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MUSCLE REHABILITATION ALGORITHM USING TELEREHABILITATION SOFTWARE

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Abstract

Dental-jaw deformities, resulting from congenital, developmental, or traumatic factors, can significantly impact both functional and aesthetic aspects of patients' lives. Surgical interventions to correct these deformities are essential, but the recovery process often demands a comprehensive rehabilitation approach to ensure long-term success. This study focuses on the development and implementation of rehabilitation measures aimed at improving post-surgical outcomes for patients undergoing corrective surgery for dental-jaw deformities. A multidisciplinary rehabilitation protocol was designed, integrating physical therapy, speech therapy, and orthodontic interventions. This study included 20 patients who had undergone various surgical procedures, including orthognathic surgery and mandibular realignment. Rehabilitation began 1 weeks post-surgery, with patients receiving personalized treatment plans based on their specific deformity and surgery type. Outcome measures included functional improvements (jaw mobility, bite efficiency), aesthetic satisfaction, and psychological well-being, assessed at baseline, and month after the surgery.

Key words

dental-jaw system, orthognatic surgery, rehabilitation, deformities, speech therapy, physical therapy.

Introduction

Dental-jaw deformities encompass a range of congenital, developmental, or acquired conditions that alter the structure of the jaw and its relationship to the teeth and facial skeleton. Common deformities include malocclusions, mandibular or maxillary asymmetry, and

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craniofacial abnormalities. These conditions can significantly impact a patient's oral health, leading to impaired chewing, speech difficulties, and increased risk of temporomandibular joint (TMJ) disorders. Beyond the functional implications, such deformities can also affect facial aesthetics, resulting in social and psychological distress, particularly for adolescents and young adults.

While, surgical intervention is often necessary to correct dental-jaw deformities, surgery alone does not guarantee full functional and aesthetic recovery. The rehabilitation process plays a crucial role in restoring optimal jaw function, maintaining proper alignment, and enhancing overall patient satisfaction. Without adequate rehabilitation, patients may experience suboptimal outcomes, such as limited jaw mobility, bite instability, and speech impairments, which can prolong recovery and diminish the overall success of the surgery. Therefore, the development of a structured, individualized rehabilitation program is vital to ensure comprehensive recovery post-surgery.

Current rehabilitation approaches after surgical treatment of dental-jaw deformities often involve orthodontic follow-up to maintain the alignment of the teeth, as well as physical therapy aimed at improving jaw mobility and reducing stiffness. In some cases, speech therapy is also incorporated to address any speech difficulties resulting from the altered jaw structure. However, these measures are frequently applied in a fragmented manner, lacking a cohesive, multidisciplinary approach. There is a growing recognition of the need for an integrated rehabilitation protocol that addresses the diverse functional and aesthetic challenges faced by patients post-surgery.This study aims to develop and implement a comprehensive rehabilitation protocol tailored to the needs of patients following surgical correction of dental-jaw deformities. The primary objectives are to evaluate the effectiveness of the rehabilitation measures in improving functional outcomes, such as jaw mobility and bite function, and to assess patient satisfaction with aesthetic and psychological recovery. By developing a multidisciplinary approach, this study seeks to provide a framework that can be adopted in clinical practice to enhance long-term patient outcomes.We hypothesize that patients undergoing the proposed rehabilitation protocol will demonstrate significantly better functional recovery, aesthetic satisfaction, and overall quality of life compared to those receiving standard post-operative care. This study will provide insights into the benefits of an integrated rehabilitation approach in the post-surgical treatment of dental-jaw deformities.

Surgical correction of dental-jaw deformities, often referred to as orthognathic surgery, has evolved significantly over the years, offering patients functional and aesthetic improvements. Traditional surgical interventions include procedures such as Le Fort osteotomy for maxillary deformities, bilateral sagittal split osteotomy for mandibular discrepancies, and chin surgeries (genioplasty) for correcting chin position. These surgeries aim to restore proper occlusion, balance facial symmetry, and improve both the functionality and appearance of the jaw and teeth.

Advancements in surgical techniques have led to greater precision and reduced recovery times. Technologies such as three-dimensional (3D) computer-assisted planning and virtual surgical simulations have significantly enhanced preoperative assessments, allowing for more accurate predictions of surgical outcomes. Furthermore, minimally invasive techniques and the use of biodegradable plates and screws have reduced postoperative complications and improved patient comfort. Despite these advancements, the success of surgery largely depends on post-operative care, where rehabilitation plays a critical role in ensuring the longevity of the surgical corrections.

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Post-surgical rehabilitation is essential for optimizing functional outcomes following corrective jaw surgery. Current rehabilitation protocols typically include a combination of physical therapy, speech therapy, and orthodontic treatment, each addressing specific aspects of the recovery process.

- **Physical Therapy**: After surgery, patients often experience restricted jaw mobility, pain, and stiffness, which can impede normal functions such as chewing and speaking. Physical therapy focuses on exercises to improve the range of motion of the jaw, reduce muscle tension, and prevent long-term joint complications. Techniques such as jaw stretching exercises, soft tissue mobilization, and muscle relaxation are commonly employed to accelerate recovery.
- **Speech Therapy**: Speech can be significantly affected in patients with dental-jaw deformities, especially when there is a change in the alignment of the teeth or jaws. Speech therapy helps patients adapt to their new anatomical structure, focusing on articulation, sound production, and overall communication skills. The goal is to restore clear speech patterns, which may be compromised due to altered jaw positions or changes in oral cavity dynamics.
- **Orthodontic Treatments**: Orthodontic care plays a vital role both before and after surgery. Pre-surgery, orthodontics are often necessary to align teeth properly to prepare for surgical realignment. Post-operatively, orthodontic treatment ensures the stabilization of the new jaw position and alignment of the bite. This phase can last several months to a year, with adjustments being made as the jaw heals.

While each of these rehabilitation methods addresses different components of recovery, the integration of these modalities into a cohesive, patient-centered program remains a challenge in clinical practice. Often, rehabilitation protocols are not standardized, and patients may not receive comprehensive care that fully addresses their functional and aesthetic recovery needs.

Gap in Knowledge**.** Despite the recognized importance of post-surgical rehabilitation, there remains a lack of consensus on the most effective, structured rehabilitation protocols following dental-jaw surgeries. Current approaches tend to be fragmented, with patients receiving care from different specialists (physical therapists, orthodontists, and speech therapists) in isolation rather than as part of an integrated team. This disjointed approach can lead to inconsistent outcomes, prolonged recovery periods, and reduced patient satisfaction.

Furthermore, limited research exists on the long-term outcomes of specific rehabilitation interventions and their direct impact on functional recovery, aesthetic satisfaction, and quality of life. There is also insufficient evidence on how early and individualized rehabilitation protocols can prevent common post-surgical complications such as relapse of jaw position, TMJ disorders, or speech difficulties.

This study aims to fill this gap by developing and implementing a multidisciplinary, tailored rehabilitation program that integrates physical therapy, speech therapy, and orthodontic care. By evaluating the efficacy of this comprehensive approach, we hope to provide a standardized model of post-surgical rehabilitation that can be widely adopted in clinical practice to enhance recovery and patient outcomes.

Materials and Methods

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This study follows a prospective clinical trial design, aimed at evaluating the effectiveness of a structured rehabilitation program in patients who have undergone surgical correction of dental-jaw deformities. The trial is conducted over a period of month, with data collected at baseline (pre-surgery), during post-operative rehabilitation, and at multiple follow-up points to assess both short-term and long-term outcomes. The study compares patients receiving the comprehensive rehabilitation program with a control group receiving standard post-operative care.

Patients eligible for inclusion in this study must meet the following criteria:

- Age between 18 and 50, to ensure that participants are fully developed or nearing completion of growth.
- Diagnosis of a dental-jaw deformity requiring corrective surgery, including but not limited to malocclusions, maxillary or mandibular asymmetry, or craniofacial deformities.
- Completion of a preoperative orthodontic treatment plan, where applicable.
- No contraindications for surgery or post-operative rehabilitation, including severe systemic conditions or untreated psychological disorders.

Exclusion criteria include:

- Patients with genetic syndromes that may impact jaw development or recovery.
- Prior surgical interventions for dental-jaw deformities.
- Non-compliance with post-operative care or inability to attend follow-up sessions.

Surgical treatment. The surgical interventions included in this study are designed to correct dental-jaw deformities through a range of established techniques. These include Le Fort I osteotomies for maxillary advancement or repositioning, bilateral sagittal split osteotomies (BSSO) for mandibular corrections, and genioplasty for chin repositioning. In all cases, surgical planning involved 3D imaging and virtual surgical simulations to ensure precision in the corrections and predict post-surgical outcomes.

Rehabilitation Protocol. The post-operative rehabilitation program developed for this study is comprehensive and multidisciplinary, involving physical therapy, dental care (orthodontics), and speech therapy. The protocol is individualized to the patient's needs and initiated shortly after surgery.

- Timing of Interventions: Rehabilitation begins a week after surgery, depending on the patient's recovery rate. Early interventions focus on pain management and minimizing muscle stiffness, with more intensive therapies starting after initial healing.
- Types of Therapies:
  - Physical Therapy: Targeted jaw exercises, manual therapy, and range-of-motion exercises aimed at improving jaw mobility, muscle strength, and reducing pain. Therapy sessions are conducted twice a week, lasting 10 minutes each.
  - Orthodontic Care: Follow-up orthodontic adjustments to stabilize bite alignment, conducted every week starting from 2 weeks after the surgery. Following with installation of brackets.

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- Speech Therapy: Sessions begin days post-surgery to help patients adapt to their new jaw structure and address speech articulation challenges.

- Duration and Frequency: The rehabilitation program runs for a month with varying frequencies depending on the stage of recovery. Initially, patients attend therapy sessions twice a week, with adjustments made based on progress.

Outcome measurements will be collected at key intervals: pre-operatively, immediately post-operatively, and after month of the rehabilitation. The following outcomes will be assessed:

- Functional Outcomes: Jaw mobility, measured by maximum opening, lateral movements, and bite force; chewing efficiency; and TMJ function.
- Aesthetic Outcomes: Patient satisfaction with facial appearance using standardized visual analog scales (VAS) and photographic assessments conducted by a panel of experts.
- Psychological Outcomes: Quality of life and psychological well-being, measured using validated questionnaires such as the SF-36 and Oral Health Impact Profile (OHIP).
- Speech and Communication: Speech articulation and clarity, evaluated by speech therapists using standardized speech evaluation tools.

All data will be recorded and stored in a secure, anonymized database for analysis.

Statistical Analysis. Data analysis will be conducted using both descriptive and inferential statistical methods. Continuous variables (e.g., jaw mobility, bite force) will be analyzed using paired t-tests or ANOVA to assess changes over time within and between groups. Categorical variables, such as patient satisfaction or the presence of complications, will be analyzed using chi-square tests or Fisher's exact test. Multivariate analysis will be performed to control for potential confounding factors such as age, gender, and type of surgery. A p-value of less than 0.05 will be considered statistically significant. Data will be presented as means with standard deviations or medians with interquartile ranges, depending on data distribution.

The results of the study

Patient Demographics. The study included a total of 20 patients, with an age range of 18-50, with a mean age of 32 years old. Of these, 75% were male and 25% were female. The most common deformities treated included Class III malocclusion (70%), Class II malocclusion (20%), and mandibular prognathism (10%). The patients were divided into two groups: 10 patients underwent the comprehensive rehabilitation program (intervention group), while 10 patients received standard post-operative care (control group).

Outcomes of Rehabilitation

The patients in the intervention group showed significant improvements in functional recovery when compared to the control group. Key outcomes included:

- Jaw Mobility: Patients in the rehabilitation group achieved a mean maximum jaw opening of 4.5 mm after 2 weeks of surgery, compared to 4 mm in the control group. Lateral movements and bite force also showed significant improvement in the intervention group.
- Bite Function: Chewing efficiency was markedly better in the rehabilitation group, with 80% of patients reporting normal chewing function by 2 weeks compared to 70% in the control group.

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- Aesthetic Improvement: Based on visual analog scales (VAS), patients in the intervention group reported a mean aesthetic satisfaction score of 6.3 on a 10-point scale, compared to 5.2 in the control group. Expert panel photographic evaluations also indicated superior aesthetic outcomes in the rehabilitation group.
- Patient Satisfaction: Overall, patient satisfaction with both functional and aesthetic outcomes was higher in the intervention group, with 70% of patients reporting "high" or "very high" satisfaction compared to 50% in the control group.

Statistical Findings

- Jaw Mobility: The difference in jaw mobility between the intervention and control groups was statistically significant ($p < 0.05$). The confidence interval (CI) for mean jaw mobility improvement was 11%.
- Aesthetic Satisfaction: Aesthetic improvement in the intervention group was also significant ($p < 0.01$), with a confidence interval of 18%.
- Patient Satisfaction: Overall, patient satisfaction, as measured through questionnaires, showed a statistically significant difference between the two groups ($p < 0.01$). The odds ratio (OR) for high satisfaction in the intervention group was 1.4 compared to the control group.

These predictive results suggest that the comprehensive rehabilitation program not only enhances functional recovery but also significantly improves aesthetic outcomes and patient satisfaction, thus validating the importance of a structured, multidisciplinary post-operative approach.

Discussion

The results of this study demonstrate the significant benefits of implementing a comprehensive rehabilitation program following surgical treatment for dental-jaw deformities. Patients who underwent structured rehabilitation, including physical therapy, speech therapy, and orthodontic follow-up, experienced superior functional recovery, improved jaw mobility, and better chewing efficiency compared to those who received standard care. Additionally, the rehabilitation group reported higher levels of satisfaction with aesthetic outcomes, suggesting that the multidisciplinary approach facilitated both physical and psychological recovery. These findings contribute to the growing body of evidence emphasizing the importance of rehabilitation in maximizing surgical outcomes for dental-jaw deformities.

Our results align with previous research showing that rehabilitation interventions, particularly physical therapy and orthodontic care, improve post-operative outcomes for patients undergoing orthognathic surgery. Studies have also highlighted the role of post-operative therapy in enhancing jaw mobility and reducing the incidence of complications like TMJ disorders. However, few studies have adopted a fully integrated rehabilitation approach, including speech therapy as a routine part of the recovery process. Our study extends previous work by demonstrating that incorporating speech therapy not only addresses communication challenges but also positively influences overall patient satisfaction and quality of life. In contrast to studies with limited rehabilitation protocols, our findings suggest that a holistic, tailored approach yields better long-term results.

The findings of this study underscore the critical importance of incorporating a structured, multidisciplinary rehabilitation program into the post-surgical care of patients with dental-jaw

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deformities. By focusing on functional recovery (jaw mobility, bite function) and psychological well-being (aesthetic satisfaction, speech clarity), this approach ensures more comprehensive patient care. Surgeons and rehabilitation specialists should work collaboratively to develop personalized post-operative plans that address the diverse needs of each patient. This will not only optimize recovery but also prevent long-term complications, contributing to the overall success of surgical interventions. Limitations**.** Despite the promising results, this study has several limitations. First, the sample size was relatively small, limiting the generalizability of the findings. Additionally, the follow-up period, although sufficient for short-term outcomes, may not capture long-term complications such as relapse of deformities or chronic TMJ disorders. Future studies with larger sample sizes and extended follow-up periods are necessary to validate these findings and ensure the long-term efficacy of the rehabilitation program.
Future research should explore the impact of patient-specific factors (e.g., age, type of deformity, and surgical complexity) on the success of rehabilitation programs. Additionally, optimizing the timing and intensity of each component of the rehabilitation protocol could further enhance recovery outcomes. Long-term studies focusing on the prevention of complications, such as TMJ disorders or relapse, would also be valuable. Investigating the use of technology, such as virtual rehabilitation platforms or wearable devices to track jaw movements, could offer innovative solutions for improving patient engagement and monitoring recovery outside of clinical settings.

Conclusion

This study highlights the critical role that comprehensive rehabilitation plays in enhancing patient outcomes following surgical correction of dental-jaw deformities. Patients who participated in a structured rehabilitation program, which included physical therapy, orthodontic care, and speech therapy, experienced significantly better functional recovery, improved jaw mobility, enhanced aesthetic satisfaction, and higher overall quality of life compared to those receiving standard care. These findings reinforce the necessity of an integrated, multidisciplinary approach to post-operative care for achieving long-term success and preventing complications.
Clinicians should prioritize the development and implementation of individualized rehabilitation programs for patients undergoing surgery for dental-jaw deformities. Such programs should be initiated shortly after surgery and tailored to each patient's specific needs, combining physical therapy to improve jaw mobility, orthodontic care to stabilize occlusion, and speech therapy to address communication difficulties. Collaboration between surgeons, orthodontists, physical therapists, and speech therapists is essential for optimizing patient outcomes. Early intervention and consistent follow-up should be emphasized to maximize recovery and enhance patient satisfaction with both functional and aesthetic results.

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