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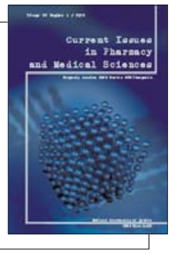

Modern treatment methods of sialolithiasis

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ABSTRACT

Salivary stones (*sialolithiasis*) are diagnosed in 0.007% of the population and are the most common cause of submandibular and parotid salivary glands obstruction. In the past, sialolithiasis was the leading cause of submandibular gland resection. The dynamic development of medical technology greatly expanded the range of therapeutic options used in the treatment of salivary stones. The introduction of ultrasound and endoscopic techniques to the process of salivary stones diagnosis greatly facilitated the identification of salivary stones. Endoscopic methods made it possible to perform surgeries on the salivary glands in an almost atraumatic way. The use of laser devices, piezoelectric or magnetostrictive effect, enabled the efficient crushing of large salivary calculus deposits (sialolithotrypsis) and removal of stones fragments through the lumen of salivary duct. Modern therapeutic methods enabled to reduce the number of sialoadenectomies to a minimum. In addition, these methods are characterized by a small number of serious complications and a very high success ratio, reaching up to 97%.

Keywords: Sialolithiasis, Endoscopy, sialolithotrypsy

INTRODUCTION

Sialolithiasis is the most common cause of salivary glands obstruction. It is diagnosed in 1 out of 15-30 thousand people [6]. This process usually occurs in the parenchyma or salivary duct of submandibular gland (60 to 85% of cases). Salivary stones localized in the parotid glands (6 to 40% of the analyzed cases) and sublingual (about 2% of cases) are less common [4,5]. Salivary calculosis occurs more frequently in males, mostly in the 4-6 decade of life. Sialolithiasis is rarely found in children. The disease is caused by the deposition of salts in the form of salivary stones (sialoliths). Depending on the diameter of the stone, calculus may cause impediment or complete obstruction of the duct which leads to the reduction of outflow of glandular secretion. Consequently, this leads to swelling of the gland, particularly intensifying during chewing, and following inflammations. By the end of the twentieth century sialolithiasis was one of the most common indications for sialoadenectomy. The dynamic development of medical technologies has enabled the introduction of new diagnostic and therapeutic methods to the treatment of salivary stones. Endoscopic, laser or ultrasound techniques significantly increased the therapeutic options and severely reduced the classic indications for surgery in the treatment of sialolithiasis. The use of technological achievements in the treatment of salivary stones allows performing surgeries in a safe and minimally invasive manner.

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ETHIOPATHOGENESIS OF SALIVARY CALCULI

Salivary stones can be oval or irregular in shape. Calculi size varies from 2 to over 20 mm [8]. Stones are composed of the organic and inorganic components [7]. Organic compounds are mainly formed of mucopolysaccharides, glycoproteins and cell debris. Inorganic part consists mainly of calcium carbonate and phosphate forming microapathytes. Other elements such as magnesium, potassium, iron or copper are rarely found in salivary stones. Studies have shown a slightly different composition of the salivary stones in the parotid and submandibular gland. Calculi forming in the parotid gland are composed in 51% of the organic and in 49% inorganic substances. The inverse ratio is detected in submandibular sialolithiasis - 82% minerals and 18% of the organic components [13]. Differences in the incidence of salivary stones in particular salivary glands result from differences in the composition of the salivary secretion. Submandibular gland saliva contains more carbonates, phosphates, mucins, and is the most alkaline. These factors greatly favor the formation of stones. The organic material locates in the core of the calculi, minerals predominate in the peripheral part. This is due to the process of the salivary stones formation. Accumulation of organic material results in a partial stagnation of saliva, which leads to change in the consistency of saliva. Secretion of salivary glands becomes thicker. Thickened saliva creates favorable conditions for the deposition of mineral salts in the organic core. Subsequent layers of calculus are loosely interconnected. These layers may have lamellar or globular structure. Lamellae are composed mainly of hydroxyapatites crystals, while the spherical structures are formed with nonorganic and organic parts. The organic part consists essentially of salivary proteins, denatured collagen and keratin. The study by Washio and associates demonstrated a high level of sulfur compounds in the organic part of the plaque, which proved the influence of bacteria on the formation of sialolith [14]. Studies employing technique of nucleic acid reproduction chains revealed that the salivary stones contain fragments of bacterial DNA from the Streptococcus family [12]. Until now no connection has been detected between the type of diet, water hardness or disorders of calcium metabolism and the presence of salivary stones. Only systemic disease which significantly increases the risk of sialolithiasis is gout. Sialoliths in patients with this disease are mainly composed of uric acids [12]. Studies have also shown a positive correlation between smoking and increased incidence of salivary calculi [9].

DIAGNOSIS OF SALIVARY STONES

Recurrent swelling and tenderness in the area of submandibular or parotid gland, intensifying during meals, these are the symptoms which should bring the suspicion of salivary stones. Sialoliths in very few cases occur in more than one gland, that is why sialolithiasis usually does not load to xerostomia. Standard radiographs (occlusal/*panoramic image)* are often used but do not always allow to set correct diagnosis. Noteworthy is the fact, that about 40% of the stones located in the parotid gland and 20% of submandibular stones are transsmisive to radiation and do not give a shadow on the X-ray image [4]. For this reason, standard radiographs should be used only if there is no possibility of using other diagnostic methods. Once considered as the “gold diagnostic standard”, sialography also loses its importance. Despite the significant advantages such as: the ability to determine the exact location of the stone and the structure of ducts, this method carries a significant risk of many complications. Administered contrast can lead to perforation of the duct, bacterial infection of the gland or anaphylactic reactions in patients who are allergic to iodine compounds. In addition, the diagnostic procedure involves the exposure of the patient to a relatively high dose of radiation and the pain associated with injection of contrast to the salivary duct. Popular and non-invasive diagnostic method used in the process of identification of salivary stones is ultrasonography (USG) but ultrasonography also has limitations. Research conducted by Jäger and associates, compared the diagnostic usefulness of sialography using magnetic resonance imaging, computer sialography and USG showed that the sensitivity and specificity of ultrasonography is approximately on the 80% level [4]. It should also be noted that an important factor in determining the effectiveness of ultrasound examination is the human factor, which is why it would be preferable if the USG was carried out directly by the surgeon who will be performing the surgery of sialolith removal. Application of endoscopic techniques in the diagnosis of obstructive diseases of the salivary glands seems to be very promising. The use of an endoscope with a small outer diameter (0.9-1.3 mm) allows for an accurate assessment of salivary ducts [7]. Nahlieli and colleagues in their study described the results of 450 salivary endoscopies, 98% of which resulted in obtaining the correct diagnosis [10]. It is worth noting, that endoscopic examination is slightly invasive, does not expose the patient to the radiation and allows obtaining a direct image of salivary duct. Technique is painless for the patient due to the use of local anesthetics. Endoscopic examination brings only a few limitations. Difficulties in using the endoscope may occur in the case of very twisted and narrow ducts, because in these cases there are problems with maneuvering the tip of the endoscope and the risk of damage to the salivary duct occurs. Operator skills are also significant during the procedure. It should be noted that, endoscopy combines diagnostic and treatment options.

INTERVENTIONAL SIALOENDOSCOPY

The sialolithiasis recently used to be the most common cause of submandibular gland resection [7]. In the early nineties of the twentieth century, endoscope was used for the first time used in the diagnosis and treatment of lesions of the salivary gland. Possibility of removal of salivary stones using endoscopic techniques has opened a new chapter in the treatment sialolithiasis. According to some publications success rate of endoscopy treatment reaches the level of 97% [7]. It should be emphasized, that interventional endoscopic technique also allows the removal of hypertrophic changes, salivary plugs or extension, salivary stenoses. Currently used sialoendoscopes have small diameter (about 0.9 to 1.8 millimeters) adjusted to fit the ducts of the salivary glands [6,7]. The introduction of the endoscope into the narrow papilla of the duct requires a dilatation. If necessary, the diameter of the salivary duct can be extended by using probes of increasing diameter. Depending on the flexibility we have: semi-rigid or rigid sialoendoscopes and fiberscopes [6]. Endoscopes are equipped with rinsing and "working" canal for the introduction of surgical instruments. Rinsing canal allows to inject anesthetic (2% lignocaine usually) and saline directly into the salivary duct. This allows for local anesthesia, minor widening of canal diameter, obtaining good visibility and washing fragments of salivary stones. Modern sialoendoscopes through the use of fiber optics allow obtaining high-resolution image (at least 6000 pixels). This enables accurate and precise movement within the duct [7]. Working canal allows for operating with instruments for crushing (lithotripsy) or total removal of the salivary stones. Surgeon can use baskets, tongs, tweezers and chisels. Ultrasound devices and lasers are in common use.

In 1989 Iro and associates described the Extracorporeal Shock Wave Lithotripsy (ESWL) [3]. This technique uses a high energy shock wave, which creates significant stress within the sialolith. This stress leads to crushing calculus into smaller fragments. Lithotryptors using ESWL can be divided to piezoelectric and electromagnetic. In case of sialolithiasis of Stenon duct, success rate of electromagnetic lithotryptors reaches the level of 34-69%. In case of sialoliths located in Wharton duct the success rate ranges from 32 to 42 % [1]. Piezoelectric lithotryptors allow for complete removal of deposits in more than half of the cases (50-58%). An extension of this method is Intracorporeal shock wave lithotripsy (ISWL). The energy needed to crush the stone is supplied by a laser beam or electro-hydraulic probe. The use of electro-hydraulic probe in the treatment of sialolithiasis has been abandoned. Despite of the good results (68.97% of procedures completed with total crushing of sialoliths) and quick fragmentation of deposits, the method was considered too risky because of the large forces generated during the procedure. Generated forces brought with them a high risk of the damage of salivary duct walls. For similar reasons, the use of pneumatic lithotryptors was abandoned. Use of pneumatic lithotryptors in treatment of urinary stones was characterized by high efficiency, however, the use of pneumatic devices in the treatment of sialolithiasis was associated with a very high risk of the duct wall perforation, because of the thickness of the wall [1].

Modern lithotryptors use laser technology. The essence of lasers is generation of short pulses with high power, which causes the release of electrons from the atomic nuclei. Free electrons collide with molecules, which leads to successive excitation. High power wave with oscillation frequency of 5 to 10 Hz rises inside the calculus. Vibrations lead to disturbances of internal structure and in result to crushing of sialolith [5]. Different active materials can be used in lasers, this is why particular lasers differ in their properties. Holmium laser (Ho: YAG) have been successfully used in lithotripsy of urinary stones. The length of the emitted radiation wave is about 2100 nm. An important advantage of Ho: YAG laser is a low degree of penetration of the laser radiation, which is about 10 times smaller than in the case of argon lasers. Use of argon lasers treatment of sialolithiasis should be cautious due to the heat generated during the procedure, which may cause damage to the surrounding tissues in the case of narrow salivary ducts [7]. Another active material used in lasers is a crystal of yttrium-aluminum garnet with neodymium (Nd: YAG). Nd: YAG laser radiation has a wave length of 1064 nm. Marchal and Dulguerov recommend use of dye lasers with different wave lengths. The active substance is dye specific for a particular laser. The advantage of dye lasers is the lack of absorption of energy emitted by the surrounding tissues [5,7]. The current optical devices allow distinguishing the patient's tissues from substances forming sialolith. Any contact of the fiber end with the tissues of duct automatically reduces power of laser radiation. Thanks to this a laser lithotripsy procedure is largely atraumatic. 5-year results presented by Janas showed that all of 12 performed laser high-energy Nd-YAG lithotripsies were successful [5]. Raif and associates described the effects of use of Er: YAG laser in endoscopic lithotripsy. 15 of 18 procedures were successful and resulted with full restoration of the salivary gland function [11].

LIMITATIONS OF SIALOENDOSCOPY

Endoscopic methods, in spite of the numerous advantages, have some limitations. Hasson in his study indicated that conducting endoscopy is contraindicated in acute inflammation of the salivary glands [2]. Endoscopy should be postponed until the acute symptoms of the inflammation descent. Other contraindications result from the technical limitations of the procedure. The localization of calculus in salivary gland parenchyma or secondary ducts is also a contraindication for sialoendoscopy [6]. It is also impossible to carry out endoscopic surgery, where it is not possible to the dilatate the diameter of the duct in order to allow for the insertion of the speculum. In these cases, it is necessary to use radiological diagnostic methods and perform a classical operation of sialolith removal.

COMPLICATIONS

Endoscopic procedures, despite of minimal invasiveness, require great skill of the operator performing the surgery. The most common complication of endoscopic surgery is a temporary swelling of the salivary gland. This complication, according to data cited by Capaccio and associates, occurs in 80-100% of cases. Swelling is the result of continuous rinsing of the duct with saline. The surgeon performing the surgery should be careful not to cause iatrogenic damage to the duct wall. Such injuries occur in 1-8% of cases [1]. The possibility of such complication is especially important in patients undergoing anticoagulation treatment. Procedures carried out in those patients should be performed by highly experienced operators, due to the possibility of tissue injury and excessive bleeding which can be difficult to control [6]. In 2-4% of cases postoperative duct stenosis occurs [1]. The infrequent complications include paresthesias or infections. Another important complication is pushing of the calculus further into the duct or even into the salivary gland parenchyma. It is vital to remove all the fragments of crushed sialolith. Remaining fragment can become the core, of another calculus which may result in recurrent sialolithiasis. An important aspect is the experience of the operator. Surgeon should choose treatment method in an appropriate manner to the existing clinical situation, bearing in mind that the aim of the treatment is to restore secretion of gland with a minimal tissue trauma.

SUMMARY

Sialolithiasis is the most common non-neoplasm cause of obstructive salivary disorders. The development of medical technology has extended the range of diagnostic and therapeutic techniques used in treatment of this disease. Modern therapeutic methods allow to perform highly atraumatic surgical procedures. Moreover, these methods are characterized by a high success rate, up to 90%. According to data provided by Capaccio and associates, the indication to perform complete resection of the salivary gland decreased to 3% [1]. Invasive surgical procedures are often reduced only to performing papillotomy in order to dilatate the narrow ostium of the salivary duct. Endoscopic methods allow to perform accurate diagnosis and effective treatment. The risk of complications is low, especially when the procedure is performed by an experienced surgeon.

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