**Embouchure** (origin; French = mouth, mouthpiece or outlet). In brass playing, it can be defined as the lip conformation resulting from the activity of the facial muscles, supported by the teeth and jaw.

In brass instruments, the pitch of a note depends on the frequency of lip vibration. The underlying muscles oscillate passively in the airstream at a frequency determined by their tension and the mass of the vibrating part of the lip (Fuks and Fadle, 2002) and the fluctuating difference in air pressure between the oral cavity and the mouthpiece cup. The central component of the embouchure is the orbicularis oris, a purse-string muscle surrounding the mouth opening (oris). Radiating from it are a series of muscles that are anchored to the upper and lower jaw (Fig. 1). Like guy ropes, these apply tension to the embouchure and alter its shape by raising (levating) or depressing the upper (superior) or lower (inferior) lip (labium) or the corners of the mouth (anguli oris). In addition, the zygomaticus muscle (a levator) runs from the upper lip to the zygomatic (cheek) bone while the mentalis (chin) muscle pulls the lower lip downwards and outwards. Risorious (from Latin; ridere = to laugh) is a weak muscle ending not on bone but in the soft tissues of the cheek. The buccinator (Latin = trumpeter), forms the muscular wall of the cheek, merging with the orbicularis oris in front and the muscles of the throat (pharynx) behind to form a continuous muscular tube from the larynx to the embouchure, which contains the pressure of the airway. The embouchure muscles are supplied by branches of the facial nerve but the left and right upper and lower quadrants of the orbicularis oris are controlled separately by different branches. Facial nerve (or Bell’s) palsy, a condition in which nerve function is impaired or blocked, leads to paralysis of embouchure muscles. This relatively common condition has a number of causes including viral infections and often resolves spontaneously within a few weeks (Lederman, 2010).
Except for buccinator, the embouchure muscles contain an unusually high proportion of fatigue resistance fast twitch muscle fibres (designated type IIAB) (Stal, 1994). The zygomaticus has the highest proportion of these of any human muscle but it is the orbicularis oris that is most fatigue resistant (van Boxtel et al., 1983). However, as the primary role of embouchure muscles is to control facial expression and ensure mouth closure, they are small and this limits the force they can produce. Muscles elsewhere in the body contain sensory structures (muscle spindles and tendon organs) that detect changes in their length and tension but these are absent from facial muscles (Cattaneo and Pavesi, 2014) so sensations arising from embouchure activity come from nerve endings in the skin and soft tissues of the face to which the muscles attach.

The embouchure has an excellent blood supply (Stal et al., 1996) but the vessels within the muscles can be compressed by strong contraction and by mouthpiece pressure, temporarily reducing the flow of oxygen and nutrients and contributing to short lasting fatigue that resolves within a few seconds as the muscles relax (Allen et al., 2008). Increased blood flow to the embouchure during warm-up can be observed as changes in facial temperature. With experienced players this is more symmetrical and more focussed on the orbicularis oris and the levator and depressor anguli oris than it is in the less experienced (Bertsch and Thomas, 2001). The rise in temperature increases muscle metabolism and hence responsiveness and so may contribute to the reported improved accuracy in hitting difficult notes after warm-up.

Though the blood flow to the buccinator increases in players who allow the cheek to bulge during playing, it does not change noticeably in those who don’t do this, suggesting that high activity levels in the muscle are not needed to contain airway pressure.

Investigations of embouchure muscle activity during playing have mainly focused on trumpet players. The muscles contract before the onset of a note and can then terminate it by relaxing abruptly, which slackens the lips and kills the vibration (Heuser and McNitt-Gray, 1991;
Hirano et al., 2013; Iltis and Givens, 2005; White and Basmajian, 1973). Embouchure activity increases with pitch and volume. The muscles on each side normally contract equally even in players who place the mouthpiece asymmetrically (Heuser and McNitt-Gray, 1993). Problems with note onset, poor tone quality and lack of flexibility may result from left-right asymmetry in muscle activation and weak control over the onset and termination of muscle contraction at the beginning and end of the note (Heuser and McNitt-Gray, 1998). Advanced players show similar levels of activity in the upper and lower lip (orbicularis oris) and more activity the peripheral muscles compared to orbicularis oris itself. Beginners show more upper lip activity than professionals and similar levels in the peripheral and orbicularis muscles, as well as larger changes in muscle activity during small interval lip slurs and between tongued and slurred arpeggios (White and Basmajian, 1973). The results of this study are potentially very significant, but require confirmation as no raw data is presented. Despite suggestions to the contrary (Farkas, 1956), significant pressure is needed between the mouthpiece and the embouchure to enable the correct patterns of lip vibration to develop and this increases with pitch. Measurements in several studies of trumpet players are very consistent with typical mean values of 5-50N (equivalent to 0.5-5kg) depending on pitch (Barbenel et al., 1988; Borchers et al., 1995; Mayer and Bertsch, 2005) with the greater pressure being applied to the lower lip (Fuhrimann et al., 1987). Though less well studied, pressures appear similar for players of the french horn (another high pressure, small mouthpiece instrument), rather lower for the flugelhorn and lower still for the tuba (Borchers et al., 1995; Petiot, 2003). Objective studies show that it is difficult even for professionals to judge the force used by other players from visual criteria alone, while self-assessments in both professionals and amateurs tend to overestimate the range of forces they employ when playing (Barbenel et al., 1986). Some professionals use very high mouthpiece pressures with little overt sign of strain. Despite their magnitude, these forces do not appear to have a
significant effect on tooth position, including overjet; i.e. the projection of the upper over the lower incisors (Grammatopoulos et al., 2012; Rindisbacher et al., 1990) however under these pressures, irregularities, sharp edges or large gaps between the load bearing teeth can irritate the inside of the lips (Howard, 2010). If the teeth are normal, it is a sensible precaution for professional players to have a dental cast made so that if damaged, the original dental configuration and feel can be restored. As the embouchure is supported by the both the upper and lower incisors, players with a large overjet may let the instrument’s lead pipe slope downwards to equalise the forces on them. Alternatively, they may push the lower jaw forward (protraction) when playing (Bejjani and Halpern, 1989) using the pterygoid muscles which run between the mandible (jaw) and maxillary bones (skull). This can cause muscle fatigue and the constant backward force on the jaw can lead to temporo-mandibular (jaw) joint pain (Howard, 2010) which is often exacerbated by stress and resultant jaw clenching or nocturnal tooth grinding.

Embouchure-related problems.

Flaking of the lips may indicate allergic contact dermatitis from the mouthpiece, nickel often being responsible. A mouthpiece coated in a more inert metal such as gold or silver or one with a plastic rim, may resolve the problem (Thomas et al., 2000). Plasticizers in case linings that contact the mouthpiece can also be a cause (Hallai et al., 2004). Compression of nerve branches that carry sensation from the tissues around the lips (particularly the upper lip) is not uncommon as a source of pain or discomfort (Termsarasab and Frucht, 2015) e.g. from the mouthpiece pressing the lip against dental irregularities. Rupture of the orbicularis oris muscle (Satchmo syndrome) is a significant embouchure injury which can develop after a change of mouthpiece or from extending the playing range upwards (Planas, 1982). Soft tissue beneath the muscle herniates through the tear making it difficult to resist the escape of air during pouting and severely affects the sound when playing. However surgical repair can
return a player to professional levels of performance (Papsin et al., 1996). The term ‘embouchure overuse’ is frequently employed as a catch-all for many different conditions and a more careful and accurate diagnosis is needed to identify the specific problem if an effective treatment is to be found (Lederman, 2001). Any related tissue swelling will tend to block the small aperture between the lips and also increase their mass, making it harder to sustain the vibration. This is best dealt using standard anti-inflammatory treatments. If overuse is really the primary cause, rest or a reduction in playing is indicated until symptoms abate (see also Embouchure dystonia).

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References


Petiot J-F. Measurement of the force applied to the mouthpiece during brass instrument playing; 2003; Stockholm, KTH. p 225-228.


Caption

The muscles of the embouchure and the direction of the forces they apply to the orbicularis oris (oo). Depressor anguli oris (dao), depressor labii inferioris (dli), levator anguli oris (lao), levator labii superioris (lls), mentalis (m), risorius (r), zygomaticus (z).