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Is the high submandibular transmasseteric approach to the mandibular condyle safe for the inferior buccal branch?

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Abstract
Purpose There are basically 3 main approaches for extra-articular mandibular condyle fractures: low cervical, retromandibular and preauricular. These include a risk of facial palsy affecting the marginal mandibular branch. We use a high submandibular transmasseteric approach featuring masseter section 10–20 mm above the mandibular basilar edge. Our null hypothesis was that both the marginal mandibular and the inferior buccal branches are not more at risk than in other surgical approaches.
Methods This study was based on 20 parotidomasseteric dissections from 10 embalmed cadaveric heads. We used as reference the vertical line, passing through the mandibular angle, parallel to the preauricular line. We performed measurements of the marginal mandibular and inferior buccal branches' heights.
Results The inferior buccal branch had an average height of 16.8 mm and the highest standard deviation (7.2). Extremes were, respectively, 32 and 7 mm. The marginal mandibular branch had an average height of 3.2 mm with standard deviation equal to 3.0. Extremes were, respectively, 9 and −3 mm.
Conclusion The high submandibular transmasseteric approach provides great exposure of facial nerve branches lying on the masseter muscle, if even encountered. Through masseteric incision performed between 10 and 20 mm above the basilar edge of the mandible, the marginal mandibular branch is safe from wound with an added safety margin of 4 mm. The surgeon using this approach is most likely to encounter the inferior buccal branch. It can then be avoided under visual control. This makes it a swift and safe approach to the mandibular condyle.

Keywords Facial nerve · Buccal branch · Marginal mandibular branch · Mandibular condyle osteosynthesis · High submandibular transmasseteric approach

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Introduction

Though controversial for long, surgical treatment of dislocated extra-articular mandibular condyle fracture appears today as the gold standard [24].

These fractures, also called subcondylar, feature a fracture line located at various heights between the articular capsule of the temporo-mandibular joint (TMJ) and the posterior edge of the ramus located above the mandibular angle. Accordingly, they are classified in high and low subcondylar fractures.

A few dedicated surgical approaches have been described [3–5, 10, 24, 25]. The most common one is the retromandibular approach traversing the parotid gland [4, 5, 10]. It results in a quite high rate of facial complications (up to 30 even 48%) [3, 11, 25] mainly affecting the marginal mandibular branch [5, 25].

Preauricular approaches based on systematic exposure of the facial nerve, as in parotidectomy procedures, are also used [3]. They lead to postoperative facial nerve palsy affecting the buccal branches in 20% of cases [3]. This technique, aside from the increased operative time necessary for nerve dissection, can also lead to salivary fistula, as

all procedures based on incision of the parotid gland. Other authors [25], through a preauricular incision also, avoid the transparotid step by splitting the masseter muscular fibers. They report no case of postoperative facial palsy, but on a series only based on a total of 3 patients. This last procedure is close to the high submandibular transmasseteric approach we use.

Cervical approaches derive from Risdon's description [17] and use a low cervical incision, far from the fracture line of interest.

The high submandibular transmasseteric approach (HSTA) is a convenient and quick way of reaching *low* subcondylar fracture lines (Fig. 1), [11–13, 23, 24], which is a common concern in Maxillo-Facial surgery. The HSTA has been developed and used in our department since 1994. One of its specific features is the section of the masseter muscle in between branches of the facial nerve (Figs. 1, 3b). This step is the one that made some surgical teams reluctant to this HSTA approach.

However, clinical experience has proved the HSTA to be quite safe regarding facial nerve wound with a very low rate of facial palsy [11]. Since then, open reduction through HSTA for subcondylar fracture reduction and plating is tending to be a standard for many authors and other surgical teams [11–13, 24].

The purpose of this dissection-based study was to assess the topography of facial nerve branches in the HSTA. Indeed, these branches can be accidently wounded particularly when masseter is incised (Figs. 1, 3b), or caught by the needle during muscle closure, especially in the posterior part of the approach.

Our study relied on collecting accurate and easily assessable measurements of the marginal mandibular branch (MMB) and the inferior buccal branch (IBB), which can be encountered through HSTA. We wanted to explain why the rate of facial palsy is so low using this approach. Our purpose was not to study distribution of the facial nerve.

Materials and methods

Anatomical study

This study was based on 20 dissections performed on 10 bilateral embalmed adult cadaveric heads from body

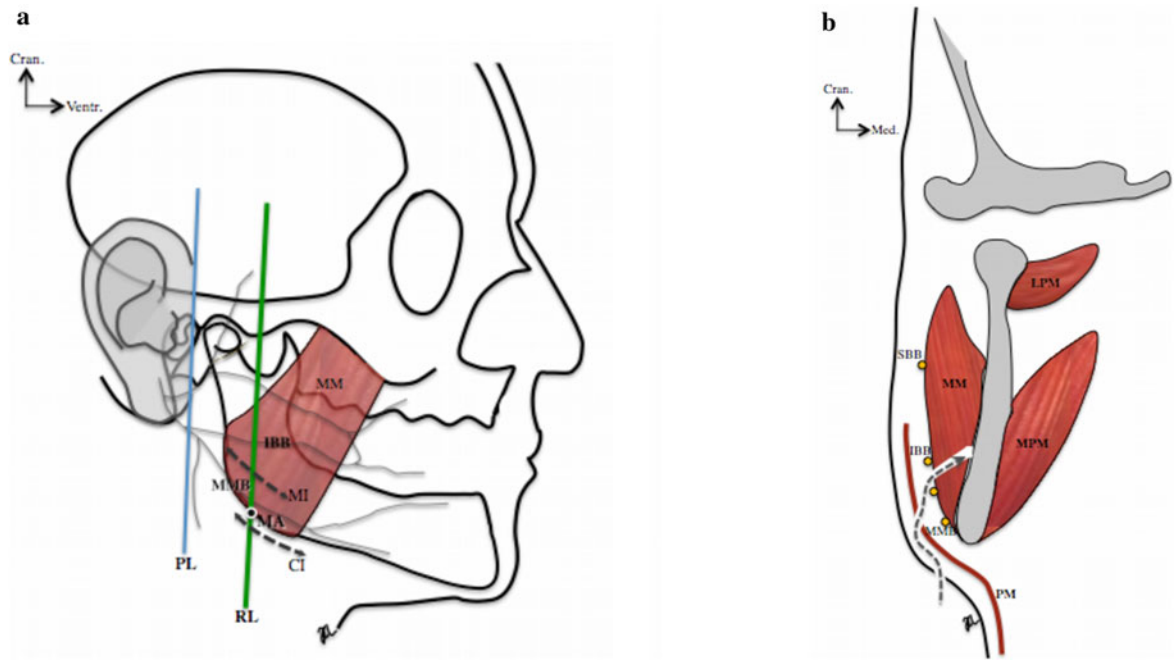

Fig. 1 **a** (*left*) Right lateral schematic view of cutaneous incision (CI) and masseter incision (MI) position in high submandibular transmasseteric approach depicting the landmarks used for cadaveric study: reference line (RL) passing through mandibular angle (MA), perpendicular to basilar rim of mandible and parallel to preauricular line (PL). Heights of inferior buccal branch (IBB) and marginal mandibular branch (MMB) of facial nerve running over masseter muscle (MM) were measured along reference line. **b** (*right*) Schematic frontal section through mandibular angle showing dissection path in the high submandibular transmasseteric approach. Note relations to facial nerve branches: superior buccal branch (SBB), inferior buccal branch (IBB), marginal mandibular branch (MMB). Two position occurrences of IBB are illustrated. Note section of masseter muscle (MM). Medial pterygoid muscle (MPM), lateral pterygoid muscle (LPM) and platysma muscle (PM) are also depicted

donation to the Anatomy Department of the Medicine University in Strasbourg, France. There were 8 males and 2 females of undetermined age (Table 1).

Dissection

Dissection of small facial nerve branches is rather delicate, additionally to the sometimes-challenging discrimination between the inferior buccal and the marginal mandibular branches [19, 22]. This is particularly relevant on *embalmed* cadaveric heads the tissues of which are quite rigid compared to living ones, reason why we conducted our series of dissection according to the standard parotidectomy procedure rather than simply performing the HSTA.

The heads were sectioned above the level of clavicles. Facial skin was incised using a standard preauricular rhytidectomy incision curving downward in the neck. The skin was carefully dissected, extending forward to 2 cm from the buccal commissure, downward to 3 cm below the basilar edge of the mandible.

The facial nerve trunk was approached and the temporofacial and cervicofacial divisions were dissected. Ultimately, undermining was carried on until individualizing the superior and inferior buccal branches and the marginal mandibular branch. During nerve dissection, the branches were not separated from underlying tissues in order not to induce change in position that would compromise the accuracy of measurements.

Measurements and landmarks (Figs. 1a, 2)

We then performed height measurements of the marginal branch (MMB) and the inferior buccal branch (IBB). While we were at it, we also measured the superior buccal branch (SBB), though our study did not focus on it.

We used an original vertical line as reference. It passed through the middle of the mandibular angle and was parallel to the preauricular line. We define this preauricular line as the one passing through the insertion point of the helix and the tragus of the ear (Fig. 1a).

We decided to use the mandibular angle as landmark for our measurements, as it is the one also used to position skin and masseter incision in the HSTA.

Additionally, the mandibular angle, even if sometimes not obvious, appears to us as the most relevant and reproducible landmark before and during surgery.

All measurements were made using a digital caliper (accuracy = 0.01 mm).

Surgical procedure to be evaluated

The HSTA is derived from Risdon's low cervical approach [17]. Compared to the latter, in the Strasbourg HSTA, the

Table 1 Results of inferior buccal branch (IBB) and marginal mandibular branch (MMB) height measurements performed on 20 cadaveric head dissections

No. of heads	Gender	Side	Height of MMB (mm)	Height of IBB (mm)	Distance IBB-MMB (mm)
1	M	R	4	9	5
		L	**9**	25	16
2	M	R	1	*15*	14
		L	2	8	6
3	M	R	**−3**	*20*	23
		L	1	*13*	12
4	M	R	0	*12*	12
		L	5	21	16
5	M	R	8	**32**	**24**
		L	4	22	18
6	F	R	5	*11*	6
		L	−1	8	9
7	F	R	6	*11*	**5**
		L	3	24	21
8	M	R	5	23	18
		L	2	**7**	**5**
9	M	R	0	*14*	14
		L	4	27	23
10	M	R	5	*15*	10
		L	3	*19*	16
Average (mm)			3.2	16.8	13.7
Standard deviation			3.0	7.2	6.4

Units used are millimeters (mm). Average and standard deviation of every parameter as well as distances between consecutive branches (IBB–MMB) were calculated. Extreme values are in bold font, and all heights ranging from 10 to 20 mm (level of masseter incision) are italicized

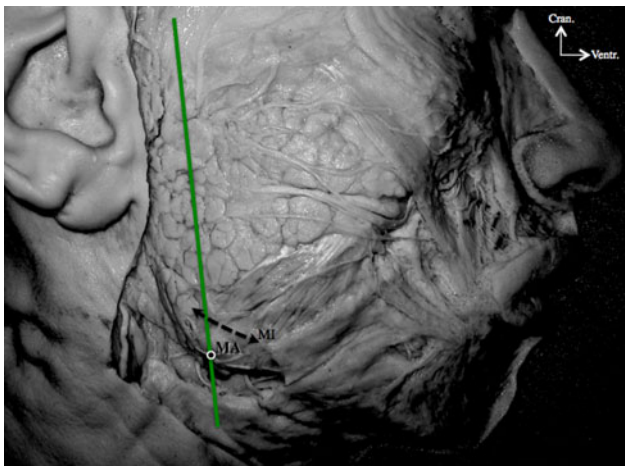

Fig. 2 Dissection photograph depicting vertical reference line passing through mandibular angle (MA) used for height measurements and position of masseter incision (MI). Height measurements were, respectively, 12 mm for inferior buccal branch, 0 mm for marginal mandibular branch and 36 mm for superior buccal branch

skin incision is placed higher, in an upper cervical crease, 1 cm below, and parallel to the basilar edge of the mandible, along the mandibular angle (Fig. 1). Its course is 5-cm long curving upward. Subsequent scar is therefore inconspicuous as positioned in a shadow area beneath the mandibular angle.

The skin is then undermined from the subcutaneous tissue upward, along 2 cm, especially in the posterior part toward the tragus of the ear, where it is well dissected.

In the next step, the platysma muscle is incised obliquely from caudal to cranial starting from the basilar border of the mandible toward the tragus of the ear.

The masseter muscle is therefore exposed. At this step, it is covered by the masseteric fascia under which run perfectly visualized facial nerve branches (Fig. 3b). The masseter is then incised down to the level of the mandibular ramus (Fig. 1b). This masseter incision starts 1 cm above the basilar border of the mandible in the anterior part of the approach and courses in an oblique fashion upwards, up to 2 cm above the basilar border, in the posterior part. In case of parotid hypertrophy, incision of the masseter can extend under the gland at the posterior border of the retracted platysma. All soft tissues including the superior part of the incised masseter are pulled upward using a cranial retractor in order to expose the fracture line. After fracture reduction and plating, the masseter is sutured as well as the platysma muscle and the skin.

Results

The inferior buccal branch (IBB) came from the inferior cervicofacial division and was located close to the alveolar ridge of the mandible at heights indicated in Table 1. This IBB provided innervation for the buccinator, risorius and orbicularis oris muscles.

Along the vertical line we used as reference (Figs. 1a, 2), IBB was usually single. We noted 2 inferior buccal branches in 3 dissections. We only considered the height of the lowest one for our measurements.

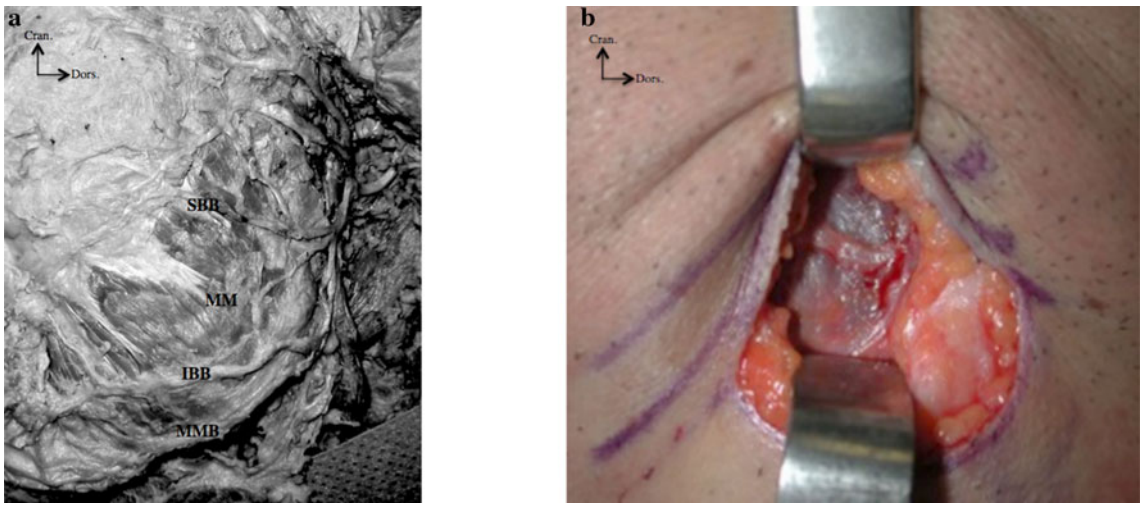

Fig. 3 **a** (*left*) Dissection photograph (close up). Height measurements were respectively 13 mm for inferior buccal branch (IBB) and 1 mm for marginal mandibular branch (MMB) and 35 mm for superior buccal branch (SBB). Branching occurs over masseter muscle (MM). Note anastomosis between SBB and IBB. **b** (*right*) Operative photograph showing inferior buccal branch (IBB) encountered along high submandibular transmasseteric approach. Depicted step after incision of platysma muscle exposing IBB overlying masseteric fascia. Photography courtesy of Dr. Barrière

The average height of the inferior buccal branch (IBB) was 16.8 mm (7 to 32, SD 7.2) (Table 1; Fig. 4).

Concerning the marginal mandibular branch (MMB), we found an average height of 3.2 mm (−3 to 9, SD 3.0) (Table 1; Fig. 4).

The highest standard deviation was the one of the inferior buccal branch (7.2). The average distance between IBB and MMB was 13.7 mm (SD = 6.4).

These results are gathered in Table 1, where extreme values are in bold font, and all results ranging between 10 and 20 mm (level of masseter incision) are italicized. Statistical distributions of measurements are depicted in Fig. 4.

Discussion

No consensus exists in classical, or modern anatomic literature about pattern of origin and number of buccal branches [1, 2, 6–9, 14, 15, 18, 20, 21] (Table 2). Our series is according to this notion even if the facial nerve branching we established in most dissections matched the description provided by Fontaine [6] (Table 2). Yet, the purpose of our study was neither to classify the origin of buccal branches nor to study branching patterns.

Our findings

Through our dissection series, it seems that through the transmasseteric approach, the surgeon is most likely to encounter the *IBB*. Indeed, masseter incision is usually performed between 10 and 20 mm above the basilar border of the mandible, according to the standard description of the procedure [24]. Only the IBB has been measured in this range of height, in 9 dissections (45%), (Table 1). Measurements of MMB were all out of this range. This is according to the description provided by Fontaine [6] of IBB being located 1 cm above the alveolar ridge of the mandible. The clinical studies of the HSTA had *never* clearly identified the IBB as the most commonly exposed branch [12, 24]. Interestingly, IBB height appears quite variable along dissections as confirmed by the *standard deviation,* which is the *highest* in measurements of the IBB (SD = 7.2) (Table 1; Fig. 4).

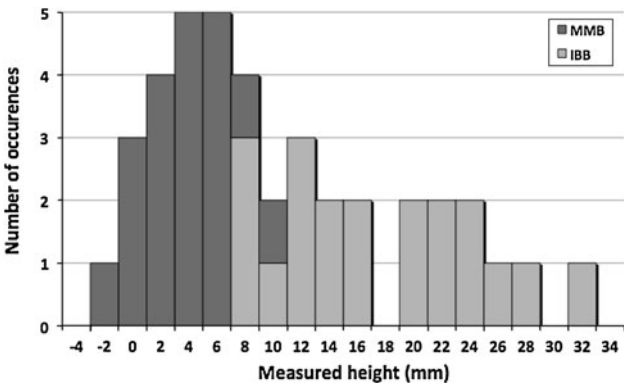

Fig. 4 Graph illustrating distribution of measured heights of marginal mandibular branch (MMB) and inferior buccal branch (IBB): number of occurrences (*Y* axis) for every measured value in millimeters (*X* axis)

On the other hand, the *highest* MMB measured was at 9 mm (Table 1; Fig. 4). Accordingly, masseter incision would thus avoid MMB when performed in the indicated range of 10 to 20 mm above the basilar border. Considering the average height of MMB being equal to 3.2 mm (with SD = 3), this also provides the surgeon with an added safety margin of 4 mm toward MMB when incising the masseter. These findings match those of Potgieter et al. [16] who also measured the position of the MMB using the mandibular angle as reference. All these elements confirm what Wilk explains in the procedure description [24], that is safety regarding MMB.

Anatomical assessment of SBB was not a primary concern of our study. Its lowest measured height at 28 mm (level rarely reached in standard HSTA) comforts us with this choice.

Trost et al. [23] have described alterations to the standard HSTA, featuring a higher extend of subcutaneous dissection and higher level of masseter incision, which could, in that case reach the level of SBB.

No correlation in measurements could be identified between the right and left sides of the same heads (Table 1).

Implications for surgery

Our anatomical findings help understanding why the HSTA appears so safe regarding the facial nerve. Indeed, open reduction and internal fixation of subcondylar fractures through this approach has lead to no facial palsy, not even a transient one, according to a prospective clinical study carried out on 64 patients [11–13]. This is mainly due to the fact that facial nerve branches involved in the approach are clearly exposed intraoperatively (Fig. 3b). Interestingly, no branch can be encountered, but in case they are (75% of cases [12]), our study has shown it to be most commonly the IBB. This provides the surgeon with a new understanding of the eventual complications of HSTA. Considering the given facial nerve topography encountered intraoperatively, one can decide to perform masseter incision below or above the visualized branch(es). Even if plexiform, the branches can be retracted, therefore protected, prior to masseter section. If needed, branches can be dissected and released from surrounding tissue to improve safety.

Table 2 Number and origin of buccal branches in classical and modern anatomic literature

Author	Number of buccal branches		Origin	Specifications	Innervated muscles
Kamina [7]	1 Buccal branch		Temporofacial (superior) division	Cervicofacial branch provides MMB and cervical branches	Orbicularis oris, buccinator
Kwak et al. [8]	1 Buccal branch		From both, the temporofacial and cervicofacial divisions (44.8%) with interconnections to zygomatic branches	In every case, no origin solely from one division	Muscles of upper lip, cheek and nose, sometimes lower portion of orbicularis oculi and depressor angulii oris
Bellocq [1]	2 Buccal branches	Superior	Temporofacial (superior) division		Cutaneous muscles located above rima oris
		Inferior	Cervicofacial (inferior) division	Course slightly above and parallel to inferior rim of mandible	Cutaneous muscles located under rima oris
Bouchet and Cuilleret [2]	2 Buccal branches	2 Superior	Temporofacial (superior) division	Course along inferior edge of parotid duct	Orbicularis oris, buccinator
		1 Inferior	Cervicofacial (inferior) division	Course crosses lateral aspect of masseter muscle	Orbicularis oris, buccinator, risorius
Chevrel and Fontaine [6]	2 Buccal branches	Superior	Temporofacial (superior) division	Course under parotid fascia	Zygomatic major and minor, levator angulii oris superioris, levator nasolabialis, orbicularis oris, buccinator
		Inferior	Cervicofacial (inferior) division	Course 1 cm above alveolar ridge of mandible	Orbicularis oris, buccinator, risorius
Maillot and Kahn [9]	2 Buccal branches	Superior	Temporofacial (superior) division	Course inferior to parotid duct	Cutaneous muscles located above rima oris
		Inferior	Cervicofacial (inferior) division	Numerous anastomosis on lateral aspect of buccinator muscle	Cutaneous muscles located under rima oris
Poirier and Charpy [15]	2 Buccal branches	Superior	Temporofacial (superior) division	In a single trunk often coming from Frohse's ramus maximus (common trunk with zygomatic branches)	Orbicularis oris (superior part), buccinator
		Inferior	Cervicofacial (inferior) division	In a single trunk running parallel to and 0.5 cm above inferior rim of mandible	Orbicularis oris (inferior part), buccinator, risorius
Rouvière [18]	2 Buccal branches	Superior	Temporofacial (superior) division		Orbicularis oris (superior part), buccinator
		Inferior	Cervicofacial (inferior) division	Branches commonly dividing above and before the level of mandibular angle	Orbicularis oris (inferior part), risorius
Saylam et al. [20]	Buccal Branches	Classification regarding position in reference to parotid duct	In a single trunk inferior to parotid duct (35%) in a single trunk superior to parotid duct (25%)	Buccal plexus inferior to parotid duct (26.7%) two groups of branches (13.3%): 1 superior, 1 inferior	

Regardless of the type of approach used, the low rate of buccal branches injury is also due to the *many communicant rami* between buccal branches that we always noticed in our dissection series (Figs. 2, 3a). Indeed, cross-communication between the zygomatic and buccal branches was found to be much more frequent (70–100%) than between the marginal mandibular branch and other branches (0–16%), according to literature [7–9, 15, 18, 21, 23–25].

In the end, our findings should help ease the reluctance of some surgeons toward the HSTA they find hazardous regarding the vicinity of facial branching. Indeed, if any facial nerve branch is encountered, the inferior buccal is the most likely to be involved. The height of masseter section can thus be placed accordingly, under visual control. In case of injury to buccal branches, a rich anastomosis plexus often prevents from definite facial palsy. Our measurements showed that the marginal mandibular nerve is usually not exposed, thus safe.

These elements make the HSTA a swift and safe procedure toward facial nerve branches, *especially IBB,* at the same time as providing great exposure of the mandibular condyle.

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