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Innovation in Cancer Care: Application of Lymphatic Mapping in Salivary Gland Tumors

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Abstract: **Subject**: Application of lymphatic mapping in salivary gland tumors. **Method**: The method of lymph node localization for salivary gland tumors is to inject a radioactive isotope-containing colloid protein (Tc99m suffer colloid) around the primary tumor. The patient undergoes a nuclear medicine lymphoscintigraphy examination within 15 minutes to 2 hours after the injection, tracking the Tc99m to show the direction of the lymph nodes. The patient can go to the operating room 2-4 hours after the injection. The surgeon refers to the lymphoscintigraphy and uses a radioactive isotope detector to detect the location of the sentinel lymph nodes that accumulate Tc-99m. The sentinel lymph nodes are found through a 2-3 cm incision at the marked area and sent for pathological examination. **Result**: If the result is negative and there is no cancer cell infection, there is no need for extensive lymph node dissection. This can avoid many side effects caused by lymph node dissection! **Discussion**: Nurses can ensure the impact of accurate care on patient outcomes by establishing clear metrics and outcome measures related to the lymphatic mapping being implemented. Nurses can evaluate the effects of implementing innovations in several ways. This can include tracking patient questionnaires, medication errors, readmission rates, and other relevant metrics to assess the impact of innovative practices on patient outcomes. The practical applications of nursing innovation are broad and varied. Nurses can develop innovative models of care to improve patient satisfaction and outcomes, such as implementing telehealth programs or developing personalized care plans. **Conclusion**: In research, nurses can innovate by exploring new approaches, technologies, or interventions to address complex health problems.

Keywords: Cancer Care; Nursing Innovation; Salivary Gland Tumors; Lymphatic Mapping.

1. Main

Salivary gland lymph mapping is a procedure that involves injecting a radioactive fluid under the skin near the site of a salivary gland tumor. The radioactive fluid travels through the lymph fluid, creating a "map" of the lymphatic system.

Lymph nodes are small, bean-shaped glands that are located along the lymph vessels. Lymph nodes filter lymph fluid and remove bacteria, viruses, cancer cells, and other waste products.

Figure 1. Lymph node mapping

A sentinel lymph node is the first lymph node that cancer cells usually spread to. This means that the sentinel lymph node is the first lymph node to receive drainage from the tumor. Sometimes, there may be more than one sentinel lymph node that receives drainage from the tumor. Sentinel lymph nodes are also called guard lymph nodes.

Lymph vessels are tiny tubes that are like blood vessels and carry fluid to and from lymph nodes to other parts of the body [5]. Lymph is a clear fluid that flows through the lymphatic system. It carries cells that help fight infection and other diseases.

This map shows where the sentinel lymph nodes are. It does not show if salivary gland cancer has spread to the sentinel lymph nodes. During the mapping procedure, you will lie on a reclining chair for about 20 minutes. Your healthcare provider will inject you with a radioactive liquid called Tc-99m.

They will inject a small amount of radioactive liquid under the skin near the site of the salivary gland tumor. This may be around the gland, in the armpit, or somewhere else. You may feel a stinging or burning sensation during the injection.

Figure 2. Injection area

After the injection, the patient will massage the salivary gland area for 10 minutes. This helps the radioactive fluid travel through the lymph fluid to the sentinel lymph nodes. The doctor will then measure the radioactivity of the radioactive fluid that was injected into the body. This will show which lymph nodes have absorbed the radioactive fluid and how much fluid they have absorbed. The lymph node that has absorbed the most radioactive fluid is the sentinel lymph node.

The doctor uses a small handheld device called a Neoprobe®.

The other way is to do a nuclear medicine scan. This is an imaging scan that may require you to lie on a larger machine.

Both methods are effective in measuring radioactivity.

Nuclear Medicine Scan: If you are having a nuclear medicine scan after your injection, the technologist will take you to the scanning room. Once you are lying on the scanning table, the technologist will take the images.

Each image takes about 2 minutes to be taken, during which the patient must lie still. Patients may find it difficult to lie still in one position for 2 minutes. If the patient is uncomfortable, the technician will schedule a countdown. The scan takes about 10 minutes. The images will show how the radioactive fluid moves. They will also show which lymph nodes have taken up the fluid. This will create a "map" of your lymphatic system. Your doctor will use this map to find your sentinel lymph nodes [7].

Ethical issues need to be considered when implementing nursing innovations. Nurses must ensure that the autonomy, privacy, and confidentiality of patients with salivary gland tumors are respected throughout the innovation process. Informed consent should be obtained from patients when necessary, and patients with salivary gland tumors should be fully informed of the potential risks, benefits, and alternatives associated with innovative practices. Nurses should also consider the equitable allocation of resources and the potential impact on vulnerable groups when implementing innovative practices [9].

2. Result

Effect of surgical margins on recurrence of salivary gland cancer: For major salivary glands, the 5-year LRFS is: negative margin is 94.1%, close margin is 89.6%, and positive margin is 74.8%. A negative margin is very important for prognosis.

High-grade tumors and T3/T4 tumors are high-risk factors for lymph node metastasis: Selective neck lymph node dissection is recommended for patients with salivary gland tumors with high-grade or T3/T4 tumors; selective neck lymph node dissection should be performed to zone II or zone III, and submandibular gland, sublingual gland, and small salivary gland tumors can be cleared to zone I.

Survival outcomes: 5-year OS was 85% [0.81-0.89], 10-year OS was 67% [0.60-0.77];

Age, BMI, and N stage are the three main clinical prognostic factors for EFS of salivary gland tumors;

Lymph node dissection has a survival benefit for T3/T4 salivary gland tumors;

Compared with head and neck squamous cell carcinoma, salivary gland tumors have a low incidence rate, complex pathological types, and relatively good prognosis;

The treatment of patients with early salivary gland tumors is mainly surgery, and the treatment of patients with local advanced salivary gland tumors is mainly surgery + radiotherapy;

The surgical principle is to achieve a radical cure of the tumor. Salivary gland cancer needs to consider the preservation of the facial nerve. Neck lymph node dissection is recommended for local advanced and high-grade cN0 patients;

The treatment of recurrent/metastatic salivary gland cancer is first-line comprehensive treatment with salvage surgery as the main treatment, followed by salvage radiotherapy and palliative systemic treatment [10].

The circulatory system is the major route of spread to distant organs, while lymphatic vessels provide access to regional lymph nodes, after which metastasis generally proceeds via the blood. Although the circulatory system appears to be the most common route, spread via lymphatic or bloodstream depends on the origin and location of the primary tumor. Lymphatic mapping identifies locations where cancer cells may have spread.

Lymph node mapping reveals invisible cancer cells that cannot be found by physical examination or imaging tests. A sentinel lymph node biopsy removes the lymph nodes most likely to have metastasized so they can be tested in a laboratory. Imaging may also be used in people with salivary gland cancer after a sentinel lymph node biopsy to look for any spread of the disease.

Lymph node mapping helps doctors predict a patient's chance of recovery, also known as prognosis. If the sentinel lymph nodes are removed, the five-year survival rate for patients with salivary gland tumors is about 80%. If the nodes are involved, the rate drops to about 50%.

Metastatic lymph nodes originate from the lips, oral mucosa, anterior nasal cavity, and facial soft tissues. It is important to distinguish between IA and IB because the lymph nodes in zone 1A are associated with metastases from the floor of the mouth, ventral side of the lower lip and tongue, and anterior nasal cavity. Lymph node mapping guides doctors to determine the best treatment plan [11].

The facial lymph node group is a general term for lymph nodes from the mandible, buccinator, infraorbital, retro-arch, and cheek. These lymph nodes are extremely difficult to identify and are more common in metastases from nasopharyngeal and epidermal malignancies. Lymph node mapping can prevent local recurrence by removing or destroying cancerous nodes[12].

3. Discussion

Salivary gland cancer is a rare head and neck malignancy, accounting for about 3% to 5% of all head and neck cancers. Salivary gland cancer mainly occurs in the three major salivary glands: parotid gland, submandibular gland, and sublingual gland. In addition, the nasal cavity, oral cavity, and pharyngeal mucosa also contain salivary gland cells, and tumors derived from these cells are called minor salivary gland tumors. The treatment of salivary gland cancer requires a combination of multiple treatments, including surgery, radiotherapy, and chemotherapy to increase disease control. General radiotherapy uses photon beam therapy. With the advancement of radiotherapy technology, it is combined with three-dimensional conformal radiotherapy, intensity-modulated radiotherapy, sharp knife arc radiotherapy, and image-guided positioning. The radiation therapy dose can be more accurately given in the treatment area, and the dose to normal tissues can be reduced. The side effects related to treatment are also significantly reduced.

Due to the superiority of protons in the dose distribution of Bragg peaks, combined with passive scattering or intensity-modulated therapy technology, proton therapy can provide considerable benefits for the treatment of salivary gland cancer. Proton therapy can provide extremely precise radiation doses to the complex organ structures of the head and neck, and reduce low-dose scattering to adjacent normal tissues to reduce treatment-related side effects. In addition, the application of pencil beam scanning technology and multi-angle dose optimization can adjust the dose gradient, which can locally increase the single dose of the tumor, hoping to increase the chance of tumor control.

Cancer cells spread through lymphatic metastasis and along certain lymphatic pathways. The so-called sentinel lymph node is the first lymph node invaded by cancer cells. The location and detection of this sentinel lymph node can determine the scope of cancer cell metastasis. Once the sentinel lymph node is removed and pathological tissue section is performed, if cancer is found, the lymph node needs to be removed. If not, the tumor can be removed locally. In this way, the surgical incision can be reduced to less than three centimeters. With this sentinel lymph node location technology, pathologists can focus more carefully on examining the frozen sections of the sentinel lymph nodes. Compared with the previous blanket inspection of 14 to 20 lymph nodes, pathologists now only need to focus on inspecting 1 to 2 lymph nodes with the most clinical significance. Doctors inspect the one or two lymph nodes that are most likely to be metastatic and perform some more clinically significant but expensive detailed inspections to determine whether there is micro-metastasis, to provide patients with more detailed prognostic indicators.

Clinical methods for locating sentinel lymph nodes:

(1) Local injection of vital blue dye: Before surgery, patients with salivary gland tumors are injected with dyes such as Lymphazurin or Methylene blue at the edge of the tumor, and the location of the sentinel lymph nodes is found and removed by naked eyes.

(2) Direct use of gamma probe: Before surgery, patients with salivary gland tumors are injected with radioactive drugs at the edge of the tumor, and then the surgeon uses a gamma probe to remove the sentinel lymph nodes.

(3) Nuclear medicine scintigraphy: Patients with salivary gland tumors are sent to the nuclear medicine department for sentinel lymph node localization 16 to 24 hours before surgery, and nuclear medicine physicians inject nuclear medicine drugs such as 99mTc-Nanocolloid or 99mTc-Sulfur colloid at the edge of the tumor..

After being injected into the human body, this radioactive drug will enter the lymphatic capillaries in the interstitial tissues and then be actively phagocytosed and absorbed by the macrophages in the first group of lymph nodes in the lymphatic pathway where tumor metastasis is most likely to occur. When the image shows the location of this first lymph node, nuclear medicine personnel will mark the skin of the salivary gland tumor patient at that location. The surgeon uses a gamma probe to remove the sentinel lymph node through the reference position. The sentinel lymph node removed by any of the above positioning methods will be pathologically sliced to determine whether lymphatic metastasis has occurred.

The accuracy of sentinel lymph node localization is a key factor in whether patients with salivary gland tumors can benefit from surgical treatment, including the precise location of the lymph node, the surgeon's clean removal technique, and a quick and accurate pathological test report. These three are indispensable and closely linked. For patients with salivary gland tumors, the scope of surgery can be narrowed by confirming that there is no lymph node metastasis, greatly reducing the probability of complications and minimizing the medical and rehabilitation expenses required after surgery.

Nurses can ensure that innovative practices are evidence-based and safe for patients with salivary gland tumors by conducting thorough research and rigorously evaluating the available evidence. Nurses should consult reputable sources, such as clinical practice guidelines and peer-reviewed journals, to ensure the effectiveness and safety of innovative approaches. Nurses need to collaborate with interdisciplinary teams, seek expert opinions, and conduct pilot studies to further validate the safety and effectiveness of innovative practices.

Nursing innovation can positively impact the nursing profession by mastering a variety of skills. Nurses can introduce new practices, technologies, and strategies to improve salivary gland tumor patient safety, improve healthcare services, and optimize resource allocation. In addition, nurses with strong innovation skills are more adaptable to changes in the healthcare system and can contribute to the development of the profession as a whole.

4. Methods

4.1. Image Acquisition

Immediately after the tracer is injected, planar continuous dynamic imaging is performed. The scanning field includes the injection site and the drainage lymph node area. When a dot-like concentrated focus is observed in the lymphatic drainage area, the planar imaging acquisition is stopped. Immediately thereafter, a SPECT/CT scan (Philips Presedece 16) of the concentrated focus and the lymphatic drainage area is performed. The scanning field should include as many lymph node drainage areas as possible, without covering the tumor injection site.

The CT scanning parameters were tube voltage 120 kV, tube current 50 mAs, FOV 350 mm, SPECT scanning parameter matrix 128×128, zoom 1.0, dual probe acquisition of 32 frames, 6 degrees/frame, 40 s per frame, and a total acquisition of 640 s. After acquisition, conventional reconstruction and fusion were performed on the post-processing workstation.

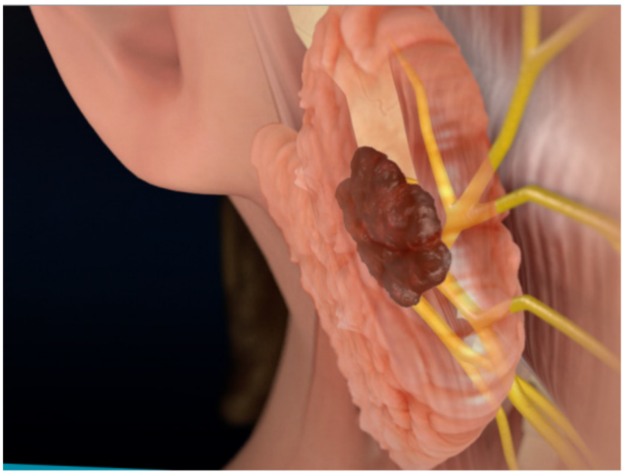

Figure 3. CT result

CT — Almost all patients with salivary gland tumors undergo CT during their evaluation. CT can identify head and neck tumors based on specific anatomic changes or tumor enhancement. In general, tumors enhance more than normal structures of the head and neck, except the mucosa, extraocular muscles, and blood vessels.[1]

A slice thickness of 3 mm is generally optimal, and >5 mm has insufficient spatial resolution. Soft tissue windows and bone windows need to be reconstructed and evaluated separately. CT techniques that reduce metal artifacts are now being incorporated into routine clinical practice.[2]

Primary site: Enhanced CT can help determine the extent of tumor invasion of the deep tongue muscles and whether the mandible is involved. The "cheek puffing" maneuver can improve the assessment of oral lesions by asking patients with salivary gland tumors to puff their cheeks by holding air in their mouths [3].

CT is particularly suitable for detecting local deep invasion or invasion of adjacent structures that are difficult to detect on physical examination. A retrospective study of 81 patients with salivary gland tumors in the head and neck showed that CT examination changed the clinical stage in 54% of cases [4]. Among them, the highest rate of stage changes was in hypopharyngeal tumors (90%), while the lowest rate of stage changes was in glottic laryngeal cancer (16%).

Regional lymph nodes: Imaging examinations can be used as a supplement to clinical examinations for lymph node staging. CT evaluation of regional lymph nodes is mainly based on size and appearance to distinguish whether they are involved. CT can also very sensitively identify extracapsular invasion of lymph nodes, but it cannot identify extracapsular invasion confined to the imaging margins of the lymph nodes, non-necrotic lymph nodes of critical size, and microscopic lymph node metastasis.[1]

The imaging criteria for pathological lymphadenopathy are usually a lymph node shortest axis diameter >10-11 mm or central necrosis[8-15].

Metastatic sites: Chest CT has been shown to detect metastases in 4% to 19% of newly diagnosed patients with salivary gland tumors in head and neck cancer.[6,28-33] Although chest CT has a higher detection rate for distant metastases than chest radiography, it cannot detect distant metastases outside the thoracic cavity (2% to 5% of patients with salivary gland tumors).[8,14]

4.2. Target Area and Normal Tissue Delineation:

1) GTV: the extent of lymphoma invasion shown by endoscopy, imaging and gross examination;

2) GTV-LN: the affected lymph nodes shown by imaging (pathological puncture should be performed when suspicious);

3) CTV-nasal cavity primary: including the entire GTV (before any treatment), 1-2 cm outside the mucosal surface tumor, bilateral nasal cavity, ipsilateral maxillary sinus, anterior ethmoid sinus, hard palate, bilateral posterior nares, nasopharynx (when the posterior nares are involved), posterior ethmoid sinus (when the anterior group is involved);

4) CTV-Waldelian ring primary: including the entire GTV, 1-2 cm outside the mucosal surface tumor, the entire Wedgren ring (nasopharynx, oropharynx), posterior nares;

5) CTV-LN: bilateral upper neck or bilateral entire neck (when the upper neck is involved);

6) IE lesions confined to the nasal cavity do not require irradiation of lymph nodes;

7) Normal organs: spinal cord, brain stem (brain stem), parotid gland, larynx, optic nerve, optic chiasma, brachial plexus, eyeball, lens, mandible, thyroid, pituitary, temporal lobe.

4.3. Positioning Details

Preparation before positioning: oral treatment; patients with long salivary gland tumors should cut their hair short; make a mouthpiece (when irradiating the nasal cavity), with the tip of the tongue behind the teeth to prevent the root of the tongue from falling back; add a compensation film to the skin surface when the skin is invaded;

Positioning device: head and neck shoulder frame, head and neck shoulder mask, foam glue can be used to make an individualized headrest, which can be fixed with the head and neck shoulder mask;

Body position: supine position, hands placed on both sides of the body, head first;

Selection of positioning center point: depending on the center of the tumor, nasal cavity/nasopharynx;

CT/PET-CT scanning parameters: enhanced, layer thickness 3 mm; PET/CT fusion: layer thickness 3.75 mm; MRI positioning can be considered to improve soft tissue resolution;

In the simulation positioning stage, the main thing is to choose the appropriate body position and fixation device. Usually, the head neck, and upper mediastinum are fixed with a whole body frame and a head, neck, and shoulder combined mask. The chest, abdomen, and pelvis are mostly fixed with body membranes. Intravenous contrast agents should be used for CT positioning.

For areas that are greatly affected by respiratory movement, such as the mediastinum and stomach, it is recommended to use respiratory management such as deep inspiration breath-holding technology or 4D-CT scanning to reduce organ movement and thus reduce the planned target area boundary or fully consider the respiratory range to prevent omission during target area irradiation;

Evaluate treatment options: For areas with dense surrounding normal organs and low tolerance to organs at risk, IMRT/VMAT treatment can better reduce the radiation dose to organs at risk. Doctors need to fully consider the long-term adverse reactions and second primary tumors of organs, especially young female patients with salivary gland tumors, and try to reduce the radiation dose and volume of the breast and heart[13].

4.4. Injection Adjustment Plan:

An isosulfan blue injection for lymphatic tracing, characterized in that the prescription composition of each 1000ml of isosulfan blue injection is:

Isosulfan blue 5-20g

pH adjuster 0.2%~1.0%

Osmotic pressure adjuster 0.25%~15.0%

Injection water is added to 1000ml.

Isosulfan blue injection for lymphatic tracing, characterized in that: the pH regulator is one or more of disodium hydrogen phosphate, sodium dihydrogen phosphate, dipotassium hydrogen phosphate, and potassium dihydrogen phosphate, wherein one or more of disodium hydrogen phosphate and potassium dihydrogen phosphate are preferred, and the dosage of disodium hydrogen phosphate is 0.2% to 1.0% (g/mL), preferably 0.5% to 0.8% (g/mL);

The dosage of potassium dihydrogen phosphate is 0.2% to

0.6% (g/mL), preferably 0.2% to 0.4% (g/mL), and the mixing ratio is disodium hydrogen phosphate: potassium dihydrogen phosphate = 1:1 to 5:1, preferably 1:1 to 3:1, and optimally 2.44:1.

The osmotic pressure regulator is one or more of sodium chloride, glucose, PEG, and mannitol, among which one or more of sodium chloride and glucose are preferred. The dosage is sodium chloride 0.25% to 4.0% (g/mL), preferably 1.2% to 2.8% (g/mL), and optimally 2.0% (g/mL); glucose 1% to 15% (g/mL), preferably 5% to 12% (g/mL), and optimally 10% (g/mL).

Preparation steps of isosulfan blue injection for lymphatic tracing:

1) Concentrated preparation: weigh the prescribed amount of pH regulator and osmotic pressure regulator, add 80% of the prescribed amount of water for injection, stir for about 15-20 minutes to dissolve, then add the prescribed amount of drug, stir for about 15-20 minutes to dissolve, add 0.1% to 0.5% needle-use activated carbon, stir and adsorb at 40℃ to 60℃ (preferably 50℃) for 10 to 30 minutes (preferably 20 minutes);

2) Diluted preparation: the concentrated preparation liquid is filtered through a 3 μm carbon rod and transferred to a dilute preparation tank, rinsed, and combined with the rinse liquid; add water for injection until the volume of the drug liquid in the dilute preparation tank reaches the specified amount, stir for about 10-15 minutes, filter through a 0.22 μm microporous filter membrane, and inspect for visible foreign matter;

3) Sterilization: The liquid medicine that has passed the visible foreign matter inspection is filled with nitrogen, sealed, sterilized at 121℃ for 15 minutes, leak tested, and inspected by light.

The application of isosulfan blue injection for lymphatic tracing in the preparation of tracing preparations for depicting and locating lymphatic vessels and lymph nodes.

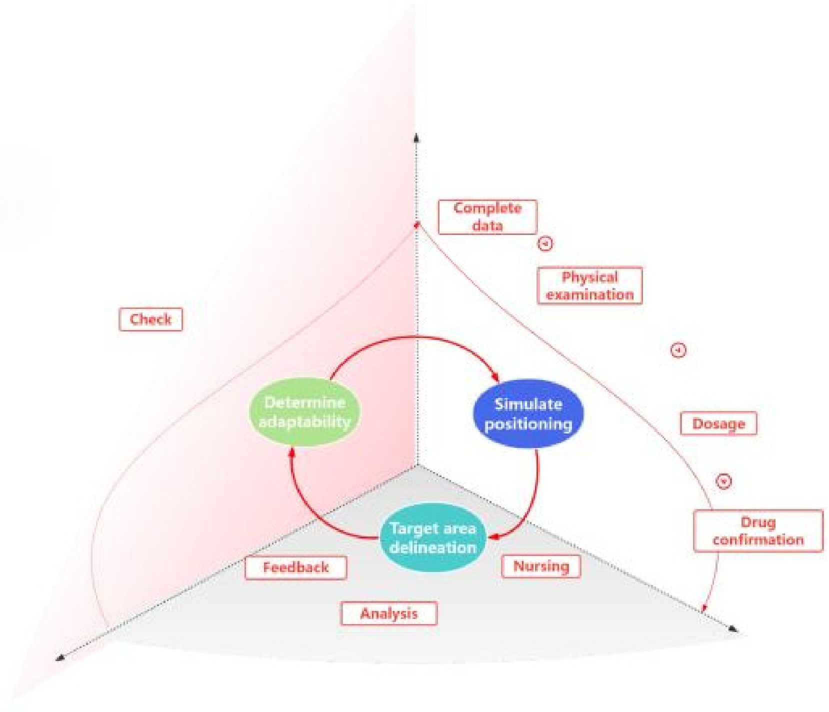

Figure 4. Cancer care innovation schematic

Coordinating care involves making sure all team members are on the same page and that the patient's needs are being met. This includes communicating with other health care providers, as well as supporting and educating the patient and their family [16]. (A nurse navigator or case manager often fills this role.)

Providing supportive care: Cancer treatment can be physically and emotionally taxing for patients. The Innovative Cancer Care team provides supportive care to help patients manage side effects and improve their quality of life. Innovative care may include pain management, counseling, and other supportive services [17].

Monitoring progress: Innovative cancer care requires monitoring a patient's progress throughout treatment [18]. Monitoring includes regular checkups and adjusting treatment plans as needed. Caregivers also communicate with patients and their families to provide updates and answer any questions.

5. Conclusion

In research, nurses can innovate by exploring new approaches, technologies, or interventions to address complex health problems.

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