CONTENTS

PREFACE

The key to the success of dental treatment is the prevention of cross-infection, protection of the working field with rubber dam sheets from saliva and disinfectant solutions, as well as from accidental traumatization of the oral mucosa. Despite the simplicity and versatility of the invention, the "rubber dam system" was not widely used for a long time due to the imperfection of dental equipment and the level of development of dentistry. At the very beginning of the invention, latex sheets were extremely expensive and were not available for mass use. Modern industrial production has created medical products made of latex rubber, including rubber dam sheets, quite affordable for widespread use.

The basis of the rubber dam system is a thin elastic sheet for tooth isolation, in which holes of various diameters are created using a special set of instruments. The rubber dam is more than 100 years old, but the isolation of the working field is still a burning question for most dentists.

Infection control is central to effective and quality dental treatment. Numerous studies have proven the influence of microorganisms and other biological factors of the oral cavity on the development, course and outcome of dental pathologies such as dental caries, pulp and periapical diseases. Aesthetic restoration of teeth with modern composite materials involves the use of adhesive systems and long working time, which requires isolation of the tooth to exclude the ingress of oral fluid into the working field. When performing endodontic treatment, the important tasks of isolation are

the exclusion of repeated infection of the root canal with oral microorganisms, prevention of chemical impact of irrigating solutions (sodium hypochlorite, EDTA) on oral mucous membranes. Since the main aspect in modern dental treatment is the creation of a dry working field, it is necessary to know about the biology of the oral cavity, as well as saliva, oral and gingival fluids and their influence on oral health and dental treatment. Isolation of the working field creates aseptic conditions, which undoubtedly increases manual control and the effectiveness of the therapy performed.

This tutorial guide is intended to create the necessary theoretical basis for the subsequent practical use of techniques for working with the rubber dam system in clinical practice. The book will be useful for students, residents, postgraduates, as well as experienced specialists who want to include the use of the rubber dam system in their daily practice.

Some chapters of the guide include quick reference QR codes, providing access to more detailed information on specific topics of oral isolation (videos). The content of the publication reflects the provisions of the current clinical guidelines and allows their application in clinical practice.

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Chapter 1
ORAL BIOLOGY

Learning objectives

- To study the anatomical structure of the oral cavity of a human.
- To understand the work of the salivary glands, their structure and functions, as well as of the composition and the features of the salivary and oral fluid.

Control questions

1. Anatomical structure of the oral cavity.
2. Large and small salivary glands.
3. What is oral fluid, its composition and features?
4. What is saliva, its composition and features?
5. What is the difference between the saliva and the oral fluid?
6. How does the oral fluid influence the condition of the oral cavity?

Lesson content

1.1. THE ANATOMICAL STRUCTURE OF THE ORAL CAVITY

The oral cavity (lat. *cavitas oris*) is the initial party of the digestive and respiratory systems of a human. The oral cavity also takes part in the processes of speech and communication.

The oral cavity is subdivided into two parts: the vestibule of the mouth (lat. *vestibulum oris*) and the oral cavity (lat. *cavitas oris propria*).

The vestibule of the mouth is the area which is limited by the internal surface of the lips and cheeks from the outside, and by the vestibular surface of the teeth and gums from inside (**Fig. 1.1**). The vestibule of the mouth communicates with the external environment through the oral fissure (lat. *rima oris*).

Pay attention to the fact that the excretory ducts of the party's salivary glands open the side walls of the vestibule of the mouth on the level of the first molar tooth of the upper jaw (**Fig. 1.2**).

The oral cavity itself is bounded by the hard and soft palate above and the muscles of the mouth's floor below (the oral diaphragm), with the rows of teeth and gums at the front and sides. At the back, the oral cavity opens into the throat (**Fig. 1.3**).

Fig. 1.1. The vestibule of the oral cavity

Fig. 1.2. The right excretory duct of the party's salivary gland

The tongue, located within the oral cavity, plays a role in the processes of chewing, speech sound formation, taste perception, and saliva production. The ducts of the anterior and posterior salivary glands of the tongue open onto the underside of the tongue and in the grooves of the foliate papillae at the tongue's root, respectively. The lingual frenulum is formed by the transition of the mucous membrane from the floor of the mouth to the undersurface of the tongue. On either side of the lingual frenulum, there are sublingual caruncles where the ducts of the submandibular and sublingual salivary glands open. The sublingual folds, situated laterally, are formed by the lingual salivary glands (**Fig. 1.4**).

Fig. 1.3. The oral cavity

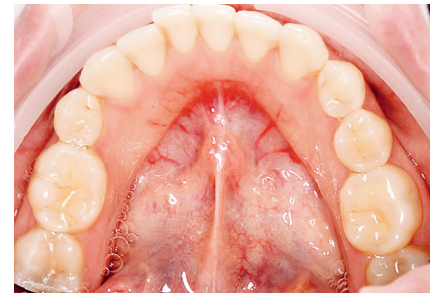

Fig. 1.4. The bottom of the oral cavity and sublingual folds, formed by the sublingual salivary glands

Note that the ducts of the submandibular and sublingual glands open into the area of the mouth's floor, just behind the lower jaw incisors.

1.2. TYPES OF SALIVARY GLANDS AND THEIR STRUCTURE

Salivary glands are exocrine glands located in the oral cavity and excreting saliva. There are three pairs of big salivary glands: parotid, submandibular and sublingual (**Fig. 1.5**). In addition to the major salivary glands, there are numerous

smaller salivary glands throughout the mouth, named for their locations as buccal, labial, lingual, and glands of the hard and soft palate. Based on the type of secretion, glands are categorized as serous, mucous, or mixed. Saliva enters the mouth from these glands through tiny tubes called ducts.

Parotid salivary gland (glandula parotidea) is located in the lateral region of the face, just in front of the earlobe, and is the largest salivary gland. In terms of secretion, it is classified as a serous gland, and structurally, it is a complex alveolar gland. The main excretory duct (Stensen's duct) runs about 15–20 mm below the zygomatic arch, is 5–6 cm in length, and opens into the vestibule of the oral cavity on the mucous membrane of the cheek, aligned with the upper second molar.

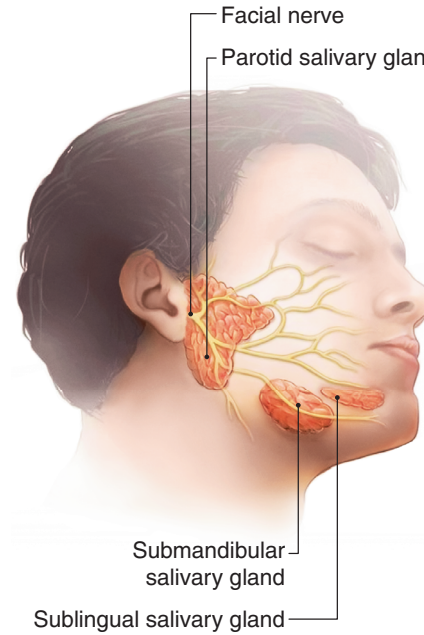

Fig. 1.5. Big salivary glands

Submandibular salivary gland (glandula submandibularis) is situated in the submandibular fossa. It is characterized as a mixed type of salivary gland in terms of its secretion, and structurally, it is a complex alveolar-tubular gland. The submandibular gland is lobulated and encapsulated. Its main excretory duct (Wharton's duct) is located between the sublingual gland and the geniohyoid muscle and opens at the sublingual caruncles, which are found on the floor of the oral cavity on both sides of the lingual frenulum.

Sublingual salivary gland (glandula sublingualis) is located on the floor of the oral cavity. In terms of the type of secretion, it belongs to the mucous category of glands; structurally, it is a complex alveolar-tubular gland. The sublingual salivary gland does not have main excretory ducts but has about 3–20 small ducts that open onto the floor of the mouth. Some of the anterior ducts may join together to form a single sublingual excretory duct (Bartholin's duct), which typically empties into Wharton's duct (the main excretory duct of the submandibular salivary gland).

Smaller salivary glands are located in groups in the mucous and submucous layer in the area of cheeks, hard and soft palate, lips, tongue, paranasal sinuses, larynx and trachea, bronchus and produce about 30% of total daily saliva. The secretion of these smaller salivary glands is mixed, but predominantly mucous. The smaller salivary glands do not have a system of branching excretory ducts.

1.3. THE CHARACTER OF THE SALIVA AND ORAL FLUID

Saliva is a fluid secreted by the salivary glands and is released into the human oral cavity through the excretory ducts of both large and small salivary glands. We can distinguish between saliva produced from the excretory ducts and mixed saliva, or oral fluid, which is a combination of microorganisms, contents from gingival crevices, gingival fluid, food remnants, etc.

Gingival fluid is a blood serum transudate, located in the gingival groove. Gingival fluid is produced through the epithelial attachment and has a complex composition: proteins, enzymes, microorganisms, mineral substances and a large number of white blood cells, as well as neutrophils — 96–97%, lymphocytes — 1–2%, monocytes — 2–3%. About 0.5–2.5 ml of gingival fluid gets into the oral cavity during a day, its quality depends on the time of the day, the location of the tooth and the condition of the periodontal tissues.

Along with this, about 1.5–2 liters of saliva per min is produced during the daytime, with the speed of about 0.05 ml/min at night and about 0.5 ml/min during the day, and after the stimulation — 2.5 ml/min. In the elderly people, the secretion of saliva declines because of the reduction of the large salivary glands and the slowing down of the activity of the smaller salivary glands.

Control over saliva production is managed through **nervous regulation**. Salivation regulation is complex and includes both an involuntary reflex component, which is mediated by the sympathetic and parasympathetic nervous systems, and a conditioned reflex component, which involves the cerebral cortex triggered by sight, smell, memories, conversations about food, and so on.

When the receptors in the mouth are stimulated, the parasympathetic nervous system (cranial nerves VII and IX) is activated, which leads to an increase in saliva secretion with a low content of organic substances. When the receptors in the mouth are irritated, the parasympathetic nervous system (cranial nerves VII and IX) is triggered, resulting in an increased secretion of saliva with a small amount of organic compounds. In contrast, when the sympathetic nervous system is stimulated, a small quantity of saliva is primarily released from the submandibular salivary glands. Salivation increases during menstruation and pregnancy and decreases during menopause, indicating the influence of sex hormones on salivation processes.

Viscosity of saliva (by Ostwald) amounts to 1.2–2.4 cP, normal acidity (pH value) fluctuates from 6.5 to 7.5.

Saliva consists of 99.0–99.4% water and of 1.0–0.6% organic and nonorganic substances. Nonorganic components include calcium salts, phosphates, potassium and sodium compounds, chlorides, bicarbonates, fluorides, rhodanides, etc. Organic components of saliva are numerous and mostly are presented by proteins and enzymes.

Mechanism of saliva formation

Saliva is produced both in the acini and the ducts of the salivary glands. The first stage of saliva formation occurs in the form of acinar synthesis of primary secretions, which contain alpha-amylase and mucin. The concentration of ions in the primary secretion is similar to their concentration in blood serum.

The second stage takes place in salivary ducts, mainly in striated ones. The content of the secret significantly changes: Na^+ ions reabsorb, while K^+ ions actively secreting. As a result, the concentration of Na^+ in saliva decreases, and the concentration of K^+ increases. Alongside with this, the secretion of HCO increases by the epithelium of the ducts in the clearance. Final saliva, coming in the oral cavity, is hypotonic.

Functions of saliva are numerous.

- **Digestive:** formation and swallowing a bolus. Food undergoes primary processing, thanks to the presence of active digestive enzymes in saliva, which partly split carbohydrates up to dextran and maltose.
- **Protective:**
  - realization of bactericidal, antifungal and antivirus activity due to the presence of lysozyme, lactoferrin, lactoperoxidase, cystatins, opinions, leucine, immunoglobulin, etc.;
  - realization of anticaries activity due to the cleaning of the surface of teeth and oral mucosa from the microorganisms, their waste products and leftovers of food, neutralization of acids in buffer effect, formation of salivary pellicles on the enamel surface, which prevents the entry of acids into the hard tooth tissues and the exit of mineral compounds from it;
  - moisturizing the oral mucosa with a layer of mucus (with mucin) for prevention of its drying out, damage and pathological impact of any kind of irritants.
- **Remineralizing:** exit prevention of enamel components from it and ensuring the supply of ions, necessary for remineralizing of teeth.
- **Buffer:** neutralization of the negative effect of strong acids and alkalis within the capacity of the buffer for protection of oral cavity and tooth enamel from destructive effects of pathogenic factors. The following systems operate in saliva:
  - *hydrocarbonate* — the main buffer system of saliva (provides 80% buffer features) mostly active when pH=6.1–6.3. Its activity depends on the speed of salivation, increases during eating and chewing;
  - *phosphate* — most active when pH=6.8–7.0. The capacity of this buffer system does not depend on eating and chewing;
  - *protein* — presented by anionic cationic proteins, in connection with which, this buffer system is effective when pH values are various.

Self-evaluation exercises

Choose one or more than one right answers.

1. The definition of "oral fluid" is:
   A. The secret of salivary glands.
   B. Biological fluid which includes the secret of salivary glands, bacteria and their metabolic products, contents of periodontal pockets, desquamated oral epithelium, leukocytes, leftovers of food products, etc.
   C. Serum sedate from the choroid plexus, located under the functional epithelium, which diffused into the gingival sulcus area.
   D. Biological fluid which includes the secret of salivary glands, bacteria and their metabolic products, contents of periodontal pockets, gingival fluid, desquamated oral epithelium, leukocytes, leftovers of food products, etc.
   E. Biological fluid which includes microflora and its meta products, contents of periodontal pockets, gingival fluid, desquamated epithelium, leukocytes, leftovers of food products, etc.
2. The number of large salivary glands is:
   A. Four.
   B. Six.
   C. Two.
   D. Three.
   E. Five.
3. Where does the excretory duct parotid salivary gland open?
   A. On the alveolar ridge between the first and the second molar.
   B. On mucous membrane of the cheek on the level of the second molar of the upper jaw.
   C. On the sublingual tip between the first and the second premolar of the lower jaw.
   D. On the mucous membrane of the cheek on the level of the first molar of the upper jaw.
4. Large salivary glands include the following.
   A. Parotid.
   B. Palatal.
   C. Labial.
   D. Submandibular.
   E. Sublingual.
   F. Buccal.
5. Small salivary glands include the following.
   A. Submandibular.
   B. Buccal.
   C. Labial.
   D. Parotid.

E. Lingual.
F. Sublingual.

6. According to the character of the secret, salivary glands are divided into the following.
   A. Serous.
   B. Purulent.
   C. Turbulent.
   D. Alveolar.
7. According to the character of the secret, salivary glands are divided into the following.
   A. Alveolar.
   B. Purulent.
   C. Mixed.
   D. Mucous.
8. According to the character of the secret, salivary glands are divided into the following.
   A. Alveolar.
   B. Purulent.
   C. Mixed.
   D. Tubular.
9. Saliva volume, produced by a person during a day is:
   A. 2100–2700 ml.
   B. 900–1300 ml.
   C. 1500–2000 ml.
   D. 1000–1700 ml.
10. pH value of oral fluid as a normal is:
    A. 6.5–7.5.
    B. 5.7–6.5.
    C. 6.8–7.0.
    D. 6.8–7.8.
11. What is the normal value of physiological viscosity of saliva?
    A. 1.2–2.4.
    B. 2.2–2.3.
    C. 5.0–7.1.
    D. 3.5–4.5.
12. Factors that influencing the speed of salivation are the following.
    A. Food irritants.
    B. Nervous excitement.
    C. Sex.
    D. Age.
    E. All of the above.

13. Buffer systems include the following.
    A. Hemoglobin, phosphate, hydrocarbonate.
    B. Hydrocarbonate, acetate, phosphate, protein.
    C. Hydrocarbonate, phosphate, protein.
    D. Protein, hydrocarbonate, acetate, hemoglobin.
14. The percentage of organic components in saliva is:
    A. 14%.
    B. 6.7%.
    C. 1%.
    D. 2.5%.
15. What is the speed of saliva production in a healthy person during rest at night and during the daytime?
    A. 0.2 ml/min at night; 0.07 ml/min during the daytime.
    B. 0.05 ml/min at night; 0.5 ml/min during the daytime.
    C. 0.8 ml/min at night; 1.5 ml/min at night; 1.5 ml/min during the daytime.
    D. 0.001 ml/min at night; 0.005 ml/min during the daytime.
16. What components are the parts of saliva?
    A. Secretions of large and small salivary glands.
    B. Secretions of large and small salivary glands, leukocytes.
    C. Secretions of large and small salivary glands, leukocytes, desquamated epithelium.
    D. Secretions of large and small salivary glands, leukocytes, platelets.
17. What is the function of protein lactoferrin in saliva?
    A. Digestive.
    B. Buffer.
    C. Protective.
    D. Mineralizing.
18. What happens to the speed of salivation with the age?
    A. Decreases.
    B. Increases.
    C. Does not change.
19. Where do the ducts of submandibular and sublingual salivary glands open?
    A. On the sublingual tip under the incisor of the lower jaw.
    B. On the bottom of the oral cavity.
    C. On the sublingual tip between the first and the second premolars of the lower jaw.
    D. On the bottom of the oral cavity at the base of the frenulum of the tongue.
20. The main mineralizing protective factor of the oral fluid is the following.
    A. Pellicle of the tooth.
    B. Bicarbonate buffer in saliva.
    C. Saliva, oversaturated with calcium and phosphorus ions.
    D. Increased viscosity of oral fluid.