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Research Progress on Prevention and Treatment Methods for Salivary Gland Leakage

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Abstract

With the increasing incidence of salivary gland tumors, partial parotidectomy has become more common, leading to a rise in the occurrence of parotid fistula post-surgery. Parotid fistula can cause redness and erosion of the surrounding skin, resulting in delayed wound healing, and it is a common postoperative complication that troubles both patients and healthcare providers. Various methods for the prevention and treatment of parotid fistula exist, each with its own advantages and disadvantages, typically requiring different approaches based on the type of fistula. The overall strategies for prevention and treatment can be divided into two categories: pharmacological and non-pharmacological treatments. Pharmacological options include anticholinergics, botulinum toxin injections, and hypertonic saline, while non-pharmacological options include low-dose radiotherapy, bandage compression, and biomembrane therapy. These methods can effectively prevent and treat parotid fistula, thereby reducing the concerns of both patients and healthcare providers.

Keywords

Parotid Fistula, Prevention of Parotid Fistula, Treatment of Parotid Fistula

1. Introduction

Salivary gland leakage refers to the secretion of saliva from the salivary glands that does not flow out through the normal duct system into the cheek area or mouth [1]. It is classified into two types: internal leakage and external leakage. Salivary gland leakage is usually caused by trauma, surgery, or postoperative inflammation

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[2] [3]. The clinical manifestations of these two types of parotid gland leakage differ. Internal leakage presents as swelling and significant saliva retention in the subcutaneous parotid area, without the formation of a fistula. The retained saliva needs to be drained through aspiration. External leakage, on the other hand, manifests as clear saliva secretion flowing from the wound due to fistula formation. In severe cases, it can lead to skin redness, ulceration, or even erosion. Additionally, eating can stimulate excessive saliva secretion, which can hinder wound healing and cause swelling, and in severe cases, even lead to infection and prolonged healing. The causes of parotid gland leakage can generally be divided into two categories: trauma and iatrogenic factors. In the early stages, trauma was the primary cause of parotid gland leakage, but with the continuous advancement of modern surgical techniques, iatrogenic factors have gradually become the main cause [4]. The incidence of parotid gland leakage is highest after parotidectomy, reaching up to 39%. However, both of these causes result in damage to the parotid gland. The primary cause of parotid gland leakage following parotidectomy is the severing of the parotid duct system during surgery. Saliva secreted by the remaining gland tissue can leak from the ruptured ducts, and when the accumulated saliva reaches a certain level, it leads to the formation of a parotid gland leak [5]. In addition to this, other possible causes of parotid gland leakage include parotid stones, infections, dry mouth syndrome, neurological issues, tumors, and congenital problems. Currently, there is no standardized protocol for the effective prevention and treatment of parotid gland leakage. However, the overall prevention and treatment approach can be divided into two main principles: inhibiting saliva secretion and preventing saliva leakage. The primary methods of prevention and treatment are categorized into pharmaceutical and non-pharmaceutical treatments. This review will summarize the research progress on both approaches, providing a theoretical basis for parotid gland leak prevention and treatment strategies.

2. Pharmacological Treatment

Currently known pharmacological treatments for the prevention and treatment of parotid gland leakage mainly include oral anticholinergic drugs, botulinum toxin injections, and hypertonic saline.

2.1. Oral Anticholinergic Drugs

Anticholinergic drugs primarily work by blocking the action of acetylcholine at its receptors, thereby reducing its effects and regulating the signaling between the nervous system and the glands. In the treatment of parotid gland leakage, anticholinergic drugs can reduce saliva secretion, helping to control the excessive production of oral secretions. This effect is achieved by interfering with the binding of acetylcholine to its receptors, thus diminishing the stimulation of neurotransmission and lowering the secretory activity of the parotid gland. Currently, the commonly used anticholinergic drug for preventing parotid gland leakage after parotidectomy is atropine. Yang Honghua *et al.* [3]. randomly divided 54 patients

undergoing parotid surgery into a study group (28 cases with postoperative pressure bandaging and oral atropine) and a control group (26 cases with postoperative pressure bandaging). They observed the occurrence of parotid gland leakage in both groups after 7 days. The probability of parotid gland leakage in the study group was 10.7%, significantly lower than the 23.1% in the control group, indicating a statistically significant difference, with symptoms of parotid gland leakage being notably milder in the study group. Atropine works by competitively blocking acetylcholine receptors, reducing the binding of acetylcholine to its receptors, and slowing down the transmission of nerve impulses. This action leads to a reduction in parotid gland secretion, alleviating symptoms of parotid gland leakage, such as excessive oral secretions. It is important to emphasize that this method has drawbacks, as it may cause a range of side effects, including dry mouth, blurred vision, and increased heart rate. Additionally, anticholinergic drugs have contraindications, such as glaucoma, prostate enlargement, heart disease, and myasthenia gravis. Since parotid tumors frequently occur in elderly patients, the use of anticholinergic medications in this population may increase the risk of acute cardiovascular events [6]. In addition, anticholinergic medications have contraindications, such as glaucoma, prostate hypertrophy, heart disease, and myasthenia gravis [7]. Therefore, a thorough medical history must be taken before use. If anticholinergic medications are prescribed for elderly patients, a careful assessment and monitoring of the medication should be conducted.

2.2. Botulinum Toxin Injection

Botulinum toxin, also known as botulinum neurotoxin, is a neurotoxic protein produced by the bacterium Clostridium botulinum during its growth. It works by affecting the release of acetylcholine, leading to paralysis of the muscles in the parotid gland area, which in turn reduces saliva secretion. Ren Kangxiong [8] analyzed two cases of parotid gland leakage due to different causes and found that treatment with type A botulinum toxin effectively controlled the leakage, with no recurrence observed during long-term follow-up. Saliva contains self-digestive components, and by inhibiting saliva secretion, botulinum toxin can prevent saliva from causing tissue damage, thereby promoting faster wound healing [9]. The drawbacks of this method include the high cost of botulinum toxin and the need for repeated injections, which can increase the financial burden on patients. The prices of different types of botulinum toxin available on the market vary, but because repeated injections are required, the cost often exceeds tens of thousands of yuan. However, in addition to the high economic cost, there are also certain risks involved. Injecting botulinum toxin in the parotid area carries the risk of facial nerve damage, potentially leading to facial nerve paralysis. This treatment is usually performed under medical supervision, requiring precise dosage calculations to ensure efficacy while minimizing side effects [10]. The effects of botulinum toxin treatment for parotid gland leakage are temporary, often requiring regular injections to maintain efficacy. Treatment outcomes can vary among individuals,

so patients should receive personalized treatment plans under the guidance of a physician.

2.3. Hypertonic Saline

Hypertonic saline stimulates parotid gland secretion by using a hyperosmotic saline solution, thereby promoting the expulsion of excessive secretions from the gland. This treatment method is known as parotid massage or flushing therapy. The osmotic effect of hypertonic saline can stimulate parotid gland cells to secrete more fluid, helping to clear accumulated secretions within the gland and promoting its drainage. This approach aids in alleviating parotid gland blockage, improving saliva flow, and relieving the symptoms of parotid gland leakage [11].

3. Non-Pharmacological Treatments

Non-pharmacological treatments for parotid gland leakage include low-dose radiotherapy, compressive bandaging of the surgical area, biological membrane therapy, and iodoform gauze packing.

3.1. Low-Dose Radiotherapy

Radiotherapy was once an important method for the early treatment of parotid gland leakage, with the earliest reports dating back to 1935 [12]. Radiotherapy for parotid gland leakage takes advantage of the high sensitivity of parotid tissue to radiation. When parotid cells are irradiated, they undergo apoptosis and atrophy, leading to a loss of secretory function. Additionally, the radiation causes capillary dilation and increased permeability in the irradiated area, resulting in edema and fibrosis in the surrounding tissues. This swelling around the fistula leads to a gradual narrowing of the fistula, ultimately causing its closure and reducing the occurrence of parotid gland leakage [13]-[16]. Although parotid acinar cells are sensitive to radiation, excessive doses of radiotherapy can cause irreversible damage to the gland's blood vessels and acinar cells, with a potential risk of inducing tissue carcinogenesis. Therefore, radiotherapy is not recommended as a routine treatment for parotid gland leakage.

3.2. Surgical Pressure Bandaging

The purpose of surgical pressure bandaging is to mechanically compress the parotid surgical area to prevent saliva leakage, thereby avoiding the occurrence of parotid leakage. This method can also eliminate dead space, ensuring tight adherence of the surgical site and promoting wound healing.

Although pressure bandaging has shown good clinical efficacy in the prevention and treatment of parotid leakage, it has significant drawbacks: patients may experience strong discomfort at the site of the bandaging, which can lead to noticeable pain and even a feeling of suffocation; prolonged bandaging may cause skin edema and gland atrophy in the surgical area; bandages in the jaw and facial region are prone to slipping; and aesthetic considerations may be lacking. To

maintain balanced pressure in bandaging, modern practices often utilize elastic bandages or elastic head wraps [17]. These options are simple to use and have successfully reduced the rates of loosening and the incidence of parotid leakage.

3.3. Biofilm Therapy

Biofilms are specialized bacterial communities formed by microbial cells and their extracellular macromolecular polymers, representing a highly organized multicellular structure. Most bacteria in nature, as well as inside and outside the human body, do not exist as free-floating individual organisms; instead, they grow as biofilms attached to the surfaces of living or non-living objects. Biofilms can help treat parotid leakage by reducing the flow rate of parotid secretions. In the study by Shen Shiyue [18], the treatment group had an effective rate of 87.5%, while the control group had an effective rate of 70.0%. The overall clinical effectiveness of the treatment group was significantly higher than that of the control group ($P < 0.05$). After treatment, there was no statistically significant difference in static saliva flow rate in the control group compared to before surgery ($P > 0.05$), whereas the treatment group showed a significant decrease ($P < 0.05$). Additionally, the stimulated saliva flow rate on the tumor side in the treatment group significantly decreased compared to before surgery ($P < 0.05$), while there was no significant change in the stimulated saliva flow rate on the non-tumor side. This indicates that the application of the biological membrane can improve the treatment rate of parotid gland leakage. However, this technique has not yet been widely promoted in clinical practice and requires further research for application.

3.4. Iodoform Gauze Packing

The principle of using iodoform gauze packing for the treatment of parotid gland leakage involves the stimulation of the parotid duct by iodoform (a compound containing iodine) to promote the contraction and closure of the glandular duct lumen. This method aims to reduce or eliminate saliva leakage by encouraging the affected duct to seal off, thereby preventing further leakage and facilitating healing. The iodoform gauze not only serves as a physical barrier but also exerts a local irritant effect that can aid in the recovery process. However, like other treatment modalities, it requires careful application and monitoring to avoid potential complications [19]. This treatment method aims to reduce the extravasation of glandular secretions, thereby alleviating the symptoms of parotid gland leakage. Iodoform is known for its irritant properties, which can induce local tissue contraction and an inflammatory response. In the treatment of parotid gland leakage, packing iodoform gauze into the parotid duct can trigger ductal contraction, promoting closure and decreasing saliva output. However, the effectiveness and safety of this approach remain controversial, as it may cause discomfort, irritant reactions, and potential infection risks.

4. Outlook

The occurrence of parotid tumors may be related to factors such as genetics, gene

mutations, and viral infections, with the main triggers including long-term smoking, infections, chemical exposure, and environmental factors. Therefore, individuals who smoke for long periods or have weakened immune systems are more prone to this condition. As the incidence of parotid tumors increases, the methods for preventing and treating parotid fistula have also become more diverse. Here, we propose a surgical approach aimed at blocking the nerves that control saliva secretion, fundamentally addressing the root cause of parotid gland leakage by inhibiting saliva production. This method necessitates a thorough understanding of the anatomical structure of the parotid gland, the pathways of the nerves that regulate saliva secretion, and the precise localization of these nerves on the body surface to facilitate surgical intervention while minimizing adverse reactions. Additionally, it is essential to consider whether the complications resulting from nerve block are within an acceptable range. In summary, the prevention and treatment strategies for parotid gland leakage will continue to expand, and the distress experienced by both patients and healthcare providers regarding this condition will gradually diminish.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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