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Research article

Surgical and topographic anatomy of the maxillary line: An important landmark for endoscopic nasal surgery

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ABSTRACT

The maxillary line is an important surgical landmark in the lateral nasal cavity. We investigated its location, variation, and relation to other landmarks in 47 formalin fixed cadaveric half-heads dissected in steps. Measurements and observations were made to describe the topography of the maxillary line, maxillary line midpoint (M-point), and their relationship with surgically important structures. The mean curved length of the maxillary line was 15 mm (SD 3.5) and can be classified into three types. The M-point had a mean vertical distance of 0.8 mm (SD 2.9) below the nasolacrimal sac–duct junction. It was found below, above, or on the same level as the nasolacrimal sac–duct junction in 57.4%, 38.3%, and 4.3% of specimens, respectively. In 51.1% the M-point was anterior to the nasolacrimal duct axis and 48.9% overlapping the lacrimal apparatus. The maxillary line and its M-point are useful surgical landmarks for localizing the nasolacrimal duct segments.

1. Introduction

1.1. The lacrimal apparatus

The lacrimal apparatus acts as a tear pump allowing drainage of excessive tears from the medial canthus to the nasal cavity. Blockage of the pump at any level will result in building up and overflow of tears (*epiphora*) affecting normal vision, periorbital/facial skin, cause social embarrassment, recurrent dacryocystitis, and less commonly mucocele formation (Yung and Hardman-Lea, 1998; Raut et al., 2000). Endoscopic dacryocystorhinostomy (DCR) is a surgical procedure which can be performed with an extranasal or intranasal approach to treat the blockage of the lacrimal apparatus. The aim of the operation is to make a new lacrimal window between the lacrimal sac and nasal cavity to facilitate tear drainage. The average duration of the modified endoscopic DCR is approximately 22 min (Yung and Hardman-Lea, 1998).

Accurate recognition of specific anatomical landmarks on the lateral nasal cavity wall is of utmost importance as they are used as a guide intraoperatively, to avoid damage to important adjacent structures such as the orbit, anterior cranial fossa, hypophyseal fossa, and carotid artery (Calhoun et al., 1990). The success of the endoscopic DCR depends on complete exposure of the lacrimal sac. For effective localization of the lacrimal sac the surgeon uses anatomical landmarks for guidance such as the axilla of the middle turbinate, uncinate process, ethmoid bulla, lacrimomaxillary suture, maxillary sinus ostium, maxillary line, and midpoint of the maxillary line (M-point) (Yung and Hardman-Lea, 1998; Raut et al., 2000; Chastain et al., 2005; Wormald et al., 2000; Kim et al., 2012).

1.2. The maxillary line

The maxillary line is an important landmark for uncinectomy, endoscopic DCR, and endoscopic orbital decompression (Chastain et al., 2005; Metson et al., 1994; Kingdom and Durairaj, 2006; Sindwani and Metson, 2008; Orhan et al., 2009; Shams et al., 2012). It is a curvilinear eminence on the lateral nasal cavity wall which projects from the axilla of the middle turbinate to the dorsum of the anterior attachment of the inferior turbinate. We can visualize it as a mucosal projection that corresponds to an underlying bony landmark. Extranasally the maxillary line corresponds to the lacrimomaxillary suture at the junction of the frontal process of the maxilla and the lacrimal bone at the medial wall of the orbit (Metson et al., 1994). The M-point bisects the maxillary line and has practical application as a surgical landmark in endoscopic DCR

Abbreviations: DCR, dacryocystorhinostomy; NLD, nasolacrimal duct; M-point, maxillary line midpoint; NL, nasolacrimal.

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(Chastain et al., 2005). Endoscopy of the lateral nasal cavity wall provides an easy view of the maxillary line due to easy identification of its entire curvilinear length in most cases. The M-point is useful for conceptualizing the maxillary sinus ostium relation which is reported to be approximately 10.8 mm posterior to it. Interestingly the M-point lies just inferiorly to the nasolacrimal (NL) sac–duct junction (Chastain et al., 2005).

1.3. Aim of the study

The number of cadaveric studies with information on the topographical and surgical anatomy of the maxillary line is very limited. The aim of this research is to describe the topography and relation of the maxillary line and its' M-point to standard anatomical landmarks of the lateral nasal cavity wall. Axial and vertical height measurements were made to determine the mean and range of distances between selected structures. Thereby we provide previously unknown information about the maxillary line and M-point along with useful hints for localization of structures such as the NL sac–duct junction. The results of the study could be used as a guide for surgeons intervening in the lateral nasal cavity.

2. Materials and methods

2.1. Human cadaveric material

For the purpose of the study, 48 (40 male and 8 female) mid-sagittally sectioned half-head formalin fixed cadavers were dissected with the aid of surgical microscope. The age of the cadavers ranged from 52 to 89 years. At the initial inspection of the material, one specimen was excluded from the study due to previous sphenoidectomy operation. The specimens were dissected in three steps.

2.2. Approach and specimen dissection

At step-1, the nasal septum and the anterior half of the inferior and middle nasal concha were removed to expose the nasolacrimal duct (NLD) opening, maxillary ostium, and uncinate process. The natural ostium of the maxillary sinus and the opening of the NLD were marked with a probe. At step-2 of the dissection, the mucosa of the lateral nasal wall was removed to unveil the frontal process of maxilla, lacrimomaxillary suture, and lacrimal bone. At step-3, the NLD and lacrimal sac were exposed by drilling away parts of the frontal process of maxilla, uncinate process, and lacrimal bone. Series of parallel photographs of the nasal cavity were taken at fixed focal length of 48 cm before and after each step.

Table 1
Maxillary line measurements, ($n = 47$).

	Mean distance (mm)	SD	Range (mm)
1. Curved length of maxillary line	15.0	3.5	8.2–22.6
2. Lacrimomaxillary suture distance to maxillary line	2.6	1.3	0–5.6

SD, standard deviation.

2.3. Elaboration and analysis of collected data

The photographic material was analyzed using ImageJ image processing software (ImageJ v1.46r, NIH, Maryland, USA). The measurements were performed by two examiners independently for reliability. Photographs taken before dissection were used to make measurements between the maxillary line and anatomical landmarks of the lateral nasal cavity wall. Further measurements were obtained by overlaying transparency adjusted photograph at step-2 onto the previously annotated step-1 photograph. This superimposed image provided information on the relationship between the mucosal projection of the maxillary line onto the lacrimomaxillary suture. Next, transparency adjusted photograph at the end of step-3 was overlapped onto previously annotated pre-step-1 photograph to gather information on the relationship of the maxillary line with parts of the exposed NL apparatus. Tabulation and statistical analysis of the data were carried out in Excel spreadsheet software and SPSS statistics package (Excel 2010, Microsoft Corp, Redmond, USA; IBM SPSS Statistics, Version 21.0. Armonk, NY, USA).

3. Results

3.1. Classification of the maxillary line

The maxillary line was found with a mean length of 15 mm (SD 3.5) ranging from 8.2 to 22.6 mm. Its shape was always curved with the upper end starting from the axilla of the middle turbinate and the lower end attaching to the dorsum of the anterior attachment of the inferior turbinate. According to our observations we classified the maxillary line into three types; (I) normal, (II) short, and (III) long (Figs. 1 and 2). Maxillary line with a length of 15 ± 3.5 mm was regarded as normal type, taking into account the mean values and SD of Table 1. Any measurement outside of this range was appointed to the other two types (Figs. 1 and 2). Type I maxillary line was found in 68.1%, type II in 17%, and type III in 14.9% of specimens. In cases with short maxillary (type II) line the inferior turbinate was always enlarged expanding the root of its anterior attachment superiorly (Fig. 2).

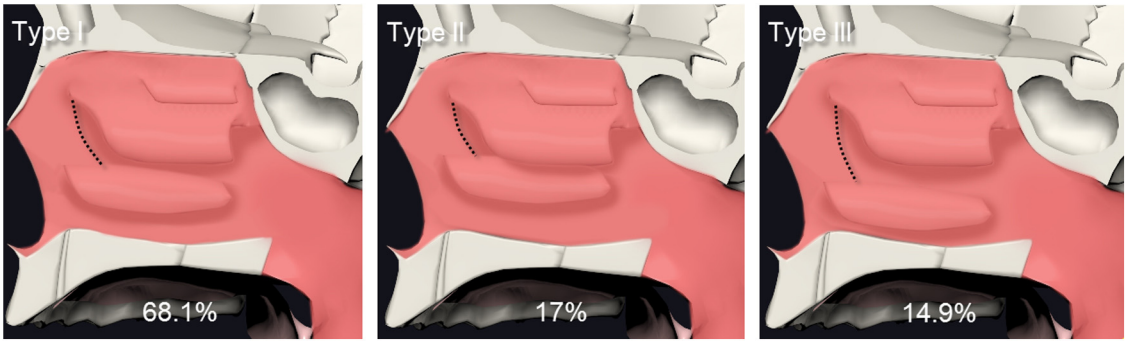

Fig. 1. Classification of maxillary line according to length. Type I, normal maxillary line 15 ± 3.5 mm. Type II, short maxillary line <11.5 mm. Type III, long maxillary line, >18.5 mm. Dotted line: maxillary line.