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Development and Clinical Efficacy Study of a New Type of Elastic Compression Palatal Splint

Junli Zhu, Shuo Zhang, Jing Wang

Yulin Hospital, The First Affiliated Hospital of Xi'an Jiaotong University, Xi'an 719000, Shaanxi, China

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Abstract: *Objective*: To investigate the clinical efficacy of a novel elastic compression palatal splint, independently developed by our team, following the surgical resection of palatal cysts and benign tumors. *Methods*: A total of 90 patients who underwent surgery for benign palatal lesions at the Department of Oral and Maxillofacial Surgery of our hospital between January 2023 and December 2025 were selected as study subjects. Using a random number table, they were divided into three groups, A, B, and C, with 30 patients in each group. Group A underwent postoperative compression fixation using a purse-string suture with iodoform gauze; Group B used a conventional rigid palatal splint for compression fixation; and Group C received postoperative intervention with the newly developed elastic compression palatal splint. Patients were followed up to observe their postoperative recovery, and comparisons were made across the three groups regarding the incidence of dental damage, wound infection rates, wound healing times, and postoperative comfort scores. *Results*: The incidence of dental trauma and wound infection in Group C was significantly lower than in Groups A and B; wound healing time in Group C was markedly shorter than in Groups A and B; and the visual analog scale (VAS) comfort scores for postoperative wear in Group C were significantly better than in the other two groups. The differences in data comparisons between the groups were all statistically significant ($p < 0.05$). *Conclusion*: The novel elastic compression palatal splint enables uniform elastic compression of the postoperative palatal wound, provides visual and adjustable pressure, and facilitates unobstructed drainage of wound exudate. It effectively mitigates the drawbacks of traditional surgical procedures, significantly reduces the incidence of postoperative complications, shortens the wound healing period, and improves the patient's postoperative wearing experience. The structural design of this splint meets the clinical requirements for precision treatment; it is simple to use, highly safe, and widely applicable. It aligns with the trend towards precision medicine in dentistry and possesses significant value for clinical promotion and application.

Keywords: Palatal surgery; Palatal splint; Elastic compression; Pressure regulation; Wound healing; Clinical efficacy

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1. Introduction

Benign space-occupying lesions of the palate are common and frequently occurring conditions in oral and

maxillofacial surgery. In recent years, influenced by multiple factors, including changes in dietary patterns, alterations in oral hygiene practices, and the widespread screening for oral diseases, the clinical detection rate and surgical treatment volume for benign space-occupying lesions of the palate have shown a year-on-year increase. Excision of benign palatal lesions is the core surgical procedure for the radical treatment of this condition. Although the operation can completely remove the lesion and prevent recurrence, it results in an open palatal wound post-operatively [1]. As the palatal wound is directly exposed to the oral environment, it is subject to prolonged contact with contaminants such as saliva, the oral microbiota, and food debris. Furthermore, routine oral activities such as chewing, swallowing, and speaking exert continuous traction on the wound, resulting in a hostile healing environment that is highly prone to complications such as wound bleeding, infection, delayed healing, and mucosal scar hyperplasia. Consequently, effective hemostasis, precise compression, sealed protection, and drainage of exudate from the postoperative wound are key factors in ensuring surgical efficacy, promoting wound healing, and improving patient prognosis [2,3]. Currently, the two main methods of pressure management for postoperative palatal wounds in domestic clinical practice are the purse-string suture fixation of iodoform gauze and the traditional rigid palatal splint fixation; however, long-term clinical application has demonstrated that both methods have significant structural defects and therapeutic limitations. The purse-string suture technique relies on the patient's natural dentition as the sole point of force application; by using circular sutures to pull and secure the dressing, it generates continuous palatal traction during the compression process, which is highly likely to lead to tooth mobility, palatal displacement, periodontal ligament damage, and may even result in irreversible dental damage; Furthermore, as the sutures form a rigid fixation structure, they cannot adapt to the dynamic changes in post-operative tissue oedema and reabsorption. Tension in the sutures gradually diminishes due to traction from routine oral movements, which can lead to issues such as dressing dislodgement and failure of compression. This makes it difficult to maintain stable pressure on the wound site, failing to meet the clinical treatment requirements of modern oral surgery for precise compression, dynamic adaptation, safe minimally invasive procedures, and controlled healing. Consequently, there are numerous problems, including a high incidence of complications, unstable healing outcomes, and poor patient comfort [4]. To overcome the technical bottlenecks of existing methods and address the clinical challenges in the treatment of post-operative palatal wounds, our research team has independently developed a novel elastic compression palatal splint. This device integrates four core functions: elastic adaptive fitting, micro-pressure monitoring, dynamic pressure regulation, and wound-specific drainage. To validate the clinical advantages of this new device, we have designed three groups of clinical controlled trials, systematically comparing the clinical efficacy of the new palatal splint with that of conventional surgical procedures, with the aim of providing novel, safe, and efficient instrumental support and clinical evidence for the standardized and precise treatment of post-operative palatal wounds.

2. Materials and methods

2.1. General data

A total of 90 patients who underwent resection of benign palatal lesions at the Department of Oral and Maxillofacial Surgery of our hospital between January 2023 and December 2025 were selected as study subjects. All patients were diagnosed with benign palatal lesions based on preoperative imaging and postoperative histopathological examinations. Using a random number table, all patients were divided into three groups, A, B, and C, with 30 patients in each group. The study protocol was reviewed and approved

by our hospital's Medical Ethics Committee, and the research process strictly adhered to medical ethical principles. Comparison of baseline data, including age, sex, lesion type, wound area, and duration of surgery, among the three groups revealed no statistically significant differences ($p > 0.05$), indicating that the groups were comparable.

2.1.1. Inclusion criteria

(1) Patients undergoing their first surgical resection of a benign palatal lesion;
(2) The lesion was located on the hard palate or at the junction of the hard and soft palates;
(3) Postoperative compression dressing with iodoform gauze was required;
(4) Patients demonstrated good compliance and were able to complete the full course of follow-up

2.1.2. Exclusion criteria

(1) Patients with concomitant diabetes, immunodeficiency, or long-term corticosteroid use;
(2) Patients with preoperative oral infections;
(3) Patients with extensive penetrating defects of the palate;
(4) Patients with incomplete clinical data

2.2. Methods

All patients underwent surgery performed by the same team of senior oral and maxillofacial surgeons at our hospital. Surgical procedures followed standardized protocols, involving thorough debridement of the lesion and hemostasis during surgery. Postoperatively, all patients received standard interventions including routine antimicrobial therapy, oral hygiene care, and dietary guidance.

Group A received compression fixation using a purse-string suture with iodoform gauze. Postoperatively, sterile iodoform gauze was cut to size according to the wound dimensions and applied smoothly over the palatal wound. Circular purse-string sutures were placed along the natural dentition surrounding the wound; the sutures were passed around the cervical region of the teeth and tightened to ensure the iodoform gauze adhered closely to the wound surface. Pressure was applied via the tension of the sutures to achieve hemostasis and fixation. Following ligation, the fit of the dressing was checked to ensure there was no looseness or displacement. The sutures were removed 7 days postoperatively, and the wound healing was assessed; routine oral care and follow-up were carried out.

Group B was treated with a traditional rigid palatal splint for compression and fixation. An oral impression was taken one week prior to surgery, and a one-piece traditional rigid palatal splint was fabricated using hard acrylic resin; the edges were ground and polished to conform to the patient's palatal anatomy. Following hemostasis and coverage of the wound with iodine-impregnated gauze at the conclusion of surgery, the pre-fabricated rigid palatal splint was fitted. The compressive force exerted by the splint's rigid structure was utilized to secure the dressing and apply pressure to the wound. The fit of the splint was assessed daily, with adjustments made to the tightness as required; the splint was cleaned regularly and worn continuously until the wound had achieved initial healing.

Group C was treated with a novel elastic compression palatal splint for compression fixation: this utilized a new type of elastic compression palatal splint independently developed by our research team. The core structure of the device comprises four major modules: a medical-grade, highly elastic silicone conforming body, a micro-pressure monitoring module, an adjustable helical compression assembly, and

longitudinal drainage grooves for the wound surface.

(1) The elastic conforming body is made of medical-grade, highly elastic silicone, which adapts to the curvature of the palate, offering excellent fit, high biocompatibility and no irritation;

(2) Micro-pressure monitoring module

Equipped with a high-precision pressure sensor that displays real-time pressure readings on the wound, enabling pressure visualization;

(3) Adjustable compression assembly

Utilizes a micro-screw adjustment mechanism to fine-tune the compression intensity according to the wound's healing progress;

(4) Drainage channels

Longitudinal drainage channels run through the inner side of the splint, allowing for the timely drainage of wound exudate and haematoma.

After hemostasis of the surgical wound and application of a sterile iodine dressing, the novel elastic pressure-applied palatal splint is fitted, the pressure monitoring module is calibrated, and the initial post-operative pressure value is recorded. Dynamic pressure adjustment is implemented according to the different stages of wound healing: during the peak period of tissue oedema (1–3 days post-operatively), the pressure is moderately reduced to avoid excessive local compression that could impair blood flow; during the oedema resolution phase (4–7 days post-operatively), stable pressure is maintained to ensure the dressing adheres to the wound; from day 8 post-operatively through to the wound healing and repair phase, pressure is slightly reduced to provide optimal conditions for epithelial tissue migration and repair. Monitor wound exudate throughout the process via the drainage channels, clear secretions promptly to keep the wound dry and clean, and carry out standardized oral care until the wound has completely healed.

2.3. Observation criteria

(1) Incidence of complications

Observe patients for post-operative dental damage, such as tooth mobility, palatal displacement, periodontal tenderness, and gingival recession, as well as the occurrence of wound infection, using symptoms such as redness and swelling of the wound, increased pain, purulent discharge, and elevated local skin temperature as criteria for diagnosis.

(2) Wound healing time

Record the time elapsed from the end of the operation until complete wound healing. The criteria for wound healing are: complete epithelialization of the wound surface; absence of bleeding or exudate; absence of redness, swelling, or inflammation; intact and continuous mucosa; and no obvious scar indentation.

(3) Comfort score

The Visual Analog Scale (VAS) was used to assess patients' postoperative comfort, with a score range of 0–10. A score of 0 indicates no discomfort whatsoever, whilst a score of 10 indicates severe distending pain, an extremely strong sensation of a foreign body, and intolerable discomfort; a higher score indicates greater discomfort.

2.4. Statistical methods

Data analysis and processing were performed using SPSS 26.0 statistical software. Quantitative data (wound healing time, VAS comfort scores) are expressed as 'mean ± standard deviation ($\overline{x} \pm s$)'. Comparisons between multiple groups were performed using one-way analysis of variance (ANOVA), whilst pairwise comparisons between groups were performed using the LSD-*t* test. Categorical data (incidence of dental tissue damage, wound infection rate) are expressed as 'number of cases (%)', and comparisons between groups were performed using the chi-squared χ^2 test. A *p*-value of < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of the incidence of postoperative complications among the three groups

Complications were monitored throughout the postoperative follow-up period. In Group A, 7 cases of dental tissue damage and 6 cases of wound infection were observed; in Group B, 6 cases of dental tissue damage and 8 cases of wound infection were observed; Group C had no cases of dental, periodontal injury or wound infection. Comparisons between Groups A and B showed $p > 0.05$ in all cases; however, comparisons between Group C and Groups A and B regarding the rates of dental injury and wound infection were statistically significant ($p < 0.05$). Specific data are shown in **Table 1**.

Table 1. Comparison of postoperative complication rates among the three groups [n (%)]

Group	Number of cases	Dental tissue injury [cases (%)]	Wound infection [cases (%)]
Group A	30	7 (23.33)	6 (20.00)
Group B	30	6 (20.00)*	8 (26.67)*
Group C	30	0 (0.00)	0 (0.00)
χ^2	-	5.822, 4.630	4.630, 7.067
p	-	0.016, 0.031	0.031, 0.008

Note: Compared with Group A, *$p > 0.05$

3.2. Comparison of wound healing times across the three groups

The wound healing time was (11.20 ± 1.52) days in Group A, (12.13 ± 1.81) days in Group B, and (8.31 ± 1.24) days in Group C. Comparisons between Groups A and B showed $p > 0.05$ in both cases, whilst comparisons between Group C and Groups A and B revealed statistically significant differences in wound healing time ($p < 0.001$). See **Table 2**.

Table 2. Comparison of wound healing times among the three groups of patients ($\overline{x} \pm s$, days)

Group	Number of cases	Wound healing time
Group A	30	11.20 ± 1.52
Group B	30	12.03 ± 1.81*
Group C	30	8.31 ± 1.24
t-value	-	8.070, 9.287
p-value	-	< 0.001, < 0.001

Note: Compared with Group A, *$p > 0.05$

3.3. Comparison of postoperative VAS comfort scores among the three patient groups

The results of the postoperative comfort assessment at 7 days showed that the VAS comfort score was (5.62 ± 1.13) points in Group A, (6.24 ± 1.30) points in Group B, and (2.83 ± 0.92) points in Group C. Comparisons between Groups A and B showed $p > 0.05$ in all cases. Group C was significantly lower than both Groups A and B, with the differences being statistically significant ($p < 0.001$). See **Table 3**.

Table 3. Comparison of postoperative VAS comfort scores among the three groups of patients ($\overline{x} \pm s$, points)

Group	Number of cases	VAS comfort score
Group A	30	5.62 ± 1.13
Group B	30	6.24 ± 1.30*
Group C	30	2.83 ± 0.92
t-value	-	10.487, 11.728
p-value	-	< 0.001, < 0.001

Note: Compared with Group A, *$p > 0.05$

4. Discussion

The quality of postoperative wound healing in the palate is directly related to surgical efficacy, the patient's postoperative pain levels, the restoration of oral function, and long-term quality of life. The unique anatomical location and physiological environment of the palate mean that postoperative wound healing is far more challenging than for skin or other oral mucosal wounds [5]. Precise postoperative compression, effective drainage, minimally invasive protection, and stable healing are the core requirements for palatal wound repair, and also represent the key focus and challenges of current clinical postoperative interventions. The purse-string suture with iodoform gauze compression method is the most widely used postoperative management technique for the palate in primary care hospitals; its advantages include ease of operation, no need for prefabricated splints, and immediate applicability, but its shortcomings are particularly pronounced [6,7]. This technique relies entirely on dental tissues to bear the tension of the sutures; continuous palatal traction stress acts directly on the periodontal ligament and the tooth. Prolonged traction can easily lead to hyperemia and edema of the periodontal ligament, as well as mild alveolar bone resorption, ultimately resulting in tooth mobility and displacement. This is also the primary reason for the high rate of dental damage (23.33%) observed in Group A in this study. Furthermore, rigid sutures lack elastic buffer space; when tissue at the surgical site swells and expands postoperatively, excessive tension in the sutures may compress the wound. Once the edema subsides, the sutures become slack, and the tension diminishes, making the dressing prone to displacement or detachment. This results in the interruption of pressure on the wound, causing the protective seal to fail, allowing saliva and contaminants to continuously invade the wound, thereby leading to wound infection and delayed healing, which significantly impairs postoperative recovery [8]. Traditional rigid palatal splints effectively resolve the issue of tooth structure damage associated with the purse-string suture technique, as they do not rely on tooth structure tension for fixation; however, their core shortcomings lie in the lack of pressure regulation, rigid fixation, and limited functionality. The rigid resin material lacks elasticity and adaptability, and is unable to adjust the pressure applied in response to the dynamic changes in tissue edema and its resolution, maintaining constant pressure throughout the entire process [9]. During the peak period of post-operative edema, high-pressure compression can disrupt local microcirculation at the wound

site, leading to tissue ischemia and hypoxia, hindering the migration of epithelial cells and stalling wound repair; once the edema subsides, the fit of the splint deteriorates; insufficient pressure causes the dressing to become loose and compromises the seal, significantly increasing the risk of bacterial proliferation. In this study, Group B exhibited a wound infection rate of 20.00% and the longest healing time, fully confirming the therapeutic limitations of traditional rigid palatal splints.

The novel elastic compression palatal splint developed by our research team integrates the anatomical characteristics of the palate with the physiological mechanisms of wound healing, achieving comprehensive innovation in materials, structure, and function. Its four core advantages thoroughly address the shortcomings of traditional surgical approaches. Firstly, the elastic, self-adaptive, pressure-equalizing design. The novel elastic compression palatal splint utilizes a medical-grade, highly elastic silicone substrate, which is soft and possesses excellent biocompatibility, allowing it to conform precisely to the curved anatomical contours of the palate. It adapts to the dynamic changes in post-operative tissue swelling and retraction, ensuring that the overall force applied to the wound is uniform and gentle, without localized stress concentration. This not only guarantees the hemostatic effect of pressure on the wound but also avoids compressing microvascular blood flow, providing a stable physiological environment for tissue repair and fundamentally preventing issues of excessive or insufficient pressure. Secondly, the new elastic compression palatal splint incorporates a built-in micro high-precision pressure monitoring module, which quantitatively displays the pressure applied to the wound in real time. This transforms the traditional, experience-based application of pressure by clinicians into a standardized, quantified process, eliminating blind spots in clinical practice and achieving 'precise compression based on evidence' [10]. Thirdly, the new elastic compression palatal splint utilizes an external micro-spiral pressure-adjustment component to fine-tune compression intensity in real time according to the differing physiological requirements of the wound's oedema, de-oedema and repair phases, thereby aligning with the wound's full-cycle healing process and enabling personalized, stage-specific, precise intervention; Fourthly, longitudinal drainage grooves are incorporated on the inner surface of the splint to promptly drain stasis, inflammatory exudates and secretions from the wound site, thereby preventing the accumulation of exudates that could lead to inflammatory infection. This ensures the wound remains dry and clean at all times, significantly reducing the risk of infection and accelerating the repair of the mucosal epithelium.

The data from this clinical controlled study fully validate the clinical advantages of the novel elastic compression palatal splint. In terms of complication prevention and control, Group C recorded no cases of tooth damage, completely avoiding the risk of tooth and periodontal damage associated with the purse-string suture technique; the wound infection rate was only 3.33 percent, significantly lower than that of Groups A and B, with the synergistic effect of the drainage and pressure-stabilizing structures effectively reducing the probability of post-operative infection. In terms of healing efficiency, wound healing time in Group C was reduced by 3–4 days compared with traditional surgical procedures. The integrated advantages of elastic pressure equalization, stabilized blood supply, and unobstructed drainage effectively accelerated epithelial migration and wound repair, shortening the patients' postoperative recovery period. In terms of patient experience, the VAS comfort score in Group C was only (2.83 ± 0.92) points. The soft, elastic material, absence of rigid compression, and excellent adaptability significantly reduced the sensation of a foreign body in the mouth and feelings of distension and pain, thereby markedly improving patients' postoperative quality of life.

5. Conclusion

In summary, the novel elastic compression palatal splint innovatively integrates four core functions: elastic adaptive compression, visual pressure monitoring, dynamic and precise pressure adjustment, and unobstructed wound drainage. It establishes an integrated, precise intervention system for post-operative palatal wounds, fundamentally overcoming the technical limitations of traditional purse-string suture compression and rigid palatal splint compression, effectively preventing postoperative complications such as dental and periodontal damage and wound infection, significantly shortening the wound healing period, and substantially enhancing patients' postoperative comfort and quality of life. It also offers clinical advantages, including ease of use, high safety, broad applicability, and excellent cost-effectiveness, aligning with the development principles of modern precision dentistry and rapid recovery surgery.

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Disclosure statement

The authors declare no conflict of interest.

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