Wide-Diameter Implant Placement and Internal Sinus Membrane Elevation in the Immediate Postextraction Phase: Clinical and Radiographic Observations in 12 Consecutive Molar Sites

Zvi Artzi, DMD[1]/Alex Parson, DMD[2]/Carlos E. Nemcovsky, DMD[1]

Purpose: *To evaluate whether the combination of 5 surgical techniques in implant dentistry could be performed simultaneously in a predictable manner as effectively as each technique separately.* ***Materials and Methods:*** *Immediately postextraction, 12 wide-diameter (WD) implants were placed in maxillary first or second molar sites. The residual vertical bone height ranged between 6 and 9 mm (average 7.8 mm). An internal sinus elevation, via the osteotomy site, was carried out in 10 sites using an osteotome tool. Implants were then self-tapped into the osteotomy site followed by insertion of a customized healing screw. Consequently, horizontal gaps between the bony walls and the implant neck were filled by either bovine bone mineral or tricalcium phosphate particles. Full soft tissue closure around the healing cap screw was achieved by coronal positioning of the buccal flap.* ***Results:*** *Soft tissue healing around the 12 implants was immaculate. In 10 sites, internal osteotome sinus membrane elevation resulted in a height gain of between 2.5 and 6 mm (average 4.3 mm). Radiographically, bone-to-implant contact was evident. All implants were integrated and the prosthetic phase was completed after 6 months.* ***Discussion and Conclusions:*** *The combination of 1-stage technique and immediate placement of WD implants, along with internal sinus floor elevation and no soft tissue reflection at the time of implantation, is an achievable task and can be performed predictably. Time, cost, and morbidity are reduced, and the prosthetic solution is also eased for the benefit of the patient.* (Int J Oral Maxillofac Implants 2003;18:242–249)

Key words: *dental implants, extraction site, immediate implantation, maxillary sinus, sinus augmentation, wide-diameter dental implants*

Tooth loss associated with periodontal breakdown occurs frequently in the first and second maxillary molar region.[1,2] Together with rapid residual ridge resorption in the postextraction phase,[3] this tooth loss often results in inadequate bone volume for the accommodation of endosseous implants. Furthermore, low bone density, ie, types III or IV,[4] and pneumatization of the sinus challenge fixed implant reconstruction in the posterior maxilla. A sinus floor lift procedure[5,6] can be the solution for inadequate height and for an appropriate implant length of at least 10 mm. This surgical sinus floor elevation procedure has proved to be highly predictable.[7–14]

Functional implant success rates for osseointegrated implants in the augmented sinus have been reported to be comparable to those for implant placement in an edentulous ridge.[14,15] However, this procedure is more time consuming and expensive, increases morbidity, and requires a highly skilled medical-surgical team. Summers[16,17] introduced a more conservative approach for gently elevating the sinus membrane via the implant osteotomy site.

[1]Senior Lecturer, Department of Periodontology, The Maurice and Gabriela Goldschleger School of Dental Medicine, Tel Aviv University, Tel Aviv, Israel.
[2]Postgraduate Student, Department of Prosthodontics, The Maurice and Gabriela Goldschleger School of Dental Medicine, Tel Aviv University, Tel Aviv, Israel.

Reprint requests: Dr Zvi Artzi, Department of Periodontology, The Maurice and Gabriela Goldschleger School of Dental Medicine, Tel Aviv University, Tel Aviv, Israel. Fax: +972-3-6409250. E-mail: zviartzi@post.tau.ac.il

Autogenous bone chips, or any biocompatible and osteoconductive allograft or xenograft, can be applied via the osteotomy site before implant placement. This can result in a gain of 2 to 3 mm for the implant housing within the sinus space without the need for a lateral fractured-window technique. Healing time is also shortened.

Implant placement in the immediate postextraction phase is another approach that can reduce treatment time. Implantation into fresh extraction sites[18–26] is generally as successful and predictable as placement of implants in a matured edentulous ridge. However, in most of these studies, single-rooted tooth sites have been used.

Wide-diameter (WD) implants have been introduced[27–31] to facilitate immediate implantation in multi-rooted socket sites. Some investigators[28,29,31–34] have achieved comparable results, while others[35,36] have shown a reduced success rate. The purpose of this study was to introduce and evaluate 1-stage WD implant placement in maxillary multi-rooted socket sites immediately postextraction, with some placed in conjunction with internal sinus membrane elevation via the osteotomy site.

MATERIALS AND METHODS

Patients who required endosseous implants to replace a maxillary first or second molar scheduled for extraction were selected for the study. When the residual ridge was less than 10 mm in height, an internal sinus elevation technique was carried out during preparation of the osteotomy site followed by implant placement.

The study consisted of 10 adult patients (7 men and 3 women) aged 34 to 58 years (average 47.5 years). All patients were in good health with no systemic disorders. No ongoing pathologies and/or chronic sinusitis in the maxillary sinuses were known. Patients were nonsmokers or smoked less than 10 cigarettes per day. All participants signed an informed consent form. A detailed explanation of each stage of the surgical procedure and the rationale for combining all surgical phases were provided. The Ethics Committee of Tel Aviv University approved the study.

Advanced chronic periodontitis, residual asymptomatic roots, root caries, and/or loss of tooth substance that precluded restoration were indications for extraction, as were teeth scheduled for extraction as part of the overall prosthetic treatment plan. No ongoing periapical pathology and/or radiolucency that could implicate an inflammatory process were observed. Such incidences or symptomatic and/or purulent sites were excluded. In 2 patients, the procedure was performed bilaterally with the same surgical protocol; thus, 12 sites in 10 patients were examined.

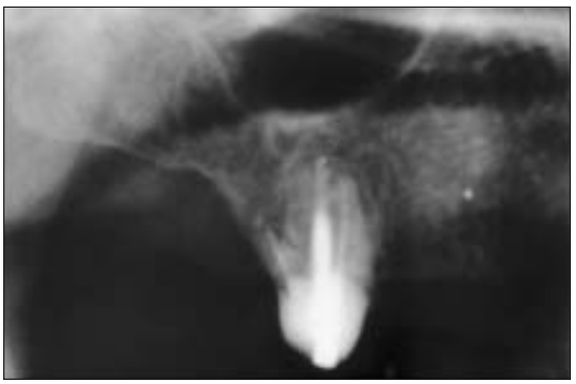

Fig 1 Preoperative radiograph of the maxillary right molar before extraction.

One hour before surgery, 1.0 g of amoxycillin (Moxypen Forte, Teva Pharmaceutical, Petach Tikva, Israel) was administered. Preoperative orthoradial periapical and panaromic radiographs were taken (Fig 1). In each patient, periapical radiographs were fixed to their surgical templates by an acrylic resin wing to obtain reproducibility and standardization of the radiographs during all phases of the procedure. The distance between the alveolar bone crest (BC) and the radiopaque sinus floor (SF) demarcation was measured and recorded. BC-SF as measured on the radiograph was assumed as the preoperative residual bone height. The implant neck was then positioned flush with the BC reference point.

Local anesthetic infiltration (lidocaine and noradrenaline 1:100,000) was administered buccally and palatally. Extraction was carried out by careful root separation and by using delicate root elevators and forceps. Roots were removed with a rotational and extrusion motion to ensure minimal damage to the residual bony walls. The socket orifice was then measured with a periodontal probe mesiodistally and buccolingually. The osteotomy site was prepared using progressively larger cutting burs (2.0 mm, 2.7 mm, and 3.5 mm) (Fig 2a), to a depth of approximately 7 to 8 mm, depending on the location of the maxillary sinus floor. A periapical radiograph, connected to the acrylic resin wing in the surgical template (Fig 2b), was taken to estimate the residual bone height. The 3.5-mm cutting bur showed the exact apical end of the osteotomy site in relation to the sinus floor in an immediate periapical radiograph (Fig 2c).

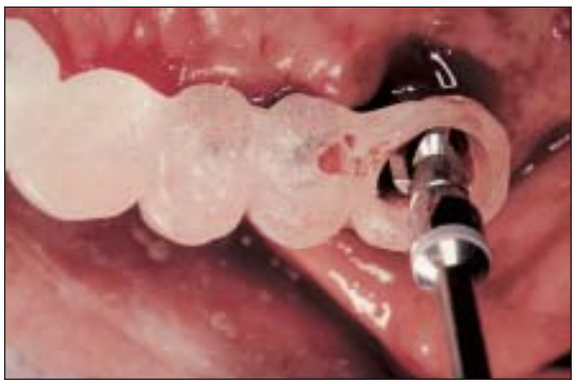

Fig 2a The osteotome bur drills through the socket site, guided by the surgical template.

Fig 2b The periapical x-ray film and its base are connected to the surgical template by an acrylic resin.

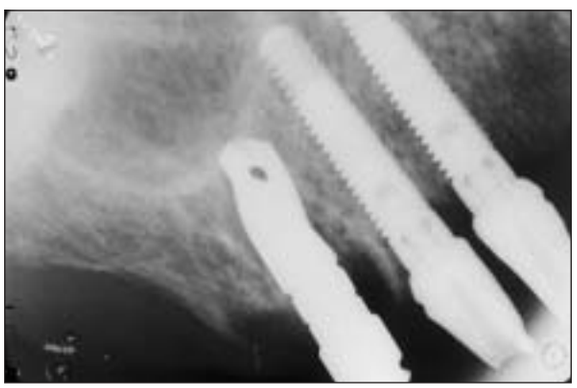

Fig 2c The 8-mm mark on the osteotome cutting bur shows the exact bone height between the crestal extraction site and the maxillary sinus floor.

Fig 3 Measurement of the osteotome sinus membrane elevation instrument before placement.

Subsequently, a 3.75-mm screw tap was inserted manually with cautious rotational movement to penetrate the sinus floor corticalis. An osteotome sinus membrane elevation instrument (ACE Surgical Supply, Brockton, MA) (Fig 3) was inserted with controlled force to infracture the sinus floor and to press the Schneiderian membrane gently upward. Patients were then asked to blow air through their purposely obstructed nose to verify that the sinus membrane was still intact. The implant site was then enlarged to its final diameter. A bone derivative, either a natural inorganic bovine bone mineral (Bio-Oss, Geistlich Biomaterials, Wolhusen, Switzerland) or a synthetic beta-tricalcium phosphate (β-TCP) (Cerasorb, Curasan, Kleinastheim, Germany), was applied before implant placement via the osteotomy site, extending to the antral area under the reflected Schneiderian membrane by an osteotome plugger (ACE Surgical Supply) (Fig 4a).

The self-tapping SBM implant (grit-blasted with soluble tricalcium phosphate; Tapered Screw-Vent, Sulzer Dental, Carlsbad, CA), 6 mm wide at the platform neck and 10 or 13 mm in length, was placed to its full length beyond the socket into the antral area. Thus, the grafted mineral surrounded the apical portion of the implant. The implant neck was even with the crestal bone level. Initial stability of the implant was ensured by the threaded implant. A broad healing cap was then screwed into the implant neck. When necessary, gaps greater than 1 mm between the implant and the socket walls were filled with the bone derivative (Fig 4b). Two vertical releasing incisions and a buccal flap reflection enabled tension-free complete soft tissue closure to completely embrace the implant superstructure (Fig 4c). A postoperative radiograph showed the extended implant body in the sinus area (Fig 4d). A healing phase followed for 6 months (Fig 4e).

Postoperative systemic antibiotics (500 mg amoxicillin 3 times daily for 1 week; Moxypen Forte, Teva Pharmaceutical) and analgesics (275 mg naproxen, 2 tablets initially and 1 tablet thereafter every 6 to 8

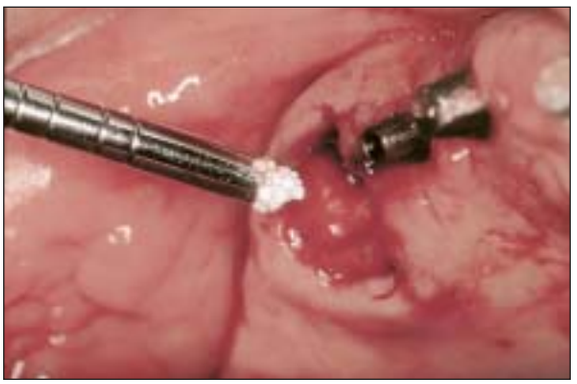

Fig 4a β-TCP particles are inserted by a plugger to the apical portion of the prepared site, under the slightly elevated sinus membrane.

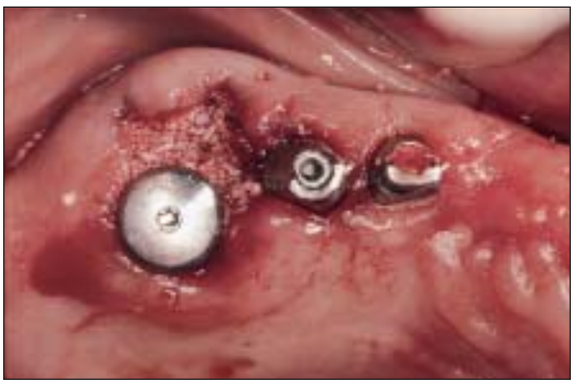

Fig 4b The WD implant is placed, followed by insertion of a healing screw. Remaining bony gaps, ie, buccal socket roots, are filled with mineral particles.

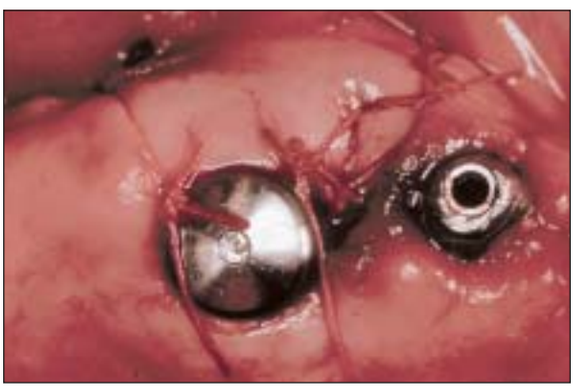

Fig 4c A coronally positioned buccal flap enables soft tissue closure around implant.

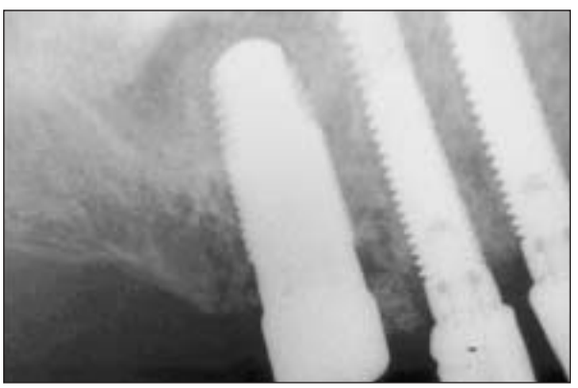

Fig 4d Periapical radiograph shows osseous healing around the WD implant under the slightly elevated sinus membrane.

hours as needed; Narocin, Teva Pharmaceutical) were prescribed. As an antiseptic solution, 0.2% chlorohexidine gluconate mouthwash (Tarodent, Taro Pharmaceutical Industries, Haifa Bay, Israel) was used for 45 seconds twice daily for 2 weeks.

RESULTS

Twelve WD implants were placed in maxillary first and second molar fresh socket sites in 10 patients. In 8 patients, an internal sinus elevation was performed via the osteotomy site. In 2 patients, although the postextraction/preimplantation periapical radiograph revealed residual bone height of no more than 8 mm, the continual deepening of these implant sites ended without antral penetration. Apparently, the surgical template dictated palatal positioning of the implant apical end palatally to the antral space. Consequently, implants with a 6-mm diameter neck and 10-mm length were placed without sinus area intervention.

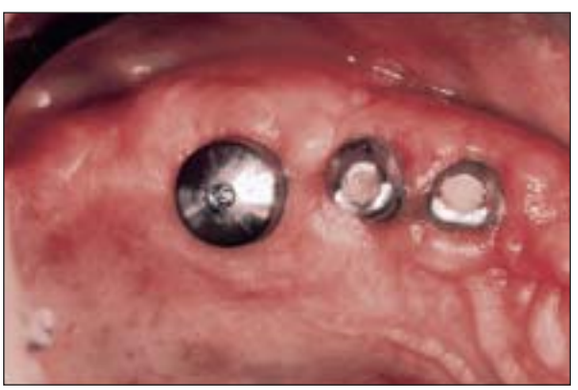

Fig 4e Soft tissue healing is established by a masticatory mucosal collar around the 1-stage WD implant.

After extraction and before osteotomy site preparation, residual ridge height was between 6 and 9 mm (mean 7.8 mm). In 3 of these sites, a microperforation of the Schneiderian membrane occurred during the internal sinus elevation procedure. The

Table 1 Pre- and Postoperative Clinical and Radiographic Measurement of the 12 Sites

Implant sites	Preoperative residual ridge depth (BC-SF) (mm)	Internal sinus membrane elevation	Implant length (mm)	Horizontal bone to implant neck distance (mm)	Height gain (mm)	Type of restoration
1	7	Yes	13	4	6	NS
2	7.5	Yes	10	5	2.5	S
3	8	Yes	13	5	5	S
4	6	Yes	10	5	4	S
5	9	Yes	13	4	4	S
6	8.5	Yes	13	4	4.5	S
7	8.5	Yes	13	4	4.5	S
8	7	Yes	10	4	3	S
9	8.5	Yes	13	5	4.5	NS
10	8	Yes	13	5	5	NS
11	7.5	No	10	3.5	—	S
12	8	No	10	4.5	—	S
Average	7.8	N/A	N/A	4.4	4.3*	

NS = non-splinted single unit restoration; S = splinted multiple unit restorations.
*Average height gain to only those who performed internal sinus elevation.

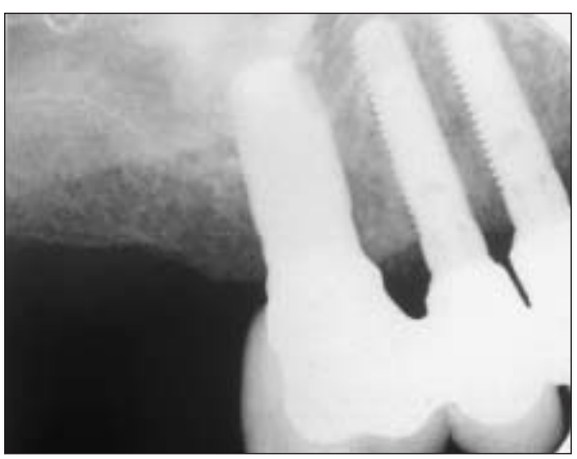

Fig 5 Periapical radiograph shows implant after 2 years in function.

augmentation material of choice was bovine bone mineral, since it had larger particles (500 to 1,000 μm) than β-TCP (300 to 500 μm) and could therefore prevent microtears.

A radiograph was taken immediately after implant placement to verify confinement of the augmented mineral under the microperforated elevated Schneiderian membrane. Follow-up visits showed that the healing phase was without complication. Postoperative nose bleeding occurred in 2 patients but subsided within 24 hours.

A postoperative periapical radiograph revealed a vertical height of 10 to 13 mm as determined by the implant length and augmentation mineral, resulting in an average augmentation height gain of 4.3 mm (Table 1). The horizontal distance gap between the crestal bony plate, primarily the buccal aspect, and the implant neck ranged between 3.5 and 5.0 mm (average 4.4 mm). The application of bovine bone mineral or β-TCP, followed by coronally positioned complete soft tissue coverage, resulted in complete osseous healing that embraced the implant neck.

All implants showed clinical stability. Follow-up radiographs demonstrated radiopaque bone surrounding the implants. No crestal bone resorption was observed around the implant neck. The wide healing screw, which enabled the procedure to become a 1-stage approach, determined the cervical superstructure soft tissue profile. A soft tissue collar embraced the implant abutment with no signs of clinical inflammation. Six months later, the prosthetic treatment was completed by a cemented metal-ceramic restoration. Three patients who had single molar replacement in the posterior maxillary quadrants were restored with a single prosthetic unit. Nine implants were placed distal to multiple implants in the edentulous ridge. These were restored and connected to a cemented fixed metal-ceramic restoration (3 to 14 units). Follow-up of the 10 patients after 2 years showed good stability and support for the prosthesis (Fig 5).

DISCUSSION

Since the development of traditional 2-stage, 3.75-mm, root-form implant placement in an edentulous ridge,[37,38] there have been modifications in surgical approaches and advancing techniques. One-stage techniques,[39–42] immediate implant placement in fresh extraction socket sites without flap reflection,[26,43] WD root-form configuration, and internal sinus membrane elevation all have shown predictability and a high success rate when performed as separate procedures. In this patient population, combination of these 5 modifications into a single procedure was as successful and predictable as each procedure separately.

ln the present multiple-root extraction sites, the intraradicular residual bone was completely drilled during implant site preparation; thus, bone-to-implant contact could only be obtained by basal bone anchorage. Therefore, a wide-body implant configuration enhanced the chance of initial stability,[44] which is a prerequisite to success.[45]

Implant placement immediately postextraction[18–26,46] not only reduces treatment time but also inhibits residual ridge resorption, which could complicate future implantation procedures once the healing stage is complete. However, 2 obstacles remain: the distance between the bony walls and the implant, especially in multiple-root sockets, and a lack of overlying soft tissue as advocated in the 2-stage implant placement. The long-term success rates provided by a single, 2-stage implant technique[39,40] and the introduction of WD implants[27–29] address these complications when performed simultaneously.[47] WD implants reduce the distance between the socket bony walls and the implant neck to minimize gaps, which facilitates healing to enhance osseointegration. Gaps over 2 mm are incapable of achieving such integration.[48,49]

In the present study, the 1-stage technique was performed using a custom healing screw inserted over the WD implant. This predetermined an adjustable soft tissue collar for an appropriate molar abutment. The wide platform led to a broad emergence profile of the prosthetic superstructure. Abutment strain and superstructure screw loosening and/or fracture may also be reduced.[50,51] The broad emergence profile also facilitated plaque control by the patient and provided a proper occlusal table for the definitive prosthesis.

Generally, the 1-stage approach is ideally indicated in fresh extraction sites, since no soft tissue coverage is needed, which otherwise requires modified surgical techniques.[52–55] One-stage procedures also eliminate undesired spontaneous exposure of the implant cover screw, which can occur in the 2-stage approach and can lead to crestal bone resorption around the implant neck.[56–58]

Another advantage in this presented clinical series of patients was the very conservative implant placement. Surgically, soft tissue flap reflection was only applied as a finishing procedure to coronally embrace the healing implant screw. An incision-free technique, which is especially indicated in broad buccolingual dimensions, ie, in the posterior molar region, has been reported with satisfactory results.[26,43]

In the presented patients, there was no risk of approaching the palatal or buccal bony plate envelope during implant site preparation. That is, optimal blood nourishment was maintained in the alveolar ridge and no bone resorption caused by flap reflection occurred.[59,60] In the 12 consecutive molar sites of this study, crestal bone level was maintained around the implant neck and did not exceed the 1 mm of resorption that typically occurs during the first year.

The final stage of advanced surgical techniques applied in the present sample was the internal sinus elevation,[16,17,61] which was performed to elongate the implant length housing. This is a delicate, noninvasive approach, much less traumatic than the lateral window fracture technique, and is mostly advocated for single-unit implantation. Within a period of 9 to 90 months, a cumulative success rate of 88.6% has been reported[62] for implants placed in conjunction with the internal sinus elevation technique and loaded for an average of 3 years.

In retrospective data provided by 9 clinicians, where the loading period was between 6 and 66 months, a survival rate of 96% was reported when the residual bone height was 5 mm or more. When bone height was 4 mm or less, the survival rate decreased to 85.7%.[63]

In the present series, the decision to use a 13-mm-long implant rather than a 10-mm implant was based on establishing initial stability, which was achieved by increasing the bone-to-implant contact and anchoring the implant to the sinus floor corticalis. Consequently, the internal sinus elevation enabled appropriate implant length and the widest configuration of its coronal part to be placed in the residual ridge, thus increasing bone-to-implant contact.

The space established by the elevated membrane was filled with either β-TCP or bovine bone mineral. The material consequently embraced the apical portion of the implant. These grafting materials lengthened the osteotomy site for appropriate implant length and achieved an internal sinus floor augmentation. However, while radiopacity of the β-TCP disappeared because of complete resorption after 2 years, bovine bone mineral was still evident radiographically.

CONCLUSION

The combined techniques performed as a single procedure clinically achieved short-term results comparable to each technique performed separately. When all surgical steps are carefully observed, successful predictability can be anticipated. This multitechnique approach reduced time, cost, and morbidity and enhanced the prosthetic solution in the posterior maxilla. Reducing surgical procedures in an atrophic residual ridge with relatively poor bone quality, ie, type III or IV, can provide an advantageous outcome and solutions equal to serial sequential surgical intervention.

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