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Case report

Utilization of magnetic mallet during dental implantation in narrow mandibular alveolar ridge: A case report

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ABSTRACT

Introduction and importance: Placing dental implants in a narrow mandibular alveolar ridge poses a range of significant challenges. The objective of this paper is to demonstrate the combined application of piezoelectric surgery and magnetic mallet for alveolar ridge splitting and bone expansion in dental implant procedures. It aims to highlight the potential benefits of integrating these technologies in mandibular implant sites.
Case presentation: A 39-year-old female patient sought dental implants for missing teeth in the mandible. She was a non-smoker with no systemic diseases, and clinical examinations revealed no abnormalities. Cone-beam computed tomography (CBCT) showed a narrow alveolar ridge, insufficient for 4 mm diameter implants. To address this, an alveolar ridge split and expansion were performed under local anesthesia. Ridge splitting and bone expansion were achieved with a piezoelectric device and magnetic mallet, followed by implant placement. A two-stage approach was used, with a 4-month healing period before prosthetic restoration. Post-surgery and post-loading evaluations showed satisfactory results, with minimal marginal bone loss and high patient satisfaction. The follow-up CBCT confirmed stable outcomes.
Clinical discussion: In this case report, a magnetic mallet was used to place dental implants in a patient with a narrow mandibular ridge, suitable for ridge splitting and bone expansion. Ridge expansion was preferred over alternatives due to its compatibility with established protocols. The procedure yielded positive outcomes, including minimal discomfort and good implant stability. However, the magnetic mallet requires specific skills and may be costlier. Its effectiveness can vary by patient factors, emphasizing the need for careful candidate selection and further research on long-term outcomes.
Conclusion: The use of magnetic mallets for dental implant placement in narrow mandibular ridges shows promising results. Combining piezosurgery for bone splitting with magnetic mallet usage for bone expansion may enhance outcomes, providing a synergistic effect on the success of implants in these challenging cases.

1. Introduction

Dental implantology has become a cornerstone of modern dentistry, addressing issues ranging from single tooth replacements to full arch restorations. However, one of the significant challenges faced by surgeons is insufficient bone dimensions at the alveolar ridge, which necessitates additional procedures to augment bone volume before dental implant placement can proceed [1]. Techniques such as alveolar ridge splitting have been extensively documented in medical literature as successful methods to increase bone width [2,3].

Several approaches have been employed to perform bone splitting and expansion [4]. One commonly used approach involves the use of osteotomes, which are surgical instruments designed to split and widen the alveolar ridge. This method utilizes gradual force to expand the bone without fracturing it, thereby creating sufficient space for implant insertion. The use of hammering osteotomes in bone splitting and expansion for dental implant placement can present several drawbacks and challenges. Firstly, the technique involves applying mechanical force through hammering, which can lead to uncontrolled fractures or microfractures in the surrounding bone tissue, especially in the mandible [5]. This unintended damage may compromise the integrity of the bone structure and affect the stability of the implant site. Additionally, the force applied by hammering osteotomes can sometimes cause trauma to teeth and soft tissues surrounding the surgical site [3],

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leading to post-operative discomfort or delayed healing. Moreover, the level of precision with hammering osteotomes may vary, potentially resulting in uneven bone expansion or insufficient width for optimal implant placement. The prevalence of bad split (buccal bone fracture) complications can range from 7 % to 43 % in cases involving alveolar ridge splitting [6,7]. It was noted that bad splits occurred more frequently when a hammering osteotome was used [4,8]. These factors underscore the importance of careful technique selection and the consideration of alternative methods that offer more controlled and predictable outcomes in ridge splitting procedures.

Piezoelectric surgery and magnetic mallet have emerged as valuable alternatives to potentially overcome the limitations associated with traditional techniques like hammering osteotomes in bone expansion and dental implant placement procedures. The combined use of piezoelectric surgery and magnetic mallet in the context of alveolar ridge expansion for dental implant placement is relatively underexplored in medical literature. While both technologies individually have shown promising results in enhancing precision and minimizing tissue trauma during bone surgery [1–4], their simultaneous application for ridge expansion procedures has been mentioned sparingly in published works.

The potential benefits of integrating piezoelectric surgery and magnetic mallet in bone augmentation procedures could offer enhanced predictability, reduced surgical trauma, and improved patient outcomes in dental implantology. Thus, this paper aims to demonstrate the use of piezoelectric surgery and magnetic mallet in dental implantation on narrow mandibular alveolar ridges. This case report has been prepared in accordance with the SCARE criteria, ensuring adherence to established guidelines for reporting [9,10].

2. Case description

A 39-year-old female patient reviewed the outpatient clinics of the Department of Oral and Maxillofacial Surgery at the Faculty of Dental Medicine (Damascus University) for the replacement of missing teeth through dental implants. The patient was a non-smoker and did not complain of any systemic diseases. Upon extraoral clinical examination, no abnormalities such as asymmetry or palpable lymph nodes were noted. Intraoral examination revealed missing teeth in positions 35, 36, and 37. The attached gingiva at the site of teeth loss measured 3 mm. A cone-beam computed tomography (CBCT) examination was performed (PaXi3D Green, Vatech Co. Ltd.; Gyeonggi-do, South Korea), which indicated that the width of the alveolar ridge in the area of the missing teeth was approximately 4 mm. This distance was insufficient for placing 4 mm diameter implants. The vertical distance to the mandibular canal on CBCT was approximately 13 mm. Therefore, it was decided to perform alveolar ridge split and expansion, placing two implants each with a diameter of 4 mm and a length of 10 mm in the sites of the missing teeth 35 and 36.

Prior to the surgical procedure, sterile surgical drapes were applied, and the oral area was exposed. The peri-oral region and the oral cavity were cleansed and disinfected using 10 % povidone-iodine and 0.12 % chlorhexidine solutions, respectively. Local infiltrative anesthesia was administered using 4 % articaine solution with 1:100,000 adrenaline. Regional anesthesia was not used to avoid the risk of neurological complications, such as unintended nerve injury during site preparation and implant placement [11].

A surgical incision was made at the crest of the alveolar process. Two releasing incisions were performed anteriorly and posteriorly, creating a trapezoidal surgical flap. The releasing incisions extended beyond the mucogingival junction, ensuring a sufficient distance from the planned vertical bone cuts. A full-thickness mucoperiosteal flap was reflected. The mucoperiosteal flap was wide enough, ensuring optimal access and visibility for the surgical procedure site. A pencil was used to mark the bone, outlining the bone cuts and designating the implant site. A piezoelectric device (PIEZOSURGERY® white, Mectron; Carasco, Italy) was used to perform three bone cuts: a horizontal bone cut at the alveolar crest and two vertical bone cuts. The device was set to the cortical function. A standard ridge-splitting insert, namely OT7, was used to perform the bone cuts with copious irrigation. Bone cuts were made so that both horizontal and vertical cuts were at least 1 mm away from the adjacent teeth. The vertical cuts were made deep enough to extend beyond the cortical bone into the cancellous bone. In the case of posterior vertical cut, where there were no adjacent teeth distally, the vertical cut extended 3-4 mm posteriorly from the implant site. Sequential implant site drilling was started after ridge expansion. The alveolar bone was expanded using progressively sized tools attached to the magnetic mallet device (Magnetic Mallet, Meta Ergonomica Srl; Turbigo MI, Italy). The device was set during ridge expansion at force level 2, utilizing a sequential set of expansion tools, i.e., osteotome ridge expansion chisels. Double-angled instrument shafts facilitated easy access to the posterior area. These instruments have depth measures marked on the working tip (Fig. 1).

The tapping force was focused on the target area, and applied with each tool until reaching the predetermined depth (Fig. 2). The required depth for expansion with each expander was less than the depth the implant would reach by 3 mm; All four expanders were advanced to a depth of approximately 8 mm. The forces were precisely controlled, focused, and delivered within fractions of a second, facilitated by the magnetic mallet (Video: https://www.youtube.com/watch?v=K_lwxxN5CE0). This procedure was considered minimal-traumatic, generating a minimum amount of heat, and so did not require irrigation.

After ridge splitting and expansion, initial implant site drilling was performed using a pilot drill (2 mm in diameter). Sequential drilling (AnyOne® System, MegaGen Implant Co., Ltd.; Dalseong-gun, Korea) was carried out until reaching the final drill (3.6 mm in diameter). Two implants (AnyOne® Internal, MegaGen Implant Co., Ltd.; Dalseong-gun, Korea) with a diameter of 4 mm and a length of 10 mm were placed as planned. A bovine-sourced xenograft (Botiss Cerabone®, Botiss Biomaterials GmbH; Zossen, Germany) was used to fill the gaps between the bone plates and within the bone cuts. Bone graft granules size was 0.5–1 mm.

A two-stage surgical approach was implemented with a healing period of 4 months before the prosthetic phase. Clinically, the patient was monitored for six months following the loading of the implants. During this period, there were no complications related to abnormal healing, such as necrosis of the partially fractured buccal shelf. The patient expressed high satisfaction with the surgical procedure and its outcomes. The prosthetic restoration over the implants was fabricated using porcelain fused to metal (PFM) fixed bridge (Fig. 3). The impression for the restoration was taken using the open tray technique. To minimize metal artifacts, the restoration was removed during a CBCT scan performed 6 months post-loading.

Radiographically, the vertical dimension around the implants and marginal bone loss (MBL) were assessed using CBCT (Fig. 4). For the implant at the site of the missing tooth 35, there was no detectable marginal bone loss after 4 months from the surgery and 6 months post-loading. For the implant at the site of the missing tooth 36, a slight marginal bone loss of approximately 0.6 mm was found at 4 months post-surgery and increased to 1 mm after 6 months of loading. Overall, the results were satisfactory and are considered a success for the presented case within the follow-up period.

3. Discussion

The placement of dental implants in a narrow mandibular alveolar ridge presents several challenges, including the risk of compromising implant stability and longevity due to limited space and potential for complications, e.g., exposure of implant body surface and damage to adjacent anatomical structures. Traditional methods, such as osteotomes and standard surgical drills, may not always provide the precision and control needed in such scenarios [1]. The advent of the magnetic mallet, an innovative tool designed to enhance bone expansion and provide

Fig. 1. Sequential tools used with the magnetic mallet for alveolar ridge expansion: SPLIT: First introduction to the crest; CUT: Initial expander; EXP1: First expander; EXP2: Second expander.

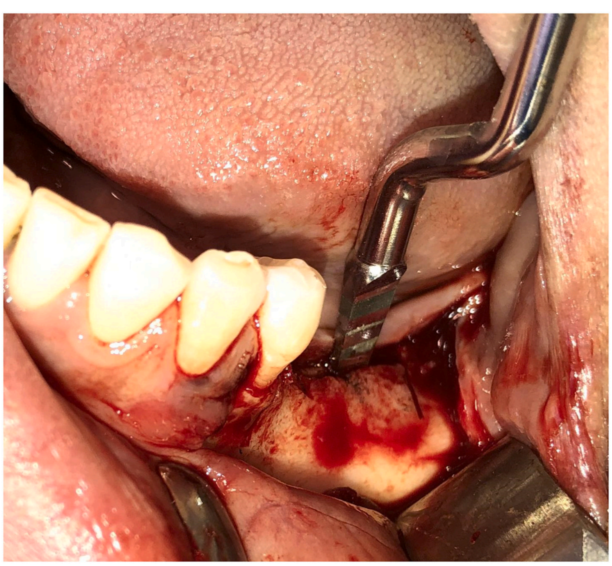

Fig. 2. Introducing the magnetic mallet expander into the horizontal bone cut at the alveolar crest.

precise control during preparation for implant placement, offers a novel approach to addressing these challenges.

The magnetic mallet utilizes electromagnetic forces to produce precise, controlled impacts [12]. This innovative tool has revolutionized various procedures in dentistry due to its ability to minimize trauma and enhance precision. In the dental field, magnetic mallets find wide-ranging applications, including extraction of teeth and roots, the delicate removal of impacted or retained teeth, maxillary sinus floor lifting, and aiding in bone manipulation procedures such as bone expansion, condensation, and ridge splitting [12]. Additionally, they can provide a quick and easy method for the effective removal of fixed crowns and bridges, making them an invaluable asset in modern dental practices [13].

Piezoelectric surgery, known for its ability to cut bone with high precision and minimal damage to surrounding soft tissues using ultrasonic vibrations, offers advantages in creating precise bone-selective osteotomies [14]. It significantly reduces the risk of damaging vital soft-tissue structures like nerves and blood vessels, and also preserving osteocytes during osteotomies, thereby enhancing the bone healing processes [1]. On the other hand, magnetic mallet technology provides controlled percussion force without the physical impact associated with traditional hammers, potentially reducing the risk of bone microfractures and enhancing procedural safety [4]. However, research specifically documenting the combined use of these technologies in ridge expansion is limited, highlighting an area where further exploration and clinical studies are warranted.

Piezoelectric surgery utilizes ultrasonic vibrations to precisely cut bone tissue while minimizing trauma to surrounding soft tissues [14]. This technology allows for controlled and gentle bone cutting, potentially reducing the risk of microfractures and preserving the integrity of the bone structure. It enables surgeons to achieve accurate bone dimensions needed for optimal implant placement without causing

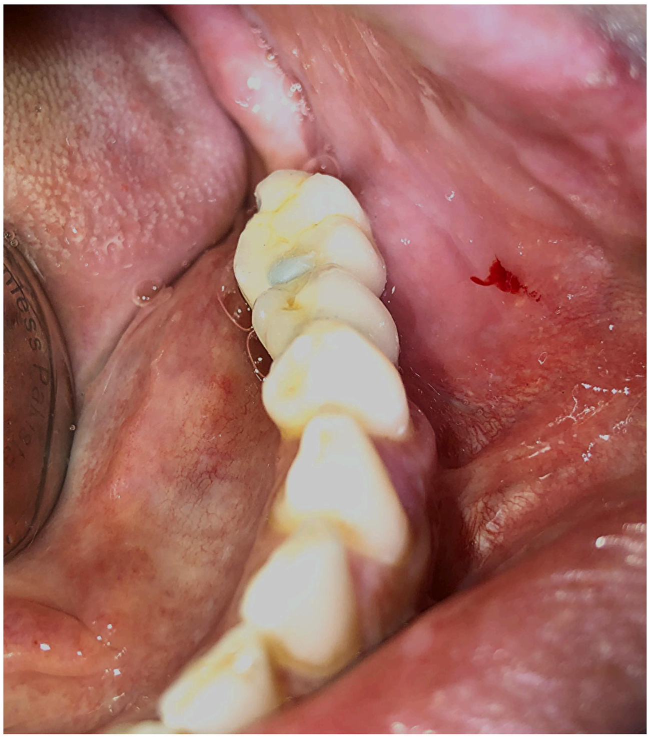

Fig. 3. A clinical image illustrating a fixed porcelain-fused-to-metal restoration placed over implants, effectively splinting the two implants together for enhanced stability and function.

unnecessary damage. On the other hand, magnetic mallet technology offers a unique advantage by providing controlled, non-invasive percussion force through electromagnetic principles [11]. Unlike traditional hammering, which relies on manual force and can lead to unpredictable outcomes, the magnetic mallet delivers consistent and precise impacts. This helps in achieving controlled bone splitting and expansion with minimal trauma to surrounding tissues, promoting quicker healing and reducing patient discomfort post-operatively [4]. Both piezoelectric surgery and magnetic mallet represent advancements that address the shortcomings of hammering osteotomes, offering safer and more predictable outcomes in ridge expansion procedures. Their ability to enhance precision, minimize tissue trauma, and promote efficient bone healing underscores their importance in modern dental implantology, ensuring successful and sustainable results for patients undergoing implant treatment.

The magnetic mallet provides enhanced control and precision during the bone expansion process. Its design allows for finely tuned mechanical force, which can be crucial in narrow ridges where excessive force might lead to fracture or other complications [15]. The ability to adjust the force settings and maintain consistent pressure minimizes the risk of over-expansion or damage to surrounding tissues. In addition to that, compared to traditional methods, the magnetic mallet can reduce the amount of trauma to the bone and soft tissues. By using magnetic pulses, it promotes bone expansion without the need for aggressive drilling or extensive bone removal. This can be particularly beneficial in preserving the integrity of the surrounding bone and minimizing post-operative discomfort. Also, the magnetic mallet's action promotes a more controlled and gradual expansion of the alveolar ridge. This approach can improve bone quality and density in the region of the implant, leading to better primary stability and potentially enhancing the success rate of the implant [16]. The effectiveness of the magnetic mallet in expanding the ridge may reduce or eliminate the need for bone grafting procedures. In cases where the ridge width is insufficient, this tool can facilitate the placement of implants without additional grafting, thus simplifying the surgical process and reducing overall treatment time.

One alternative option was to use narrower diameter implants; however, the ridge-splitting technique was employed in this presented case. The primary reasons for this choice included that the narrower implants could feature wider thread diameters (i.e., 3.9 mm thread diameter for a 3.5 mm fixture diameter), as well as the fact that the implants were placed free-hand, which does not guarantee the preservation of at least 1 mm of bone on the buccal and lingual sides in this narrow ridge.

In the presented case report, the magnetic mallet was employed to facilitate dental implant placement in a patient with a narrow mandibular alveolar ridge. The patient's condition was deemed suitable for ridge splitting and bone expansion. This treatment choice was based on comprehensive clinical and radiographic evaluations that confirmed the appropriateness for ridge expansion and the absence of contraindications. Indications for ridge expansion include a narrow alveolar ridge with a minimum buccolingual width of 2–3 mm, edentulous sites involving more than one tooth or in posterior distal-extension edentulous mandibular sites with adequate alveolar bone height [17,18]. Additionally, there were no contraindications present such as inadequate alveolar bone height, concavities, or fused bone cortices [17]. Among the available treatment options [19–21], such as guided bone regeneration (GBR), monocortical block bone grafts, and mesh particulate grafting, ridge expansion was chosen because it aligns well with established protocols [17,22]. The magnetic mallet was used to gently expand the alveolar ridge, allowing for the placement of implants with appropriate dimensions. The procedure was performed under local anesthesia, with careful monitoring to ensure optimal force application. Post-operative follow-ups indicated favorable outcomes, including minimal discomfort, neglectable marginal bone loss and good implant stability. The magnetic mallet technique was shown to substantially enhance the formation of new bone tissue and increase the number of osteoblasts [23]. The mallet's inherent ability to osteocondensate the bone tissue may improve primary stability and indicates a favorable trend for secondary implant stability [23]. The controlled expansion achieved with the magnetic mallet contributed to successful implant integration and a positive overall prognosis.

The use of a magnetic mallet for bone expansion is not yet commonly adopted in clinical practice in the region. For instance, clinicians in Syria still favor traditional methods for bone cutting, such as rotary discs, and for expansion, they mainly rely on conventional expanders or osteotomes. A comprehensive and careful evaluation of the pros, cons, benefits, and potential risks of the bone splitting and expansion technique should be conducted before opting for the faster method, especially if it may involve increased risks. Furthermore, bone expansion procedures are generally more common in the upper jaw, as it responds more easily to expansion, while the denser bone in the lower jaw makes expansion more difficult. The magneto-dynamic technique is usually the preferred method for maxillary implant sites in cases of poor bone quality and thin cortical bone [23]. However, this case showcases a successful approach for performing a bone crest osteotomy and expansion in the lower jaw, using techniques that minimized complications risk, allowing for the successful placement of dental implants.

Despite the advantages, there are several limitations and considerations associated with the use of the magnetic mallet in narrow mandibular ridges. The magnetic mallet requires a specific skill set and technique that may involve a learning curve for practitioners unfamiliar with its use. Proper training and experience are essential to achieve the best outcomes and avoid potential complications. Further, the magnetic mallet represents a relatively advanced technology, which may come with higher costs compared to traditional tools. Its availability and affordability could be a limiting factor in some clinical settings. Moreover, while initial results are promising, long-term data on the effectiveness and success rates of implants placed with the magnetic mallet are still limited. Ongoing research and longitudinal studies are necessary to fully understand the long-term outcomes and durability of this

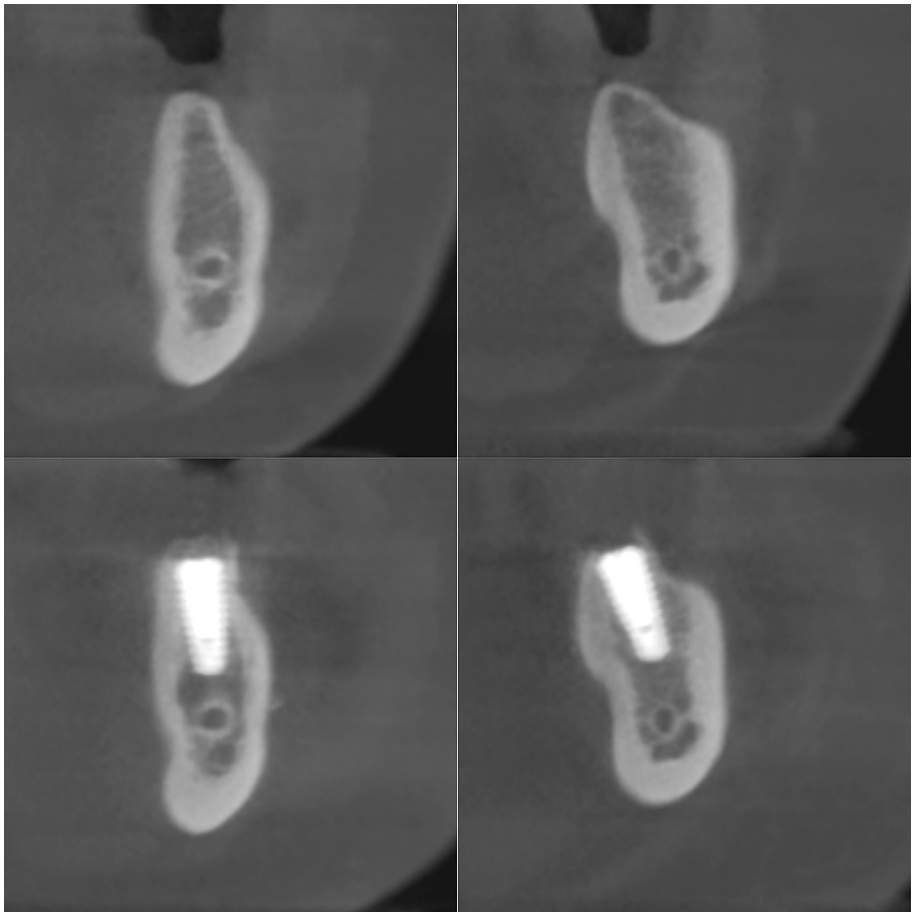

Fig. 4. Implant positions depicted before and after ridge splitting, bone expansion, and implant placement, as shown in a CBCT image.

approach. Also, the efficacy of the magnetic mallet may vary depending on individual patient factors, including bone quality, anatomical variations, and overall oral health. Not all patients with narrow ridges may be ideal candidates for this technique, and careful patient selection is crucial. For instance, the use of a magnetic mallet may interfere with pacemakers, as magnetic fields can affect implanted medical devices [24–26]. Although the magnetic field in bone expansion procedures is localized and modern pacemakers are relatively resistant to electromagnetic interference due to the protection of their internal circuitry [24], precautions should still be taken when treating patients with pacemakers or other electronic implanted systems. Alternative methods should be considered to avoid potential electromagnetic interference.

4. Conclusion

The use of the magnetic mallet for dental implant placement in narrow mandibular alveolar ridges provides several significant advantages, including reduced surgical trauma, improved precision, and effective bone expansion with minimal marginal bone loss. However, its application is not without limitations, including a learning curve, cost considerations, and the need for further long-term evaluation. As with any advanced technology, careful assessment of patient-specific factors and thorough understanding of the technique are essential for optimizing outcomes. Further research and clinical experience will help to refine the use of the magnetic mallet and establish its role in the broader context of dental implantology.

Author contribution

All authors have contributed substantially to the work.

Conceptualization, A.A., N.M.A and M.H.; methodology, A.A.; investigation, A.A. and N.M.A.; data curation, A.A.; writing—original draft preparation, A.A. and N.M.A.; writing—review and editing, N.M.A and M.H. All authors have read and agreed to the published version of the manuscript.

Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Ethical approval

Ethical approval was provided by the Ethical Committee of Damascus University, Damascus, Syria (Approval No. UDDS-OMFS-01-2023).

Guarantor

All authors accept full responsibility for the work and conduct of the study, had access to the data, and approved the decision to publish this work in *International Journal of Surgery Case Reports*.

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Conflict of interest statement

Each named author has no conflict of interest, financial or otherwise.

Data availability

The original contributions presented in the study are included in the article material, further inquiries can be directed to the corresponding author.

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