with the inferior division of the face nerve, which impaired mastication since it prevented the masseter muscle from contracting.13 In individuals with Möbius syndrome with dysgenic portions of the facial nerve, Lifchez et al.14 necrotized the nerve using the masseteric nerve. Conventional wisdom held that the masseteric nerve precludes the maturation of fully autonomous facial and jaw movements. Reanimating the masseteric branch of the trigeminal nerve, however, makes it possible to close one's jaw and grin independently.

Alternative surgical procedures, such as free muscle transfer (gracilis muscle transplantation, latissimus dorsi), are more intrusive, have a high risk of morbidity, and may harm the facial innervation that is still there.15

On the other hand, a study conducted by Tarabbia et al.16 retrospectively examined ten patients, ranging in age from eighteen to fifty, who had undergone a masseteric-to-facial nerve transfer in conjunction with a cross-face facial nerve graft, as well as physical therapy, for the treatment of unilateral segmental midface paresis. There was a marked decrease in the paretic side kiss movement after surgery, and the therapy helped bring the disparities in facial displacements closer together.

Two factors contribute to the contradictory findings: first, the role of the masseteric motor source, which increases paretic-side motion while decreasing synkinesis; & second, the importance of rehabilitative recovery, which teaches the patient to modulate the motions of the healthy side of their face. Our earlier research has shown reduced activity of the non-paralyzed face and enhanced symmetry; our current findings corroborate these findings. Both naturally forced grins in healthy individuals show an asymmetry that grows about labial displacement.17

This study showed that six patients (60%) were needed to dissect the parotid gland, four patients (40%) were needed to dissect the submandibular gland, and 80% of patients needed to the superior running of the marginal mandibular nerve to the lower border of the mandible. For safe surgery, it is vital to understand the anatomical connection of the facial nerve and parotid glands with critical neighboring tissues in the neck area (12). Paralysis of the face severely impacts the quality of life of patients who suffer from facial nerve injury as a result of parotidectomy or other neck and head treatments.18

The present study shows that the mean diameter of the nerve to the front belly of the digestive tract was 1.03, with a range from 0.8 to 1.3, and the mean distance from the cervicofacial trunk to the lower border of the mandible was 7.15, with a range from 6.9 to 7.5.

Similarly, Agrogiannis et al.19 found that the vastus lateralis motor nerve has the right dimensions—length, pedicle, and caliber—to be a vascularized nerve graft in facial nerve repair. In seventy percent of the dissections, Agrogiannis et al. 19 discovered that the mean maximal length for the oblique division was 8.4±4.5 cm, and for the descending division, it was 15.03±3.87 cm. In every specimen, the oblique division was shorter than the descending branch when it was present. Until it crossed the oblique and descending divisions of the nerve, the pedicle had an average length of 2.93±1.69 cm and 3.27±1.49 cm, respectively. In this study, the average nerve diameter was 2.4±0.62 mm.

In the current study, two cadavers (20%) had a nerve length of three and (80%) four from the front belly of the digestive tract to the mandible.

This study showed that the mean diameter of the nerve to the front belly of the digestive tract was 1.03, with a range from 0.8 to 1.3, and the mean distance from the cervicofacial trunk to the lower border of the mandible was 7.15, which is larger than the nerve to the anterior belly of the digastric. While the hypoglossal nerve has over 9,000 fibers and the main trunk of the facial nerve has around 7,000, the mylohyoid nerve has about 2,000 fibers, according to Tubbs et al. 6. They went on to say that the distal facial nerve, which has much smaller branches, might potentially utilize the nerve to the mylohyoid to make up for this difference.

Kim et al.20utilized 34 cadavers, consisting of 21 men and 13 females ranging in age from 24 to 89 years old, with a mean age of sixty-five. When dissecting the submental and upper neck region, great care was used to avoid damaging the underlying muscles. Following the dissections, each specimen was meticulously drawn and photographed. They found the accessory bellies of the anterior belly of the stomach muscle in eight cases. The accessory bellies were categorized as either unilateral (3 specimens, 8.82%) or crossover (5 specimens, 14.7%), depending on whether they crossed the mandibular raphe. A branch of the mylohyoid nerve supplies sensation to the front of the digastric. Derived from the mandibular branch of the trigeminal nerve, the mylohyoid nerve is a subdivision of the inferior alveolar nerve.

Locating the nerve was done using the submental artery, the anterior belly of the digastric muscle, and the posterior border of the mylohyoid muscle in the investigation by Iwanaga et al.7. One hundred percent of the mylohyoid muscle's nerves were located in one of the three structures on either side. The mylohyoid triangle describes this specific area. The benefit of this type of triangle over the submandibular triangle is that it allows for a better understanding of the three-dimensional interactions between neighboring components. The mylohyoid muscle nerve is not clearly defined in depth in the submandibular triangle. For surgeons or anatomists to easily access the mylohyoid triangle, it must be deep enough to admit the nerve to the mylohyoid muscle. Another suprahyoid muscle frequently displaying anatomical diversity is the digastric muscle's belly, which is located anteriorly and widely recognized.

4. Conclusion

The nerve to the anterior belly of the digastric muscle can be a new donor option when planning facial re-innervation procedures.

Disclosure

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All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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