Trigeminal nerve transfer sources for facial reanimation

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Background

Facial paralysis is a significantly disabling disorder. It impairs routine hygiene and vegetative functions such as ocular tearing and eating. It can cause emotional and social distress from impaired phonation, loss of satisfactory emotional expression and stigmatizing appearance.

There are numerous procedures and therapies that can attempt to ameliorate facial paralysis, but all such procedures are challenged by the ability to recreate the large diversity and independence of facial movement.

Nerve transfers can provide both tone and renewed control to facial muscles. However, current nerve transfers procedures can produce challenging synkinetic movements, unusual tone, and complex relearning and retraining.

We hypothesized that utilizing multiple and discrete nerve transfers might help to reduce synkinesis and improve cognitive control over facial movements. We therefore sought additional motor donor nerves to utilize in facial reanimation.

Methods

Five formalin fixed cadaveric heads were bilaterally dissected to provide 10 hemifaces for evaluation of nerve sources for coaptation to the facial nerve. First the skin was removed to identify the facial nerve in the superficial muscular aponeurotic layer. The facial nerve was carefully reflected anteriorly at its pes anserinus. The masseteric nerve and the middle deep temporal nerve were then dissected to the point of branch origin. These branches of the trigeminal nerve were then externally neurolysed to the maximal extent prior to submillimeter ramification. The origin of the maximal achievable length of donor nerve was then referenced to nearby palpable anatomical landmarks. After analyzing the data on the origin of the middle deep temporal nerve, a standard reference point was selected for measuring a maximal nerve length. The intact facial nerve was then returned to its anatomical configuration and the feasibility of a direct nerve transfer was assessed.

Nerve sections from both the donor nerve branches as well as potential facial nerve recipients were then harvested for future histologic analysis.

Fig 2: Location of the deep temporal nerves

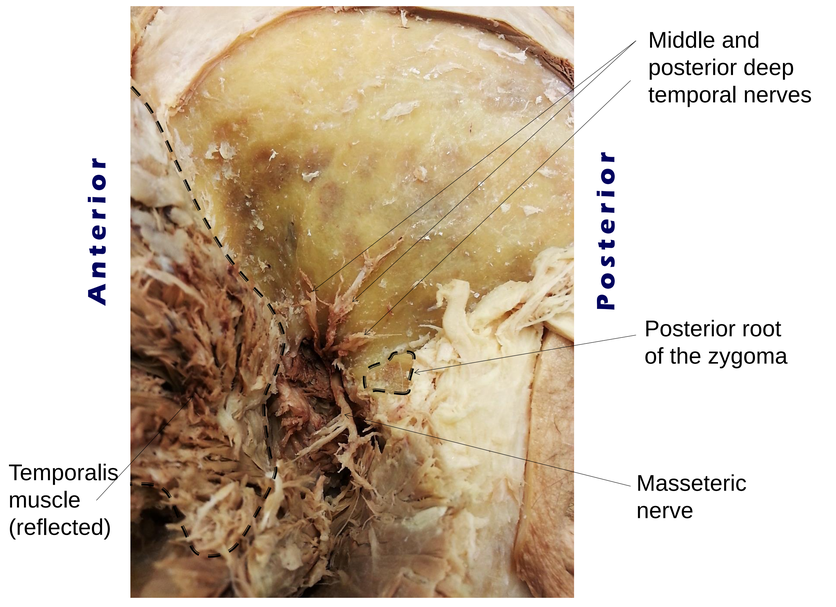
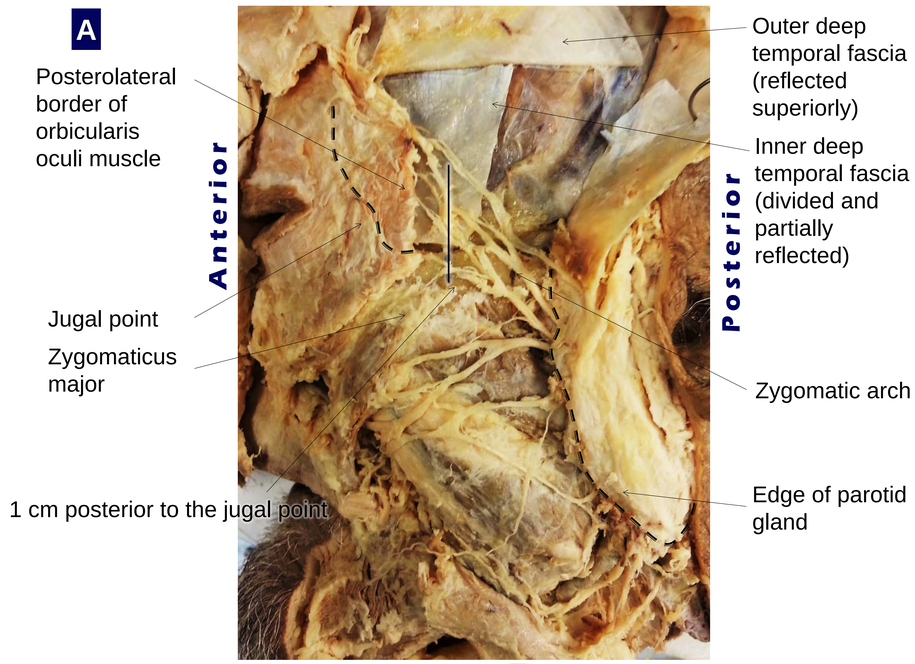


Figure 2: Deep dissection of the temporalis muscle identifies the motor branches of the first division of the trigeminal nerve. Note the early branching patterns of all motor nerves, including the masseteric nerve which splits to innervate the superficial and deep heads of the masseter muscle. The anterior deep temporal nerve is not visualized as it is a recurrent branch of the buccal nerve, and is located on the anterior aspect of the reflected temporalis muscle

Fig 1: Facial nerve in relationship to the middle deep temporal nerve



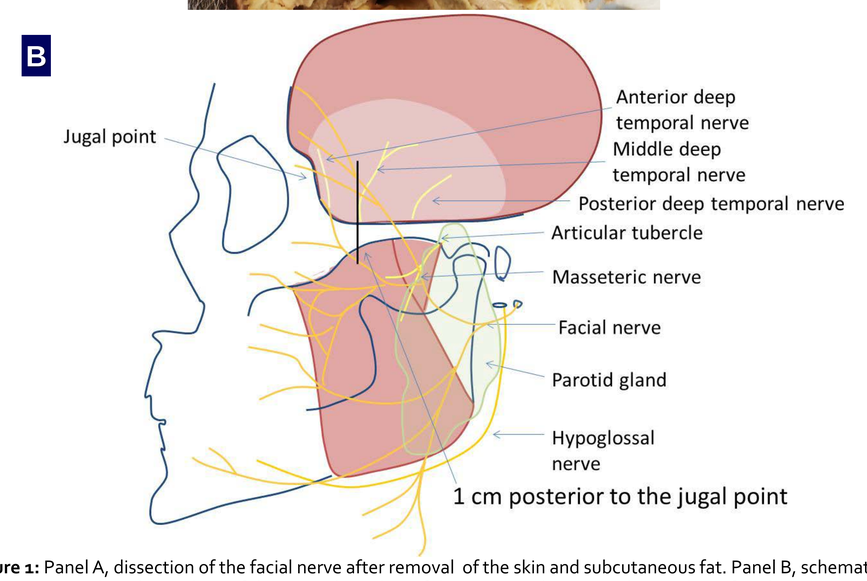


Figure 1: Panel A, dissection of the facial nerve after removal of the skin and subcutaneous fat. Panel B, schematic demonstrating the relationships of the motor branches of the trigeminal nerve to the overlying facial nerve

Table 1: Measurement of middle deep temporal nerves

Specimen	Height above zygomatic arch at 1 cm posterior to jugal point	Maximal transferable length prior to sub-millimeter ramifications	Coaptable length above muscle	Coaptable to temporal branch?
1	7 mm	12 mm	0 mm	Yes
2	6 mm	17 mm	0 mm	Yes
3	0 mm	22 mm	5 mm	Yes
4	2 mm	14 mm	3 mm	Yes
5	0 mm	18 mm	1 mm	Yes
6	2 mm	40 mm	21 mm	Yes
7	0 mm	21 mm	13 mm	Yes
8	0 mm	11 mm	4 mm	Yes
9	4 mm	13 mm	3 mm	Yes
10	0 mm	17 mm	7 mm	Yes
Average	2 mm	19 mm	6 mm	
Range	0 mm to 7 mm	11 mm to 40 mm	0 mm to 21 mm	

Results: Middle deep temporal nerve

A branch of the middle deep temporal nerve was consistently identified within the belly of the temporalis muscle between 8 and 11 mm posterior to the jugal point of the zygomatic bone. Therefore, a point 1 cm posterior to the jugal point was selected as the reference point for measurement. The branch of the nerve could be neurolysed to an average length of 19 mm (range 11 mm to 40 mm) prior to submillimeter ramification within the temporalis muscle. When this branch was mobilized to the surface of the temporalis muscle, the net length of the branch above the surface of the muscle was 6 mm on average (range 0 mm to 21 mm). In all cases, the branch of the middle deep temporal nerve could be collected two branches of the upper facial nerve, including the origins of the upper and lower temporal branches as well as upper zygomatic branches. Theses included all branches to the orbicularis occuli.

Axon counts from the masseteric, deep middle temporal, and facial nerves are pending.

Conclusions

The middle deep temporal nerve is consistently located deep within the medial aspect of the temporalis muscle approximately 1 cm posterior to the jugal point of the zygomatic bone. The consistent location of the nerve allows for appropriate planning of skin incision and muscle dissection. After distal dissection of the nerve within the temporalis muscle, sufficient length of the nerve could be brought to the surface of the muscle for coaptation to the overlying facial nerve. The facial nerve branches in the vicinity of the middle deep temporal nerve included branches to reanimate the eye and forehead. The consistent location and sufficient length available for transfer allows the middle deep temporal nerve to be readily used as a nerve donor source for facial reanimation.

Fig 3: Length available for coaptation

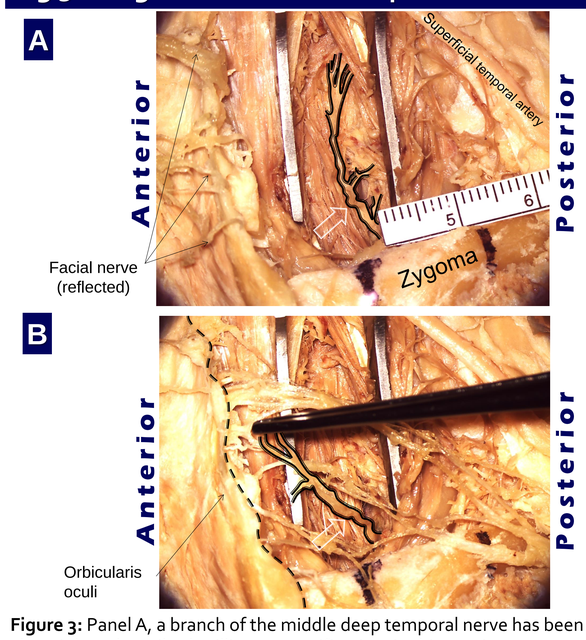


Figure 3: Panel A, a branch of the middle deep temporal nerve has been dissected along it length until submillimeter ramification; in this speciment, 22 mm total length was available for transfer. Panel B, the branch of the middle deep temporal nerves are mobilized in simulation for transfer to the temporal branches of the facial nerve.