Harvesting the Bone Ring Graft from the Mandibular Symphysis: A Technique-Focused Protocol for Safe and Predictable Procurement

Nadim Sleman[*]
Dr. Ali Khalil[**]

(Received 1 / 3 / 2026. Accepted 6 / 5 / 2026)

□ ABSTRACT □

Background: The Bone Ring Graft (BRG) technique using autogenous bone from the mandibular symphysis is an advanced solution for reconstructing localized alveolar ridge defects, offering advantages over traditional block grafts in simplicity and reduced morbidity.

Objective: To present a detailed, step-by-step surgical protocol for the safe and predictable harvesting of a BRG from the mandibular symphysis.

Methods: This protocol emphasizes rigorous preoperative CBCT analysis to establish a three-dimensional "safe zone," defined by minimum 5 mm margins from tooth apices, mental neurovascular bundles, and the inferior mandibular border. It guides clinicians through critical phases: flap design, depth-controlled trephine osteotomy, atraumatic graft retrieval, donor site management, and graft preparation.

Results: Adherence to this structured approach enables surgeons to systematically minimize risks of nerve injury and root damage while optimizing graft viability. The technique yields a cylindrical corticocancellous graft of predetermined dimensions with minimal donor site morbidity.

Conclusion: When executed according to this focused protocol, the BRG technique is a reliable method for procuring high-quality autogenous bone, supporting successful functional and aesthetic implant rehabilitation.

Keywords: Bone ring graft, mandibular symphysis, autogenous bone graft, alveolar ridge augmentation, trephine osteotomy.

[*] **PhD Student - Oral And Maxillofacial Surgery, Oral And Maxillofacial Surgery Department, Latakia University (formerly Tishreen), Latakia, Syria. Email: Nadim.Sleman@Latakia-Univ.Edu.Sy**

[**] Professor - Head Of Oral And Maxillofacial Surgery Department, Latakia University (formerly Tishreen), Latakia, Syria. Ali.Khlil@Latakia-Univ.Edu.Sy

الطعم العظمي ذو الشكل الحلقي المأخوذ من الارتفاق الذقني: بروتوكول يركز على التقنية الجراحية للحصول على نتائج آمنة ويمكن التنبؤ بها

نديم سليمان [*]
د. علي خليل [**]

(تاريخ الإيداع 1 / 3 / 2026. قبل للنشر في 6 / 5 / 2026)

☐ ملخّص ☐

الخلفيّة العلميّة: تُعدّ تقنيّة الطعم العظمي الحلقي باستخدام العظم الذاتيّ من ارتفاق الفك السفلي حلاً متقدماً لإعادة بناء العيوب الموضعيّة في الحافة السنخية، حيث تقدّم مزايا مقارنةً بالطعوم الكتليّة التقليديّة من حيث البساطة وانخفاض معدّلات الإمراضيّة.

الهدف: عرض بروتوكولٍ جراحيٍ مفصّلٍ وخطوةً بخطوة للحصول على طعمٍ عظميٍّ حلقيٍّ من ارتفاق الفك السفلي بطريقةٍ آمنةٍ ويمكن التنبؤ بنتائجها.

الطرق: يؤكّد هذا البروتوكول على أهميّة التحليل الدقيق للتصوير المقطعي المحوسب بالحزمة المخروطيّة (CBCT) قبل الجراحة لتحديد "منطقةٍ آمنةٍ ثلاثيّة الأبعاد، محدّدةٍ بهامشٍ لا يقل عن 5 مم من ذرى جذور الأسنان والحزمة الوعائيّة العصبيّة الذقنيّة والحافة السفليّة للفك السفلي. يوجّه البروتوكول الأطباء عبر المراحل الحرجة: تصميم الشريحة الجراحيّة، القطع العظمي الأسطواني المتحكّم بالعمق، استخراج الطعم بشكلٍ غير راضٍ، تدبير الموقع المانح، وتحضير الطعم.

النتائج: يمكّن الالتزام بهذا البروتوكول المنهجي الجراحين من تقليل مخاطر إصابة الأعصاب وجذور الأسنان مع تحسين حيويّة الطعم. و تنتج هذه التقنيّة طعماً عظميّاً قشريّاً إسفنجيّاً أسطوانيّاً بأبعاد محدّدة مسبقاً مع نسبة إمراضيّةٍ بسيطةٍ في الموقع المانح.

الخاتمة: عند تنفيذ تقنيّة الطعم العظميّ الحلقي وفق هذا البروتوكول المركّز، فإنّها تثبت أنّها طريقةٌ موثوقةٌ للحصول على عظمٍ ذاتيٍّ عالي الجودة، ممّا يدعم نجاح إعادة التأهيل الوظيفيّ والجماليّ للغرسات السنّيّة.

الكلمات المفتاحية: الطعم العظميّ الحلقي، ارتفاق الفك السفلي، الطعم العظميّ الذاتي، تطعيم الحافة السنخيّة، القطع العظميّ بالسنابل الأسطوانيّة.

[*] طالب دكتوراه - قسم جراحة الفم والوجه والفكين، جامعة اللاذقية (تشرين سابقاً)، اللاذقية، سورية.
nadim.sleman@latakia-univ.edu.sy
[**] أستاذ ورئيس قسم جراحة الفم والوجه والفكين، جامعة اللاذقية (تشرين سابقاً)، اللاذقية، سورية.
Ali.khlil@latakia-univ.edu.sy

1. Introduction

1.1. Clinical Context and Problem

The rehabilitation of the atrophic alveolar ridge with dental implants remains a cornerstone of modern oral rehabilitation. Successful outcomes are predicated on the availability of sufficient bone volume to ensure implant stability, function, and aesthetics. In cases of localized horizontal and vertical deficiencies, autogenous bone grafting is still considered the "gold standard" due to its unparalleled osteogenic, osteoinductive, and osteoconductive properties, lack of immunogenicity, and complete biocompatibility [1, 2]. Among intraoral donor sites, the mandibular symphysis is a highly favored source, offering dense, corticocancellous bone in close proximity to common recipient sites in the maxilla and mandible [3].

1.2. Rationale for the Bone Ring Graft (BRG)

Traditional harvesting from the symphysis involves the procurement of a monocortical block graft, a technique well-documented but associated with specific challenges. These include the potential for graft fracture during adaptation, the need for precise contouring to fit the recipient site, and a higher risk of neurosensory disturbance due to the often-extensive osteotomy required near the mental foramina [4]. The Bone Ring Graft (BRG) harvested using a trephine bur, presents a compelling alternative. This technique yields a cylindrical graft of predetermined diameter and height. Its geometry is particularly advantageous for specific clinical scenarios, such as grafting fresh extraction sockets, narrow alveolar ridges, or small contained defects, where the ring can act as a contained scaffold. Compared to block grafts, the BRG technique can offer advantages in procedural simplicity, reduced intraoperative graft manipulation, and potentially lower morbidity due to a more limited and focused osteotomy [5,6].

1.3. Purpose of the Article

Despite its potential, the BRG technique lacks a widely adopted, step-by-step protocol that emphasizes safety and predictability. The proximity of vital structures—specifically the mental neurovascular bundle and the apices of the mandibular anterior teeth—demands meticulous planning and precise execution. This article aims to provide a detailed, technique-focused surgical protocol for the safe and predictable procurement of a BRG from the mandibular symphysis. The primary objective is to delineate a reproducible method that maximizes graft viability while systematically minimizing the risks of mental nerve injury, tooth root damage, and incision line dehiscence, thereby offering clinicians a reliable tool for autogenous bone reconstruction in implant dentistry.

2. Materials and Methods

2.1. Preoperative Planning and Anatomical Considerations

The successful and safe procurement of a bone ring graft from the mandibular symphysis is fundamentally dependent on rigorous preoperative planning and a deep understanding of the regional anatomy. This phase aims to identify suitable candidates, define the anatomical limits of the harvesting procedure, and prevent injury to critical structures.

2.1.1. Patient Selection

- **Indications:** The mandibular symphysis BRG is ideally suited for localized alveolar ridge augmentation where a small volume (typically 0.5 - 1.0 cc) of high-quality autogenous bone is required. Specific indications include socket preservation or grafting of a single-tooth extraction site, particularly in the aesthetic zone; horizontal augmentation of narrow alveolar ridges [7]; repair of small, contained peri-implant or periodontal bone defects; and as a complementary graft in conjunction with other biomaterials for staged implant placement.

- **Contraindications:** Absolute contraindications include active infection in the anterior mandible, insufficient bone volume in the symphysis (as defined radiographically), and severe uncontrolled periodontal disease. Relative contraindications include poor oral hygiene, heavy smoking, uncontrolled systemic diseases affecting bone metabolism (e.g., osteoporosis, diabetes), psychological intolerance to intraoral surgery, and a high smile line that may expose the scar [8].

2.1.2. Essential Radiographic Assessment

Three-dimensional imaging via Cone Beam Computed Tomography (CBCT) is the gold standard for preoperative assessment [9]. Its analysis is directed toward three key objectives:

1. **Quantification of Available Bone Volume:** Measurements are taken in the midline and paramedian regions to determine the maximum graft dimensions (diameter and height) that can be safely harvested. The symphysis typically offers a safe working zone extending from the canine to canine region, approximately 5 mm below the root apices and 5 mm above the inferior border [10].
2. **Mapping of Vital Structures:**
   - **Mental Foramina and Anterior Loop:** The position and trajectory of the mental foramina must be precisely located. The possible presence of an anterior looping of the mental nerve, reported in a significant percentage of the population, must be ruled out. A safety margin of at least 5 mm mesial to the mental foramen is recommended [11].
   - **Tooth Root Apices:** The proximity of the mandibular incisor and canine roots dictates the superior limit of the osteotomy. A minimum distance of 5 mm from the root apex to the planned osteotomy margin is critical to avoid devitalization.
3. **Determination of the Safe Harvesting Zone:** Synthesizing the above data, a three-dimensional "safe zone" is virtually planned. This zone is bounded anteriorly by the labial cortical plate, posteriorly by the lingual cortex, superiorly by a plane 5 mm apical to the root tips, inferiorly by a plane 5 mm coronal to the inferior border, and laterally by vertical lines 5 mm mesial to each mental foramen. The center of the trephine osteotomy must be placed within this zone.

2.1.3. Surgical Armamentarium

A specific instrument set ensures efficiency and precision:

- **Trephine Drills:** Sterile, internally cooled trephine drills with a diameter range of 6-10 mm, matching the planned graft size. Drill stoppers are essential for depth control.
- **Retrieval Instruments:** Fine bone curettes, a small bone vise, or a dedicated graft retrieval tool.
- **Bone Collection Trap:** Attached to the surgical suction to collect particulate bone debris generated during trephination for potential use as complimentary graft material.
- **Standard Surgical Kit:** Including periosteal elevators, retractors, and suturing materials.

2.2. Step-by-Step Surgical Protocol

2.2.1. Anesthesia and Preparation

1. **Anesthesia:** Administer local anesthesia via bilateral inferior alveolar nerve blocks and supplemental infiltration in the mental and incisive regions using 2% lidocaine with 1:100,000–1:200,000 epinephrine. Ensure profound anesthesia of the surgical field and lower lip to confirm mental nerve blockade.

2. **Antisepsis:** Instruct the patient to perform a 60-second oral rinse with 0.12% chlorhexidine gluconate. Apply povidone-iodine solution to the skin of the chin and perioral region. Drape the area to maintain a sterile surgical field.

3. **Antibiotic Prophylaxis:** Administer a preoperative antibiotic (e.g., 2g amoxicillin or 600mg clindamycin if allergic) one hour prior to incision, following established guidelines for bone grafting procedures.

2.2.2. Incision and Flap Design

1. **Landmark Identification:** Palpate the mucogingival junction and mental foramina bilaterally. Mark the planned incision with a sterile surgical pen.

2. **Incision:** Using a #15C blade, make a horizontal mucosal incision in the vestibular sulcus, approximately 0.5 cm below the mucogingival junction, extending from canine to canine.

3. **Flap Reflection:** Sharply dissect through the mentalis muscle fibers to expose the mandibular periosteum. Incise the periosteum and, using a sharp periosteal elevator, reflect a full-thickness mucoperiosteal flap superiorly to expose the symphysis from the alveolar crest to the inferior border. Maintain the periosteal integrity on the deep surface of the flap (Fig. 1).

4. **Exposure:** Adequately retract the flap to visualize the entire symphysis, the mental foramina, and the inferior border of the mandible.

2.2.3. Trephine Osteotomy – The Critical Phase

1. **Marking the Center:** Using a small round bur (e.g., #2), create a shallow pilot indentation at the center of the planned osteotomy within the predetermined "safe zone".

2. **Trephination Setup:** Select the trephine drill with the pre-planned diameter (e.g., 8 mm). Attach a **depth-limiting stopper** to the drill shank, calibrated to a depth 1–2 mm less than the total labio-lingual bone thickness measured on CBCT to prevent lingual cortex perforation.

3. **Osteotomy Execution:** Under copious saline irrigation, initiate drilling with the trephine perpendicular to the labial cortical plate. Apply gentle, intermittent pressure. Drill to the predetermined depth, pausing periodically to irrigate and clear bone debris (Fig. 2).

4. **Depth Verification:** Carefully remove the trephine and use a sterile periodontal probe to check the depth of the cylindrical osteotomy. Ensure the base is not perforated (Fig. 3).

5. **Completion of Cylinder:** The graft remains attached at its base to the lingual cortex. **Do not lever or twist the trephine to fracture the graft.** Instead, use the drills to prepare the site for the implant to be inserted later (Fig. 4). Use a **thin, safe-sided** bone ring osteotome to gently detach the base along the perimeter of the osteotomy. A fine, curved osteotome can be used with careful mallet taps to complete the separation, prioritizing preservation of the lingual plate.

2.2.4. Graft Retrieval and Handling

1. **Removal:** Use a fine bone curette or a dedicated graft retrieval instrument to gently elevate the cylindrical BRG from its bed. Avoid grasping the graft with forceps that may crush the trabecular structure (Fig. 5).
2. **Immediate Storage:** Place the retrieved BRG in a sterile container filled with sterile saline or the patient's blood collected from the surgical site.
3. **Optional Modification:** If required for the recipient site, the graft can be gently decorticated with a small round bur to promote bleeding or trimmed with a bone rongeur to adjust its height. Avoid excessive manipulation.

2.2.5. Donor Site Management

1. **Inspection and Hemostasis:** Irrigate the cylindrical defect thoroughly. Inspect for bleeding, particularly from the incisive canal or any visible vessels. Achieve hemostasis with pressure or topical hemostatic agents if necessary.
2. **Defect Grafting:** It is recommended to fill the residual defect to prevent contour deformity and promote bone regeneration. The defect can be filled with particulate autogenous bone collected in a bone trap during trephination; a low-substitution-rate allogeneic bone mineral (e.g., freeze-dried bone allograft) (Fig. 6); or a synthetic bone substitute. A collagen sponge or Platelet-Rich Fibrin (PRF) membrane can be placed over the graft material [12].
3. **Closure:** Re-approximate the mentalis muscle with resorbable sutures (e.g., 4-0 Vicryl) using a horizontal mattress technique to restore muscular function and support the soft tissue profile. Close the mucosal incision with either resorbable or non-resorbable monofilament sutures (e.g., 4-0 PTFE or 3-0 Nylon) in a continuous or interrupted fashion, ensuring **tension-free primary closure**.

2.2.6. Graft Preparation for Recipient Site

1. The BRG can be used immediately or stored briefly in saline.
2. For simultaneous implant placement, the implant osteotomy can be prepared through the center of the BRG prior to or after its placement at the recipient site [5].
3. The graft's cylindrical shape is inherently stable when press-fitted into a prepared osteotomy or extraction socket, often obviating the need for fixation screws.

3. Results

The described technique yields a high-quality, cylindrical corticocancellous bone ring graft of predetermined dimensions (e.g., 6-10 mm in diameter). When the preoperative planning and intraoperative protocol are followed meticulously, the graft is harvested with an intact cortical plate and viable cancellous component. The use of depth-limited trephination and adherence to the defined "safe zone" predictably avoids perforation of the lingual cortex and injury to adjacent neurovascular structures and tooth roots. Furthermore, the management of the donor site with graft material and tension-free closure promotes uneventsoft tissue healing and minimizes postoperative contour deformities.

4. Discussion

4.1. Advantages of the BRG Technique

The BRG technique harvested from the mandibular symphysis represents an evolution in autogenous bone grafting, combining efficiency, precision, and safety when performed with proper planning and technical discipline. Compared to traditional onlay block grafts, the BRG offers significant advantages. Firstly, it reduces surgical manipulation, as the cylindrical geometry often requires less contouring and can be press-fitted, potentially shortening operative time [5]. Secondly, the technique is associated with a decreased risk of postoperative complications. The constrained nature of trephine-based harvesting minimizes trauma to surrounding vital structures, including the mental nerve and tooth roots, while preserving the integrity of the labial and lingual cortical plates. This focus on a "safe zone" directly addresses the primary morbidities associated with symphyseal harvesting, such as neurosensory disturbance [4]. The predictable graft geometry also facilitates simultaneous implant placement, allowing for a more streamlined overall treatment approach [5].

4.2. Importance of the Structured Protocol

The success of the BRG technique is contingent upon strict adherence to a structured protocol. The emphasis on preoperative CBCT analysis cannot be overstated. As highlighted by Greenstein and Cavallaro [9] and Uchida et al. [11], three-dimensional imaging is essential not only for quantifying bone volume but for definitively locating the mental foramina and any anterior loop, thereby establishing a true "safe zone." The 5 mm margins recommended from root apices, the inferior border [10], and the mental foramen [11] are critical, evidence-based distances that provide a buffer against iatrogenic injury. The intraoperative steps, particularly depth-controlled trephination and atraumatic retrieval using osteotomes rather than levering, are designed to preserve graft integrity and protect the lingual plate.

4.3. Comparison with Other Techniques and Donor Sites

While the mandibular symphysis remains a workhorse for intraoral autogenous bone harvesting, a detailed comparison with alternative donor sites and graft techniques is essential to contextualize the advantages and limitations of the Bone Ring Graft (BRG) approach.

4.3.1. Mandibular Symphysis versus Mandibular Ramus

The mandibular ramus is another common intraoral donor site, offering several theoretical advantages, including its proximity to posterior maxillary and mandibular recipient sites, lower risk of visible scarring, and reportedly less postoperative morbidity regarding neurosensory disturbances [7, 13]. However, the ramus provides predominantly dense cortical bone with a minimal cancellous component. While this cortical density offers excellent mechanical stability for onlay block grafts, it is less ideal for the BRG technique, where a viable cancellous core is critical for rapid revascularization and osteogenesis [3]. The symphysis, by contrast, contains a richer cancellous matrix between thick labial and lingual cortical plates, making it uniquely suited for producing a true corticocancellous cylindrical graft. This composition enhances the graft’s biological performance when placed into a recipient site, particularly in extraction sockets or peri-implant defects where early angiogenesis is paramount [5].

4.3.2. Symphyseal BRG versus Conventional Symphyseal Block Graft

Traditional block grafting from the symphysis involves a rectangular or trapezoidal osteotomy, often requiring two or more vertical cuts and a horizontal base cut. This approach is associated with higher rates of donor site morbidity, including prolonged neurosensory alteration (reported in up to 25–40% of cases), contour deformity, and risk of tooth devitalization [4]. The BRG technique using a trephine drill fundamentally alters this risk profile. The circular, minimally invasive osteotomy preserves more of the labial cortical plate continuity, reduces the area of exposed cancellous bone, and eliminates the sharp corners that can act as stress risers predisposing to fracture [14]. Furthermore, the need for extensive periosteal elevation is reduced, which may lower the incidence of mentalis muscle dysfunction and chin ptosis [7].

4.3.3. Comparison with Extraoral Donor Sites (Iliac Crest, Tibia, Calvaria)

Extraoral sites such as the anterior iliac crest provide abundant corticocancellous or purely cancellous bone, making them suitable for large-volume or bilateral reconstructions [2]. However, these procedures require a separate surgical team, general or regional anesthesia, hospital admission, and are associated with significant donor site pain, gait disturbance (iliac crest), risk of infection, and visible scarring [15]. The tibial plateau offers a less morbid extraoral alternative but still involves lower extremity surgery and variable bone quality [16]. In contrast, the mandibular symphysis BRG is performed entirely under local anesthesia with or without conscious sedation in an outpatient setting, avoiding any extraoral incision. For localized alveolar defects requiring less than 1.5 cc of bone, the symphysis BRG offers a favorable morbidity-to-benefit ratio compared to any extraoral harvest [17].

4.3.4. BRG versus Allogeneic or Xenogeneic Bone Rings

Commercially available allogeneic (human-derived) and xenogeneic (bovine or porcine) bone rings have emerged as alternatives to autogenous grafts. These materials eliminate donor site surgery and reduce operative time. However, they lack osteogenic cells and rely entirely on osteoconduction and slow graft incorporation. Resorption rates are unpredictable, and complete remodeling may take years, during which time the mechanical integrity of the ring may decline. Autogenous BRG, by contrast, actively participates in new bone formation through osteogenesis (viable cells) and osteoinduction (growth factors within the bone matrix). The autogenous ring also maintains its volume more reliably during healing, a critical factor when simultaneous implant placement is planned [5, 18].

4.3.5. BRG versus Particulate Bone Graft with Membrane

Particulate bone grafts (autogenous, allogeneic, or xenogeneic) combined with barrier membranes represent a common alternative for ridge augmentation. While highly versatile, particulate grafts lack intrinsic structural stability and require containment by the membrane or a titanium mesh. They are more susceptible to displacement, membrane exposure, and volume loss from resorption [19]. The BRG provides immediate structural support, allowing implant placement in a single stage without the need for a separate membrane or fixation screw in many cases. The cylindrical shape also simplifies the surgical workflow compared to shaping and stabilizing particulate material [5].

4.4. Limitations

The primary limitation of this technique is the finite volume of bone available in the symphysis. It is suitable only for localized, small to moderate defects. For larger, multi-tooth reconstructions, other graft sources or techniques may be more appropriate. Additionally, patient factors such as a high smile line may still present a relative contraindication due to the potential for a visible vestibular scar.

5. Conclusion

The Bone Ring Graft (BRG) technique harvested from the mandibular symphysis represents an evolution in autogenous bone grafting, combining efficiency, precision, and safety when performed with proper planning and technical discipline. Through meticulous preoperative CBCT-based assessment, adherence to defined anatomical safety margins, and a structured surgical sequence, clinicians can reliably obtain a high-quality corticocancellous graft with minimal morbidity.

Compared to traditional onlay block grafts, the BRG offers significant advantages—namely, reduced surgical manipulation, a predictable graft geometry that facilitates simultaneous implant placement, and decreased risk of postoperative complications. Moreover, the constrained nature of trephine-based harvesting minimizes trauma to surrounding vital structures, including the mental nerve and tooth roots, while preserving the integrity of the labial and lingual cortical plates.

Ultimately, this refined, technique-focused protocol enables clinicians to perform mandibular symphysis grafting with greater confidence and reproducibility. When integrated into a comprehensive treatment plan, the BRG approach provides a reliable autogenous solution for localized alveolar ridge deficiencies, supporting the continued pursuit of functional and aesthetic excellence in implant dentistry.

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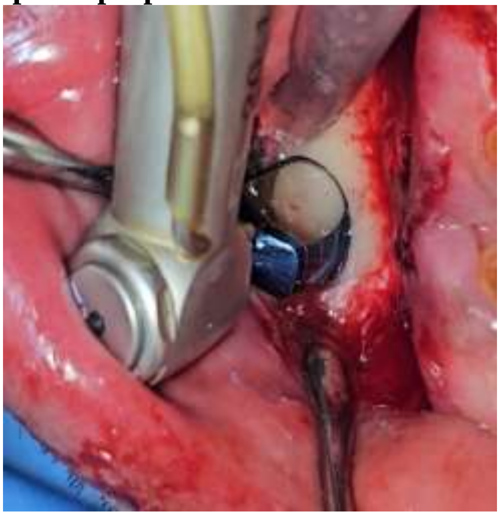
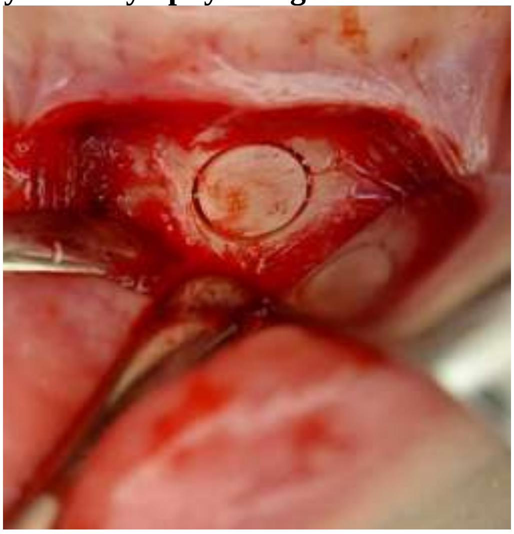
Figures:

1- A full-thickness mucoperiosteal flap exposing the symphysis

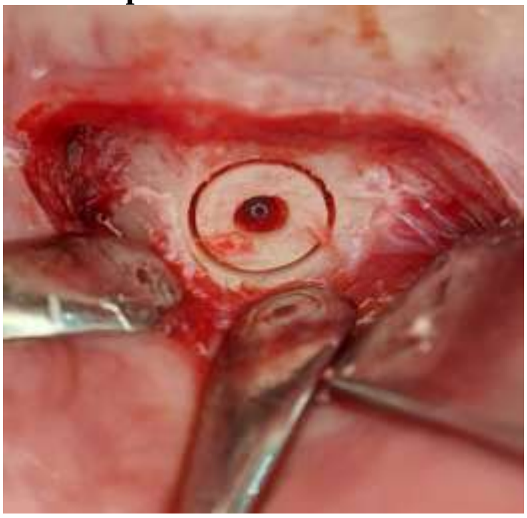
2- Drilling with the trephine perpendicular to the labial cortical plate.



3- Trephine osteotomy in the symphysis region



4- Preparing the site of the implant.



5- Cylindrical bone ring graft removal.

6- Defect grafting after bone ring harvesting.