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A LITERATURE REVIEW: CHIN GRAFT HARVESTING TECHNIQUES FOR PLACEMENT OF DENTAL IMPLANTS

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ABSTRACT

Loss of teeth renders the alveolar ridge edentulous. However, the deficiency of bone volume is often the reason restricting the use of implants for prosthetic rehabilitation. The availability of abundant bone in the mandibular symphysial region is being increasingly considered as a viable donor site. The aim of this study was to evaluateindications, limitations, presurgical evaluation, surgical protocol, and complications associated with mandibular block autografts harvested from the symphysis region for alveolar ridge augmentationwith respect to the course of the mandibular incisive canal (MIC), the intrabony continuation of the mandibular canal mesial to the mental foramen.

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INTRODUCTION

Dental implantology is quickly growing to be a reliable, esthetically acceptable option for replacement of missing teeth.However, in clinical practice, the deficiency of bone volume is often the primary reason for avoiding implant treatment (Andersson, 1995). The solution lies in re-establishing the ridge volume consistent with prosthetic design and with suitable load-bearing lamellar bone for long-term stability of the implant therapy (Buser, 1994). Bone grafting procedures have become standard care in patients with insufficient bone volumes at potential implant recipient site (D'Addona, 2000). Despite recent advances in bone grafts and bone-substitute technology, intramembranous autogenous osseous transplants are regarded as the gold standard for reconstruction of the oral and maxillofacial region, especially any deficient alveolar ridge area (D'Addona, 2000). This is because of their osteoinductive, osteoconductive, and nonimmunogenic properties. If the amount of bone necessary for augmentation is modest, intramembranous autografts can be easily obtained from regional intraoral sites such as maxillary palate and tuberosity, mandibular symphysis, angle of the mandible, ramus and bony exostosis (Hunt, 1999). Osseous ridge deficiencies require restoration before implant surgery to enable reliable and esthetic implant placement. The need to repair dentoalveolar atrophy and bone defects has resulted in the use of various techniques and sources of graft material.Auto transplant bone grafts still provide the most rapid and predictable results in terms of resultant bone quality and quantity. A variety of extra- and intraoral donor sites are available to the surgeon including the iliac crest, tibia, ribs, calvarium, zygoma, maxilla, and mandible. The obvious advantages of bone grafts from intraoral sites are convenient surgical access, avoidance of cutaneous scarring, reduced operation time, use of local anesthesia on an outpatient basis, and therefore lower costs.Furthermore, intraoral bone grafts favored because of the identical embryonic origin of donor and receptor sites, as ectomesenchyme bone exhibits less resorption due to faster revascularization compared with bone of mesenchymal origin. The mandibular symphysis is a very common intraoral donor site for autogenous bone grafts and has been used successfully in avariety of clinical applications.
Chin offers a large amount of cortico-cancellous autograft and easy access among all the intraoral sites. It can be easily harvested in the office settings under local anesthesia on an

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out-patient basis. Proximity of the donor and recipient sites reduce operative time and cost. Convenient surgical access, low morbidity, elimination of hospital stay, minimal donor site discomfort and avoidance of cutaneous scars are the added advantages.The mandibular interforaminal region is generally considered a safe surgical area, involving few risks of damage to vital anatomic structures. However, the anterior mandible contains intrabony vascular canals. Even though the mandibular symphysis is considered to have an excellent risk–benefit ratio, frequent complications have been described following chin bone harvesting. Donor site morbidity involves intraoperative bleeding, wound dehiscence, mental nerve injury, pulp canal obliteration, as well as loss of pulp sensitivity of the anterior lower teeth, the latter representing neuropraxia of the mandibular incisive nerve (Hunt, 1999).

Indication: Chin bone block can be used for predictable bone augmentation of up to 6 mm in horizontal and vertical dimensions. Cortico-cancellous graft ranging from 3 mm to 11 mm thickness, with most of the sites providing 5-8 mm can be harvested from symphysis. Up to three teeth edentulous site can be augmented. For graft volume of more than 6 to 7 mm thickness, a secondary block graft can be used after appropriate healing of the initial graft (Pikos, 2005).

Presurgical Considerations: Patient selection entails complete medical and dental evaluations for the success of the osseous transplant procedures. The symphyseal site must be clinically evaluated for hard and soft-tissue deficiencies, ridge morphology, vestibular depth, width of the attached gingiva, periodontal and endodontic health of the lower anterior teeth and premolars; and also,location of theneurovascular bundle (D'Addona, 2000). Wax pattern on diagnostic casts of the dimensions of reconstructed defect can be done to determine graft requirements and to prepare surgical template for precise placement of the transplant. Radiographic examination with the periapical, panoramic, lateral cephalogram, conventional or cone-beam computed tomography (CBCT) scan are advised as per need. Periapical radiograph should be done to check the presence of periapical pathologyand also to check the length of the roots of lower anterior tooth. Panoramic view can be taken to trace location of the mental foramen and mandibular canal. Lateral cephalogram may be made to determine width, bone quality at chin area and its relation to neighboring teeth. Computed tomography (CT)/CBCT scan should be done for accurate treatment planning, to determine the quantity and quality of the graft at the donor site and to see the neurovascular components, which can affect the surgical design (D'Addona, 2000).

Anatomical considerations

Musculature: The chin musculature is composed of three muscle groups: mentalis, orbicularis oris and depressors (anguli oris and labii inferioris). As orbicularis oris and depressors have little effect on the chin position, they are not of significant relevance surgically. The mentalis muscle is a short, stout and paired muscle; usually separated by a small column of adipose tissue in the midline. It originates from the incisive fossa of the mandible at the level of the root of the lower lateral incisors, just below the attached gingiva and insert into the integument of the chin. It is innervated by the marginal mandibular branch of the facial nerve. Over-reflection of the mentalis muscle may lead to loss of facial contour by inversion of the lower lip and flattening of the labiomental fold (pseudoprognatism) (D'Addona, 2000).

Nerves and foramina: The inferior alveolar nerve usually divides into two anterior terminal branches, the mental and incisal nerves. In the molar-premolar region, mental nerve continues upward in the mental canal (Wadu, 1997). The mental foramen is usually located apical to the second mandibular premolar or between apices of the premolars. The mental nerve can present a loop, an anterior extension of the inferior alveolar nerve mesial to the mental foramen, prior to exiting the canal. Sensory dysfunction may occur due to direct nerve damage or due to traumatic edema of the epineurium during preparation of an osteotomy (Bavitz, 1993 and Rosa, 2013). The foramen and the anterior loop may not appear on conventional radiographs. For detection, CT/CBCT scans are more accurate than conventional radiographs. Its presence should be verified surgically by using curved probes to prevent nerve injury (Apostolakis, 2013).

Mandibular incisive canal (MIC): Most of the time, the incisive nerve did not reach the area below the central incisors. It is located closer to buccal cortex than the lingual cortical plate and curves toward the lingual side at the symphysis menti (Olivier, 1928). It gives neurovascular supply to the lower incisors, canine and first premolar. Several procedures such as endosseous implant placement, genioplasty, autograft harvesting for ridge and sinus augmentations, screws and/or plate fixation in symphysial and parasymphysial fractures are performed in this interforaminal region (Mraiwa, 2003; Jacobs, 2002; Pires, 2012 and Al-Ani,).

Mandibular anterior teeth: Cuspids have the longest root in the mandibular anterior sextant followed by lateral incisors and central incisors (Ash, 2003 and Ash, 2003). To preserve tooth vitality, a minimum clearance of 5 mm from apices seems reasonable (Misch, 1992).

Osseous quality of mandibular symphysis: The maximum volume of block graft that can be harvested as a rectangular graft block from the mandibular symphysis is around 1-1.5 cm in height and around 4.0 cm in width, centred at the midline of the mandible (Park, 2004).

Surgical Harvest

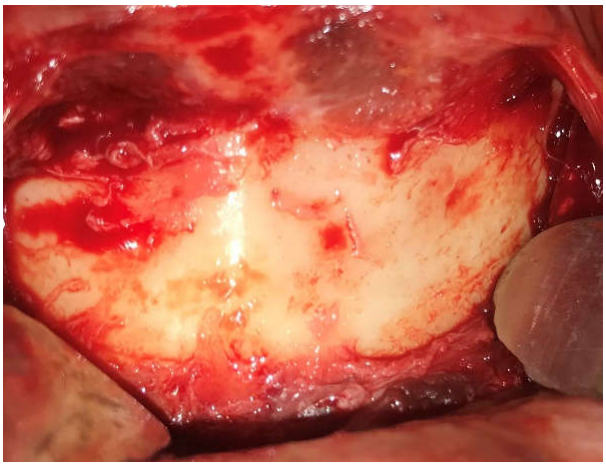
Anesthesia: Bilateral mandibular block with 2% lidocaine HCL (1:100,000 epinephrine) accomplish anesthesia for V3 innervation. One-third-carpule of infiltration in front and below each mental foramen and also in the midline at the base of the mental protuberance should be given. Another carpule of anesthetic is divided in half and an infiltration injection on each side of the superior genial tubercle near the base of the mandible should be given (Misch, 2011).

Incision design for surgical access to symphysis

Depending on anatomy, surgical access to symphysis area can be obtained via a crestal incision, vestibular incision, mid-keratinized tissue.

Vestibular/alveolar mucosa incision: Horizontal incision should be made 1 cm beyond MGJ and extends to each distal region of the canines. Vertical incision is given anterior and above the mental foramen, between canine and premolar.

Horizontal incision should be given in apicolingual direction toward the bone to incise through the mentalis muscle. It will preserve 3 mm of periosteum and mentalis muscle, which will later be used for reattachment of mentalis muscle. Below this point a full thickness incision is made and a full thickness mucoperiosteal flap is reflected toward the base of the mandible to the level of the pogonion. Keep the most inferior aspect of periosteal attachment of mentalis muscle intact (Misch, 2011 and Gapski, 2001).



Sulcular approach : The incision begins in the sulcus from second bicuspid of one side to another side. An oblique releasing incision is made at the distal buccal line angle of these teeth and continues into the depth of the buccal vestibule. A full thickness mucoperiosteal flap is reflected up to the inferior border to expose the symphysis. Short duration of bone exposure (15-30 min) and frequent irrigation should be done with saline to prevent dehydration. planning of root surface should not be done to achieve "reattachment" insteadof "new attachment" (Misch, 2011 and Gapski, 2001).

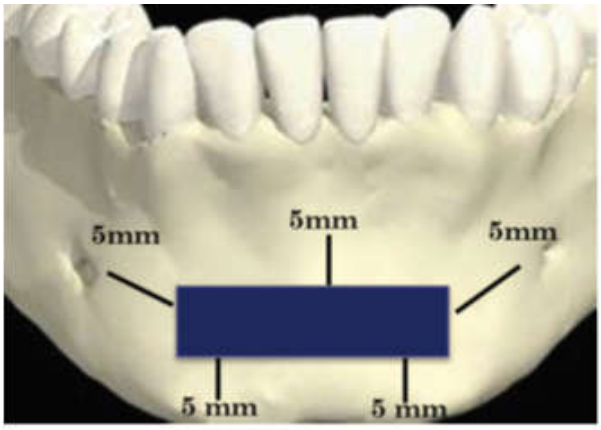
Submarginal/attached gingiva incision: *M*ost commonly advised incision of choice. The horizontal or parasulcular, scalloped incision should be given in the attached gingiva at least 1 mm above the mucogingival junction. If >3 mm keratinized gingiva present, beveled incision in apical direction is given. If >3 mm of keratinized gingiva present, perpendicular incision to the underlying bone is given to gain a butt joint for facilitation of tissue adaptation during the suturing. The vertical incision can be given between canine and first premolar or at the midline, from a safe distance of a local neurovascular bundle. The midline vertical release can be given when the harvest is for the span of 3 teeth or less and it often extends to within 5 mm of the inferior aspect of the mandible (Misch, 2011; Gapski, 2001 and Schuler, 2005).

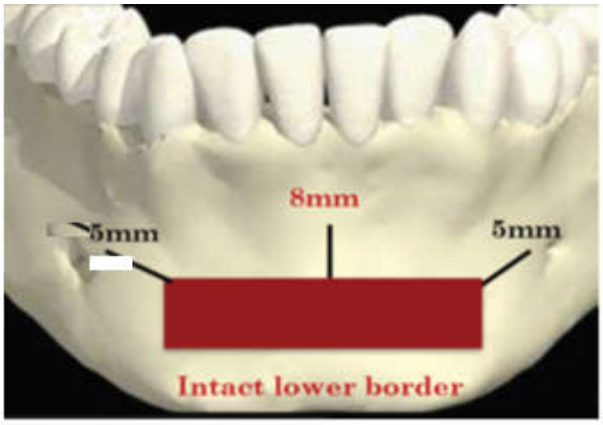
Crestalincision: It can be given when single or multiple lower anterior teeth are missing. The crestal incision on the edentulous span will be continued with the sulcular incision on the adjacent dentate area if present (Toscano, 2010).

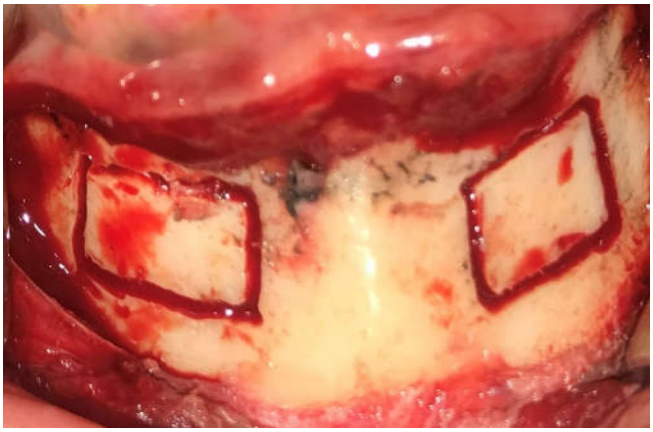
Rule of Harvesting

Rule of 5's --- Misch 1992: All the bone cuts should be perpendicular to the cortex in a right angle to the vestibular plane of the symphysis. The superior cut should be 5 mm below root apices to prevent injury to tooth roots and MIC. The inferior cut should be 5 mm above the lower border.Vertical cuts should be at least 5 mm away from the mental foramen. Depth of the cut should be at least through the outer cortex and to the opposite cortical plate to obtained monocortical graft. Lingual cortex should not be perforated.[22]

New Safety Guidelines: Due to insufficient bone height the above proposed safety rules are not possible in all patients. This has led to the contents of MIC being vulnerable to damage in over 50% of the patients. New safety margins proposed by Pommer *et al*. in 2008 for chin bone harvesting reduces the risk of injury to the MIC to 16%.The new safety margins are, depth of the bone graft should be 4 mm and the distance to the tooth apices should be kept at least 8 mm. The lower border should be kept intact with the 5 mm safety distance from the mental foramen. According to new safety guidelines of Pommer *et al*., the symphysis can be used as a donor site in 56% of patients to harvest a graft of 10 mm diameter, in 74% of patients for a graft of 8 mm diameter and in 90% of patients for a graft of 6 mm diameter. The residual 10% of the population are not suitable for chin bone harvesting (Pommer, 2008).







Armamentarium for Harvesting

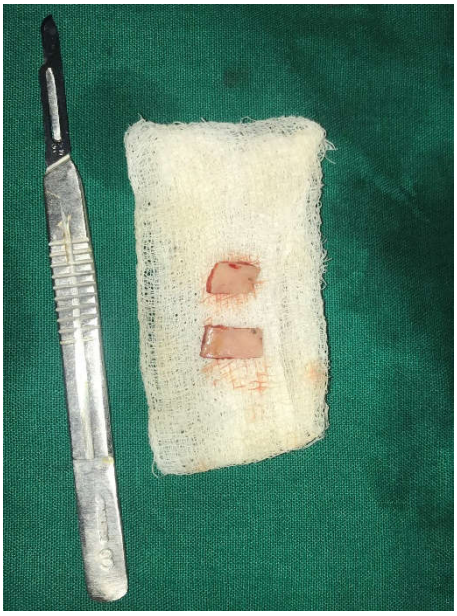
The ideal bone cutting instrument should be easy to handle, less time consuming as atraumatic as possible and should prevent more amount of bone loss during harvesting.

- Reciprocating and oscillating saws allow thin cuts and prevent bone loss
- Fissure bur no. 702 is very effective and cheap instrument. It leads to more amount of heat generation and additional bone loss of around 1 mm
- Trephines are used when small cores of cortico-cancellous bone are needed. Depending in the diameter of the trephine bur, cores of 4-10 mm can be harvested. It is very easy, atraumatic and less time-consuming procedure
- Disc acts as a saw and makes very thin cuts. A soft-tissue guard is must to prevent damage to the surrounding tissues
- Piezotomed instruments are preferred over any other instruments as they allow for maximum intra-operative precision and minimal tissue damage. It reduces the bone loss during osteotomy and gives precise cut of only 0.5-0.7 mm in width. The selective frequency of 25-30 KHz cuts only the bone as to cut the soft-tissue, ideally a frequency of 50 KHz is needed. Thus, it is atraumatic to the soft-tissues, nerves, periosteum and the Schneiderian membrane.

Patterns of Harvesting: Variouspatterns such as J-graft, ring graft, rectangular blocks or cylindrical bone cores can be harvested from chin 2 mm larger block outline than the target size is recommended to allow for contouring of the block after removal. Furthermore, leave a 3 mm midline strut of mental protuberance to retain support for the chin profile. More than one piece of bone block can be harvested from symphysis. Two bone blocks are often easier to harvest and provide good access to the second larger block. Particulate grafts can be harvested from chin by using bone scraper or bone crusher (Schuler, 2005).

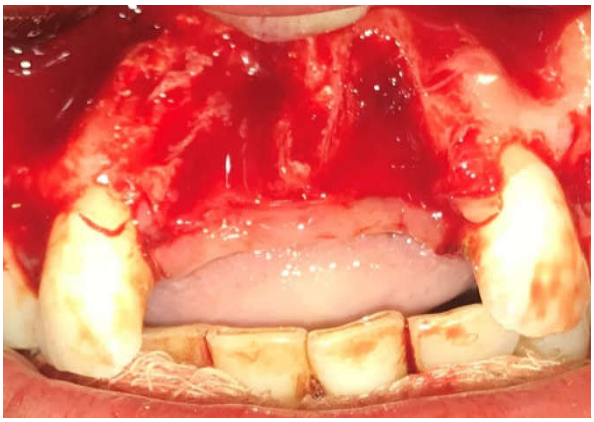
Trephine technique: In 1999, Hunt and Jovanovic followed Misch's safety margins to harvest a trephine-based bone cylinders or particulate bone. They proposed 2 designs to harvest trephine cores which are:

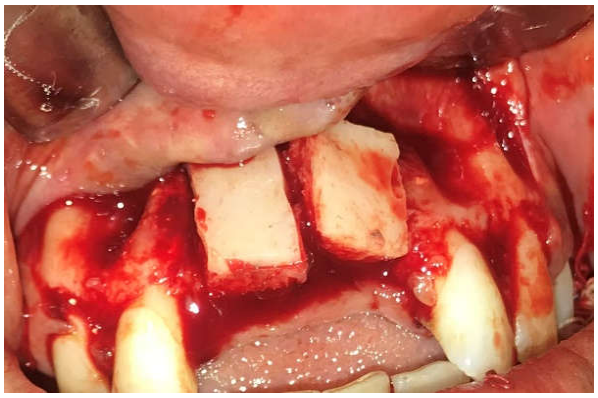
- "Audi design", pattern of 4 trephine cuts, square shaped blocks can be used when moderate harvesting is needed. It consists of 4 overlapping 8-mm rings in the mid-symphyseal region (Hunt, 1999).
- "Reverse-Olympic design" can be used when a large amount of bone is needed. 4-5 large 8-mm trephine rings in the midline of the symphysis and 2 separate small 6-mm trephine rings on the superior and lateral borders (Hunt, 1999).

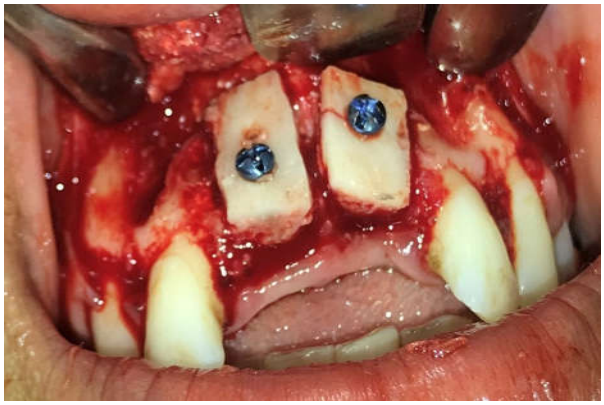


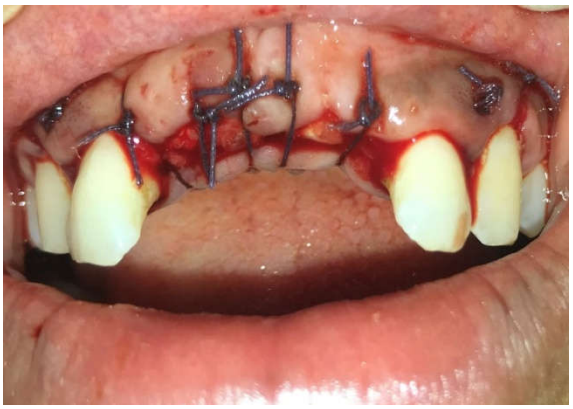
Auto transplant bone is associated with the necessity of a second surgical intervention introducing the risk of donor site morbidity. In preimplantologic surgery, the patients' acceptance of disorders emerging in previously healthy regions is generally reduced, as complications at the donor site are not considered part of the repair procedure. Avoiding nerve damage at a donor site is an essential ethical and forensic

issue, because a variety of donor sites for autogenous bone are available and alveolar reconstruction might as well be accomplished by the use of bonesubstitute materials. While each donor site has its own inherent problems hardly comparable with each other the surgeon's choice must be well grounded and justifiable. If the MIC is injured in the course of chinbone harvesting, pulpal sensitivity and vascularity of all teeth mesial to the damage may be affected (Misch, 2011; Gapski, 2001 and Schuler, 2005).









Post-operative complications include pain, swelling andbruising, ptosis of chin, infection, suture line opening andneurosensory deficits of the lower lip, chin and anteriormandibulardentition (Pikos, 2005 and Park, 2008). The most common concern of patients is thepost-operative change in soft-tissue contour of chin.No evidence of dehiscence or chin ptosis was seenusing the sulcular approach. Extra-oral pressuredressing (bandage) should be given for 3 days. In 1979Hillerup (Hillerup, 1979), suggested the reflection of flaps no deeperthan one-third of the total distance from the vermilionborder to mucogingival junction to prevent reduction inthe lower lip height and pseudoprognatism. A block leaves behind a five-wall defect with goodpotential to self-repair (Cardaropoli, 2003 and Cardaropoli, 2005). Donor-site defects regenerateby a process similar to endosteal fracture healing. Duringbone wound healing, rapid vascularization of the defectsite is paramount for successful neo-osteogenesis (Reddi, 1987 and Albrektsson, 1980). The normal cascade of physiologic healing events inresponse to surgical injury, a regionally acceleratedprocess, favors the bone repair at the donor site.This phenomenon was proposed by Frost, (Frost, 1989). Montgomery and Moed (Montgomery, 1989) found the completereplacement of the cancellous bone after 1 year in thecanine model. A studydone by Verdugo *et al*. (Verdugo, 2010) showed approximately 75%of filling of symphysis defect in around 27 months. Repair of mandibular symphysis defects is multifactorialand dependent on time and size of the harvested graft (Verdugo, 2010). Recently, a combination of bovine bone and PRPhas shown such a rapid healing that it was possible touse the same site for graft re-harvesting after 5 monthsof the healing period (Schwartz-Arad, 2009).

Conclusion

The intramembranous transplant like mandibular symphysis is a convenient source and provides a dense quality transplant. The thick cortical layer of the transplant prevents or reduces resorption and the cancellous part help to hasten the regeneration. It does not produce immune reactions and are incorporated by osteoclastic resorption with a shorter healing period compared with other methods of osseous repair. Proper case selection and accurate surgical planning is the prerequisite for successful graft harvesting. Applying the new safety recommendations and proper patient selection in chin bone harvesting could reduce the risk of altered post-operative tooth sensitivity due to injury of the mandibular incisive nerve.

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