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AUTOTRANSPLANTATION OF IMMATURE THIRD MOLAR USING A COMPUTER-AIDED RAPID PROTOTYPING MODEL: A CASE REPORT

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Abstract

Aim and background: This case report reveals successful autotransplantation case using computer-aided rapid prototyping (CARP) models with immature third molar.

Case description: The compromised right lower second molar was transplanted with third molarusing CARP model. Postoperatively, the pulp vitality and the development of the roots were examined clinically and radiographically. The patient follow-up period was 1 year after surgery. Follow-up showed that transplanted tooth was asymptomatic and functional. Radiographic examination indicated that the apex developed continuously and the root length and thickness increased. The final follow-up examination revealed that the transplant kept the vitality, with normal periodontal ligaments space and trabecular bony patterns. This case report highlights autotransplantation of immature tooth using CARP models resulted in favorable prognosis.

Conclusion: The CARP model enables a more predictable prognosis for autotransplantation. Based on long-term follow-up observations, when extra efforts are made for proper case selection and PDL cell survival, as in this case, improved clinical results such as vertical bone growth, can be expected

Keywords: Autotransplantation, CARP model, HERS, Radiograph, Third molar

1. Abbreviations

CARP- computer-aided rapid prototyping, HERS- Hertwig epithelial root sheath, CBCT- . Cone beam computed tomography, DICOM- Digital Imaging and Communications in Medicine

2. Introduction

Autotransplantation is defined as the transplantation of an embedded, impacted or erupted tooth from its original site to another extraction socket or surgically prepared site in the same individual (1). Autotransplantation was initially documented in the 1950s where immature third molars were utilized to replace decayed first molars (2). Unlike implants, which do not move vertically with the neighboring teeth during eruption, an autotransplanted tooth can erupt in harmony with adjacent teeth, maintaining proper alignment during facial growth and tooth eruption (3). Therefore, autotransplantation offers a viable alternative for restoring prematurely lost teeth(4-6). Recent studies report promising success rates of 74-100%, achieved through careful case selection and precise surgical techniques.(5-8)

Despite numerous claims of excellent success rates, tooth autotransplantation is not as common as one might anticipate. (5,7,9). Compared to dental implants, autotransplantation offers several advantages, including the preservation of proprioception, potential for orthodontic movement, relatively low cost, and pulpal regeneration in immature teeth (10,11). Autotransplantation is indicated for traumatic tooth loss, tumors, congenitally missing teeth, teeth with poor prognosis, and developmental anomalies. However, it is contraindicated in patients with cardiac anomalies, poor oral hygiene, lack of self-motivation, and insufficient alveolar bone support(12). The intricacy of the process, the sensitivity of the approach, and the uncertain prognosis due to different clinical settings could be the grounds for hesitancy in selecting this course of treatment. (13)

The computer-aided rapid prototyping (CARP)of donor tooth and jaw model was proposed by Lee et al. (14) for use in autotransplantation. Cone beam computed tomography (CBCT) imaging provides 3-dimensional image data that is used to create a CARP model. Prior to surgical procedure, technique permits analysis of the actual dimensions of the donor tooth and extraction socket. In addition, the alveolar bone site can be simulated using a CARP tooth model prior to extraction surgery to minimize extraoral duration and potential damage to the HERS during transplantation. (9,14).

The aim of this case report is to present a successful autotransplantation utilizing CARP models with immature third molar, demonstrating remarkable root maturation**.**

3. Case description

A 17-year-old female patient visited the Department of Conservative Dentistry with chief complaint of decayed lower right back tooth since 1 year. No relevant medical history reported. Patient reported dental history of right maxillary first molar was extracted 1 months back because of caries

3.1.Intraoral examination

Clinical examination showed extensive caries involving furcation of right mandibular second molar and mesio-occlusal caries in relation to right mandibular third molar (Figure 1). Right mandibular second molar showed negative response to percussion and palpation test and was found to be non-vital on assessing pulp sensibility test using cold test and electric pulp testing.

3.2.Radiographic assessment

Preoperative panoramic radiograph (Figure 2) and periapical radiograph (Figure 3)

revealed widened periodontal ligament space around right mandibular second molar and immature roots in relation to right mandibular third molar. Right mandibular second molar was diagnosed as having pulp necrosis with asymptomatic apical periodontitis.

4.3 Treatment plan

The patient was informed of the compromised condition of right mandibular second molar, and extraction was recommended. Further examination revealed that the adjacent third molar was in excellent health, with developing roots, making it an ideal candidate for autotransplantation. The patient was provided with detailed information about the treatment procedures, including associated benefits and risks. Informed consent was obtained, and the treatment was scheduled

4.4 Treatment methodology

In order to create the CARP models and assess the volumetric measures of the donor teeth, CBCT (CS9600 3D, Carestream Health Co, Rochester, New York) imaging (Figure 4) was obtained. The goal was to autotransplant the right mandibular third molar (donor tooth) to the recipient site, which is the right mandibular second molar. After obtaining the donor tooth's three-dimensional digital data, a file in the Digital Imaging and Communications in Medicine (DICOM) format was created.The DICOM file underwent analysis (Figure 5) using a visualization software (Materialise Mimics software, Materialise NV, Belgium) and subsequently transferred to a rapid prototyping machine (SLA printer - Form 3BL, BEACON, India) to produce tooth model (Figure 6)

Under local anesthetic, a mucoperiosteal flap was raised in the tooth region. First, the right mandibular second molar was removed (Figure 7). The socket was then modified using the CARP model (Figure 8) by removing the crestal bone with a surgical contra-angled handpiece and a round carbide bur (20,000 rpm) under copious saline irrigation. In order to preserve the radicular periodontal tissues, the donor tooth was extracted atraumatically. The recipient site received the tooth transplant. For three minutes, the donor tooth was firmly secured in place. The final position was verified by taking radiograph (Figure 9). Cross over sutures placed using 4-0 Vicryl without the need for splints. Occlusal interferences were modified. For one week, a regimen of antibiotics (amoxicillin 750 mg every 8 hours), analgesics (ibuprofen 600 mg), and an antibacterial rinse (0.20% chlorhexidine gluconate) was prescribed.
At the follow-up appointment, the transplant remained asymptomatic and fully functional. Restoration of caries affecting the right mandibular third molar, which had been delayed due to limited accessibility, was successfully completed. At the one-year review, the tooth exhibited positive response to cold testing, and periodontal probing indicated normal findings across all subsequent check-ups. Radiographically, continuous development of the apex was noted, accompanied by increased root length and thickness, with a trabecular bone pattern observed surrounding the tooth. (Figure 10)

4. Discussion

Following replantation, a tooth with an open apex is more likely to experience pulp revascularization (13, 15). In addition to promoting root growth, an abundant HERS also has an impact on periodontal repair. Because chances of developing pulp necrosis are frequent, teeth beyond stage 5 (full root development with half-apical constriction) are

not advised (16, 17). At our instance, the transplant's root was at Moorrees stage 4, which encouraged root growth.

Several factors influencing the healing of the periodontal ligament include the extra-oral duration of the donor tooth, the storage media prior to transplantation, surgical trauma, and contamination of the root surface and/or root canal. Among these, the extra-oral duration of the donor tooth before transplantation is the most critical for success (18). Another key factor in tooth transplantation is the distance between the recipient bone tissue and the root surface of the transplanted tooth. Optimal contact with the recipient site enhances the blood supply and nutrient delivery to the periodontal ligament cells, thereby improving the success rate of the tooth transplantation (19).
By avoiding repetitive insertion and minimizing damage to periodontal ligament (PDL) cells, the CARP model in this instance helped to minimize the extraoral time and preserve viable cells to the greatest extent possible. This allowed for continued root development and bone growth around the transplanted tooth without the need for a bone graft or membrane application. The 3D imaging software and CARP models support diagnostics, surgical planning and simulation, and communication between clinicians and patients, improving comprehension, providing adequate information about the case, and reducing the surgical period.
This case presents a distinctive instance of utilizing an immature mandibular third molar to replace an adjacent unrestorable second molar, accompanied by a comprehensive one-year evaluation to demonstrate the success and longevity of this innovative approach

5. Conclusion

Third molar transplantation is performed infrequently compared with dental implantation because of difficulties with tooth extraction and application to the recipient site as well as vague anxiety with treatment. Dental implants require a long treatment period, are costly, and almost always require a bone graft. The CARP model enables a more predictable prognosis for autotransplantation. Based on long-term follow-up observations, when extra efforts are made for proper case selection and PDL cell survival, as in this case, both clinically acceptable outcomes and improved clinical results, such as vertical bone growth, can be expected

Clinical significance: Autotransplantation of teeth using rapid prototyping technology offers significant clinical benefits. It enables the creation of highly accurate 3D models for both the donor tooth and recipient site, enhancing precision and reducing surgical trauma. This precision results in better fitting and positioning of the transplanted tooth, leading to higher success rates and faster healing. The ability to pre-plan surgeries with customized models and guides minimizes surgical time and costs, while also providing superior aesthetic outcomes. Additionally, this technology is particularly beneficial for young patients and those with impacted teeth, offering a personalized approach that traditional methods may not achieve. Overall, rapid prototyping enhances the precision, efficiency, and outcomes of dental autotransplantation procedures.

6. Conflict of interest

There is no conflict of interest.

7. Bibliography

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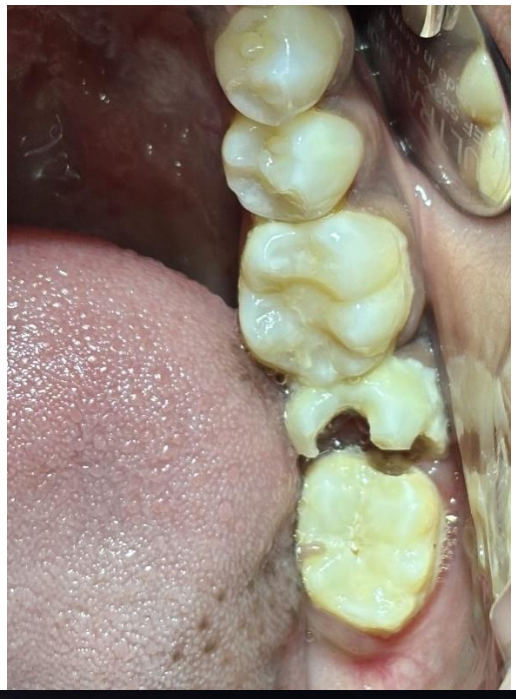

FIGURE1: Pretreatment intraoral photographs
Grossly decayed right mandibular second molar

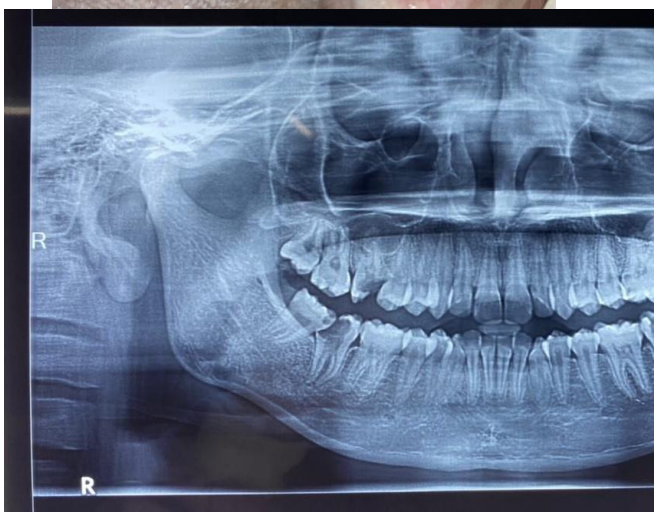

FIGURE2: Pretreatment panoramic radiograph
Widened periodontal ligament space around right mandibular second molar and developing roots in relation to third molar

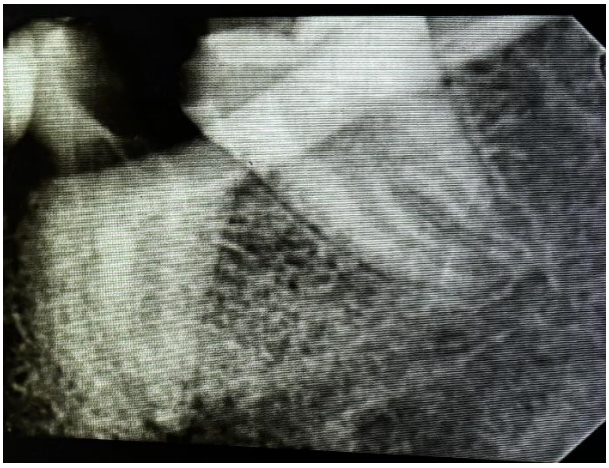

Figure 3: Pretreatment radiograph
Grossly decayed mandibular second molar

Figure 4: CBCT showing mandibular molars

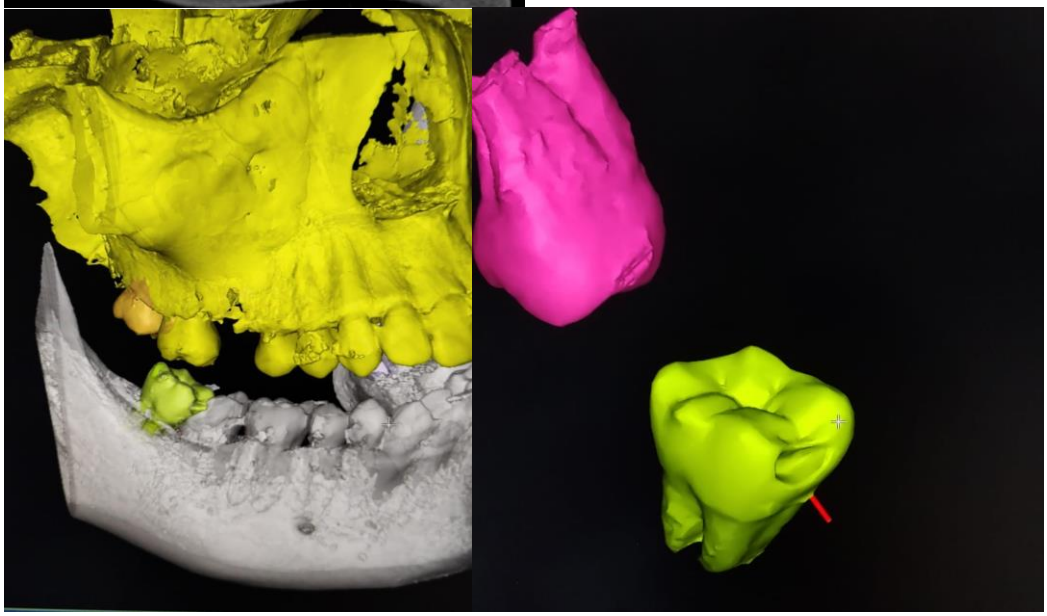

Figure 5: DICOM file was analyzed in a visualization program

Figure 6 : CARP model of donor tooth

Figure 7: Extracted mandibular second molar

Figure 8: Try in of CARP MODEL

FIGURE 6: CARP model of donor tooth

Figure 9: Immediate post operative radiograph of transplanted tooth

Figure 10: Review radiograph of transplanted tooth after 1 year