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Analysis of Therapeutic Effects of Dental Arch Splint Intermaxillary Traction Combined with Rigid Internal Fixation in Patients with Facial Comminuted Fractures

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Abstract: *Objective:* To analyze the therapeutic effect of combining dental arch splint intermaxillary traction with rigid internal fixation for the treatment of facial comminuted fractures. *Methods:* Sixty patients with facial comminuted fractures admitted for treatment between July 2023 and December 2024 were selected. Using a random number table method, 30 patients were assigned to the observation group, where moderate traction using a dental arch splint combined with rigid internal fixation was applied. Another 30 patients were assigned to the control group and only received dental arch splint traction treatment. The total effective rate, postoperative recovery indicators, periodontal status, complication rate, and quality of life scores were compared between the two groups. *Results:* The total effective rate in the observation group was higher than that in the control group. The postoperative recovery indicators and periodontal status in the observation group were superior to those in the control group. The complication rate and quality of life score were lower in the observation group compared to the control group, with $P < 0.05$. *Conclusion:* Combining dental arch splint intermaxillary traction with rigid internal fixation can improve the periodontal status and quality of life of patients with facial comminuted fractures, shorten postoperative recovery time, reduce various complications, and enhance surgical efficacy.

Keywords: Dental arch splint intermaxillary traction; Rigid internal fixation; Facial comminuted fracture; Therapeutic effect

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1. Introduction

Facial tissues are relatively delicate, rich in capillaries, and externally exposed, making them susceptible to fractures caused by occupational accidents, sports injuries, and other external trauma [1]. Facial comminuted fractures refer to complete fractures of facial bones, altering the anatomical relationship of the maxilla and mandible and impairing masticatory function. Additionally, facial tissues connect to the pharynx and cranial base, increasing the risk of complications such as respiratory distress and cranial injuries after fractures. Intermaxillary traction is a commonly used surgical technique for this condition, which involves resetting fractures using a dental arch splint, offering simplicity and cost-effectiveness. However, the stability of the splint is limited, making it challenging to restore occlusal relationships effectively, thereby reducing surgical efficacy. Rigid internal fixation, employing mini titanium plates, achieves ideal anatomical reduction, minimizes fixation areas, and promotes fracture healing [2]. The combined use of these procedures offers complementary advantages, enhancing fixation stability and facilitating postoperative recovery. This study analyzed the benefits of combining these techniques in 60 patients with facial comminuted fractures.

2. Materials and methods

2.1. General information

Sixty patients with facial comminuted fractures were enrolled in this study from July 2023 to December 2024. They were randomly divided into two groups using a random number table, with 30 patients in each group. In the observation group, there were 19 males and 11 females, with an age range of 22 to 59 years and a mean age of 33.26 ± 3.71 years. The causes of fractures in this group included blunt force trauma (7 cases), falls from heights (11 cases), and traffic accidents (12 cases). Fracture locations included the maxilla (11 cases) and mandible (19 cases). In the control group, there were 20 males and 10 females, aged between 21 and 57 years with a mean age of 33.34 ± 3.89 years. Causes of fractures in this group were blunt force trauma (9 cases), falls from heights (10 cases), and traffic accidents (11 cases). Fracture locations included the maxilla (9 cases) and mandible (21 cases). A comparison of the general information between the two groups showed no statistically significant difference ($P > 0.05$).

Inclusion criteria: Diagnosis of facial comminuted fractures confirmed by imaging examination and clinical signs; adult patients; complete basic patient information; clear consciousness; ability to cooperate with the study. Exclusion criteria: Patients who do not meet the surgical indications; patients with blood system or coagulation system diseases; patients with concurrent cranial hemorrhage, trauma, or other related diseases; poor mental state; significant fluctuations in vital signs, indicating a life-threatening condition.

2.2. Methods

Preoperative imaging, including facial X-rays and CT scans, was performed to evaluate the location and severity of the fractures.

The control group underwent dental arch splint intermaxillary traction. The surgical area of the face was sterilized, general anesthesia and intubation were administered, and a dental arch splint was placed via a C-arm X-ray. Dental arch splints (with hooks) were inserted into the upper and lower dentition, stabilizing healthy teeth and then securing adjacent teeth to the fracture. Bone forceps were used to tighten the end of the wire, and a small loop ligation procedure was performed. Manual reduction was carried out at the fracture site, and the rubber band was pulled in the direction of reduction to restore the upper dentition to its original position. The treatment duration lasted for four weeks.

In the observation group, after completing the traction treatment, the rubber bands were stabilized, and rigid internal fixation was immediately performed. The surgical approach was determined based on the specific location of the fracture. The subcutaneous tissue was incised to expose the fracture site, and free soft tissue and bone fragments were cleaned. Manual reduction was performed, and micro-titanium plates were selected for fixation.

The plates were adjusted to fit snugly against the bone surface, ensuring they were perpendicular to the fracture line, with the arc and length appropriately modified to avoid contact with the dental roots and alveolar nerves. Titanium screws were used to drill holes into the plates for shaping and fixation. After confirming satisfactory occlusal alignment, the screws were tightened. The surgical site was then cleaned with physiological saline, and the skin tissue was sutured. Traction was maintained for one week postoperatively.

2.3. Observation indices

(1) Total effective rate: Good: No facial defects or deformities, with normal anatomical structure in the fracture area. Moderate: No facial defects or deformities, but with slight anatomical deviation in the fracture area and mild periodontal inflammation. Poor: Dental damage accompanied by periodontal inflammation, facial defects or deformities, and unrecovered anatomical structure in the fracture area.

(2) Postoperative recovery indices: Observation of the recovery time for normal mouth opening, length of hospital stay, and fracture healing time.

(3) Periodontal status: The following were measured before surgery and after the removal of fixation devices: plaque index (PI, scored positively from 0 to 2 based on the amount of plaque); gingival index (GI, scored positively from 0 to 3 based on gingival inflammation); and debris index (DI, scored positively from 0 to 3 based on the coverage of debris).

(4) Complication rate: Observation of the incidence of complications such as incision infection, delayed healing, restricted mouth opening, and facial deformities.

(5) Quality of life score: Before surgery and six months after surgery, the Oral Health Impact Profile (OHIP) scale was used for measurement, which includes functional limitation (3 items), activity restrictions (5 items), pain and discomfort (3 items), and physical and psychological impairments (3 items). Each item is scored from 0 to 4, with a negative scoring system for quality of life. This means that a higher score indicates a poorer quality of life in terms of oral health.

2.4. Statistical analysis

Data were processed using SPSS28.0 software. Measurement data were expressed as mean ± standard deviation (SD) and compared using the *t*-test. Count data were expressed as numbers and percentages [*n* (%)] and compared using the chi-square test. Statistical significance was set at $P < 0.05$.

3. Results

3.1. Comparison of total effective rate between the two groups

The total effective rate of the observation group was higher than that of the control group ($P < 0.05$), as shown in **Table 1**.

Table 1. Comparison of total effective rate between two groups [*n* (%)]

Group	*n*	Good	Moderate	Poor	Total effective rate
Observation group	30	17 (56.67)	12 (40.00)	1 (3.33)	96.67 (29/30)
Control group	30	12 (40.00)	10 (33.33)	8 (26.67)	73.33 (22/30)
χ^2	-	-	-	-	6.405
P	-	-	-	-	0.011

3.2. Comparison of postoperative recovery indicators between the two groups

Based on **Table 2**, the postoperative recovery indicators of the observation group were significantly better than those of the control group ($P < 0.05$).

Table 2. Comparison of postoperative recovery indicators (mean ± SD, weeks)

Group	*n*	Recovery time of normal mouth opening	Length of hospital stay	Time for fracture healing
Observation group	30	1.82 ± 0.64	5.71 ± 1.03	6.72 ± 1.54
Control group	30	2.19 ± 0.77	6.48 ± 1.55	7.98 ± 1.58
t	-	2.024	2.266	3.128
P	-	0.048	0.027	0.003

3.3. Comparison of periodontal status between the two groups

Before surgery, there was no significant difference in periodontal status between the two groups ($P > 0.05$). However, after surgery, the periodontal status of the observation group was significantly better than that of the control group ($P < 0.05$), as presented in **Table 3**.

Table 3. Comparison of periodontal status between the two groups (mean ± SD, scores)

Group	*n*	PI		GI		DI	
		Pre-operation	Post-operation	Pre-operation	Post-operation	Pre-operation	Post-operation
Observation group	30	0.78 ± 0.19	1.19 ± 0.38	1.15 ± 0.40	2.20 ± 0.31	1.05 ± 0.43	2.14 ± 0.36
Control group	30	0.80 ± 0.23	0.95 ± 0.33	1.12 ± 0.39	1.89 ± 0.27	1.07 ± 0.41	1.89 ± 0.31
t	-	0.367	2.612	0.294	4.130	0.184	2.882
P	-	0.715	0.011	0.770	0.000	0.854	0.006

3.4. Comparison of complication rates between the two groups

As shown in **Table 4**, the complication rate in the observation group was lower than that in the control group ($P < 0.05$).

Table 4. Comparison of complication rates between the two groups [*n* (%)]

Group	n	Incision infection	Delayed healing	Restricted mouth opening	Facial deformity	Incidence rate
Observation group	30	0	1 (3.33)	1 (3.33)	0	6.67 (2/30)
Control group	30	1 (3.33)	3 (10.00)	4 (13.33)	1 (3.33)	30.00 (9/30)
χ^2	-	-	-	-	-	5.455
P	-	-	-	-	-	0.020

3.5. Comparison of quality of life scores between the two groups

Before surgery, there was no significant difference in quality of life scores between the two groups ($P > 0.05$). However, after surgery, the quality of life scores in the observation group were lower than those in the control group ($P < 0.05$), as demonstrated in **Table 5**.

Table 5. Comparison of quality of life scores between two groups (mean ± SD, points)

Group	n	Functional limitation		Activity restrictions		Pain and discomfort		Physical and mental defects	
		Pre-operation	Post-operation	Pre-operation	Post-operation	Pre-operation	Post-operation	Pre-operation	Post-operation
Observation group	30	8.65 ± 1.42	4.15 ± 0.53	12.65 ± 1.63	6.55 ± 1.20	9.02 ± 1.27	4.03 ± 0.39	7.11 ± 1.23	3.68 ± 0.52
Control group	30	8.70 ± 1.46	5.64 ± 0.66	12.69 ± 1.65	7.99 ± 1.25	9.05 ± 1.22	5.12 ± 0.45	7.15 ± 1.27	4.14 ± 0.57
t	-	0.134	9.641	0.094	4.552	0.093	10.026	0.124	3.266
P	-	0.893	0.000	0.925	0.000	0.926	0.000	0.902	0.002

4. Discussion

The maxillofacial bones are prominent and anatomically one of the weaker areas of the human skeletal system, making them prone to comminuted fractures under the impact of violent forces. Additionally, the maxillofacial region is attached to muscles such as the anterior belly of the digastric and genioglossus muscles. Post-fracture, these attached muscles may be pulled, leading to soft tissue damage and reduced masticatory function, which significantly impacts the patient's daily life [3].

Surgical treatment can restore the original facial morphology and the anatomical structure of the maxillofacial bones, thereby improving their physiological function. Traction is a commonly used surgical method that involves the use of a dental arch splint for fixation, which achieves good reduction results. However, the prolonged fixation period increases the difficulty of maintaining oral hygiene and raises the risk of infections. Moreover, the limited stability of traction techniques can prolong fracture healing, presenting certain surgical limitations. Rigid internal fixation significantly enhances the stability of fracture ends and restores maxillomandibular mobility [4,5]. Mini titanium plates, commonly used in this procedure, exhibit high biocompatibility and malleability, making them easy to shape. They can precisely adjust the morphology of the jawbone and adhere closely to the bone surface, ensuring excellent repositioning. Furthermore, this procedure features a simplified operation with minimal trauma, reducing traction time and delivering superior efficacy.

The results showed that the total efficacy rate in the observation group was higher than that in the control group, and postoperative recovery indicators were superior ($P < 0.05$). These findings are consistent with the study by Jiang and Wang [6], indicating high reliability and validity in this study. Specific analysis reveals that traction procedures can bind dental arch splints to the maxillary and mandibular dental arches, utilizing the elastic force of rubber bands to generate traction, which aids in jawbone correction. Internal fixation procedures allow for direct visualization during jawbone repositioning and the use of mini titanium plates to reduce the likelihood of fracture displacement, thereby improving fixation effectiveness. The mini titanium plates also exhibit strong resistance to bending and compression, adhering to the bone surface for extended periods and promoting fracture healing. Titanium screws, used in the procedure, are highly compatible with tissues and bond strongly with bone, sustaining intermaxillary traction for prolonged periods without loosening. This ensures long-term surgical efficacy [7]. The combined use of these two procedures generates a synergistic effect by stabilizing fracture ends through different mechanisms, resulting in higher total efficacy and shorter postoperative recovery times. The periodontal condition in the observation group was better than that in the control group ($P < 0.05$). This is because combined surgery maintains the structural stability of the maxillofacial bones without negatively impacting periodontal or oral mucosal tissues. It causes no significant foreign body sensation, restores oral function, and improves periodontal health [8]. The complication rate in the observation group was lower, and their quality of life scores were higher than those in the control group ($P < 0.05$). This is attributed to the biomechanical alignment of repositioning treatments in the combined procedure, which minimizes trauma and avoids needle injuries associated with traditional treatments, thereby preventing infections and other complications. The high comfort level of the combined surgery also facilitates oral hygiene maintenance, allowing for rapid restoration of dental function and the prevention of postoperative complications. Effective fracture repositioning and expedited healing shorten the recovery time for patients' daily abilities, enabling them to return to a normal lifestyle and enhancing their overall quality of life [9,10].

5. Conclusion

In summary, combined surgery enhances the overall efficacy of treating facial comminuted fractures, shortens the recovery period, protects periodontal tissues, reduces surgical complications, and comprehensively improves postoperative quality of life.

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