Clinical Study of New Ridge Splitting Technique using Microsaw for Implant in Atrophic Alveolar Ridge

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그리고 많은 조언과 세심한 지도 편달을 해주신 조규성 교수님, 최성호 교수님, 이근우 교수님, 심준성 교수님께 진심으로 감사드립니다.

끝으로 항상 헌신적인 사랑을 주신 양가 부모님과 여러 가지 힘든 기간을 잘 인내해준 사랑하는 아내 가현과 딸 현진, 그리고 태중의 아이에게 진정한 사랑과 고마움의 마음을 담아 전합니다.

2003년 8월

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Abstract

Clinical Study of New Ridge Splitting Technique using Microsaw for Implant in Atrophic Alveolar Ridge

The enough bone volume tissue at recipient sites is a fundamental prerequisite for a good prognosis of osseointegrated implant. Narrow dentoalveolar ridges remain a serious challenge for the successful placement of endosseous implants.

Some clinicians introduced a ridge expansion technique using hand osteotomes to create localized expansions of the developing osteotomy sites, while others introduced the bone flap in conjunction with hand chisels to create a more extensive expansion of the existing ridge. These two techniques make use of the elasticity of the bone ridge and are recommended in the presence of soft quality of bone, however, they have mechanical limits when the residual bone is extremely mineralized.

This article described and illustrated a modification of previous ridge-splitting techniques using a microsaw blade. This approach enables treatment of ridges as thin as 2.5 mm at the alveolar crest and simultaneous placement of dental implants. All 75 implants placed in the 31 consecutively treated patients reported here became successfully integrated and have been in function for periods ranging from 24 to 52 months. The purpose of this article is to present a new surgical technique that, thanks to the use of microsaw blade, permits the expansion of the ridge. The primary advantage is that microsaw blades are very thin. Consequently, less bone is removed from the already narrow ridge and with less trauma. The guiding action provided by the microsaw's disk also permits a more controlled cut and allows the clinician to manage ridges as narrow as 2.5mm with this technique. The results of clinical and radiographic analysis of new ridge splitting technique using microsaw are as follows:

1. The mean bone width was 2.8 mm at the time of first surgery. This had increased to 5.7 mm at the time of second stage surgery. The mean bone width change was 2.9 mm.
2. The mean amount of peri-implant bone loss was 0.5 mm at the time of prosthesis placement compared to the time of surgery. This had increase to 0.9 mm by 1 year and remained stable afterward
3. The cumulative success rate of microsaw technique for ridge splitting in atrophic alveolar ridge was 97.3% (24 to 52 months follow-up).

This results suggest that microsaw technique for ridge splitting in atrophic alveolar ridge is a predictable procedure with a considerably high success rate.

KEY WORDS : Alveolar ridge; dental implant; ridge split; microsaw blades.

Clinical Study of New Ridge Splitting Technique using Microsaw for Implant in Atrophic Alveolar Ridge

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Ⅰ. Introduction

Root-form dental implants with a variety of designs have come to be used with high success rates to restore function and aesthetics in both fully and partially edentulous patients. A major limitation for successful implant placement remains the problem of inadequate alveolar ridge width. For most standard implants a minimum of 6mm in ridge width is necessary for favourable outcomes (Chiapasco et al. 2001). Scipioni *et al.*(1994, 1999) suggest that wherever dental implants are placed, a minimum thickness of 1 to 1.5 mm of bone should remain on both buccal and lingual/palatal aspects of the implants to ensure a successful outcome. For situations where ridge width is marginal (i.e. less than 6mm or so), it is often possible to manage complications in osteotomy preparation such as bone fenestrations and / or dehiscences with various graft and barrier materials (Hammerle et al. 1998; Mattout et al. 1995; Misch 1997; Simion et al. 1997; von Arx et al. 1999). When the thickness of the ridge is reduced to about 4 mm in the most coronal position and the volume increase in the apical direction, preparation of the implant site with burs produce a dehiscence that is generally vestibular and leads the exposure of several millimetres of the thread of implant. In more extreme cases, however, it becomes necessary to prepare the deficient ridge with some form of separate ridge augmentation procedure, using for example, either guided bone regeneration (Buser et al. 1999; Hermann et al. 1996; von Arx et al. 1996) or block-grafting with autogenous bone (Pikos 1999, 2000). These separate ridge augmentation procedures do, however, add extra expense, time and in the case of autogenous block grafts, morbidity to patient management.

As an alternative to these approaches, some clinicians have proposed a variety of alveolar ridge-splitting techniques. For example, Summers (1994) introduced a ridge expansion technique using hand osteotomes to create localized expansions of the developing osteotomy sites, while Scipioni *et al.*(1994, 1999) introduced the bone flap in conjunction with hand chisels to create a more extensive expansion of the existing ridge. These two techniques make use of the elasticity of the bone ridge and are recommended in the presence of soft quality of bone, however, they have mechanical limits when the residual bone is extremely mineralized. These two technique do require that there be at least 3 to 4 mm of ridge width and can be extremely difficult or impossible to perform if the remaining bone is primarily cortical as there is a real risk of fracturing the expanding plates of bone and being unable to stabilize the implant sufficiently to ensure predictable osseointegration.

The traditional mechanical expansion methods cannot be used with predictable outcome in the very thin cortical bone ridge as is often seen in a long-standing edentulous zone.

The new ridge splitting technique provides better control when preparing a cut along a narrow alveolar ridge, and appears less traumatic to the bone. Additionally, less bone is lost since the microsaw creates cuts that are much thinner compared to conventional burs, which are generally used prior to using hand osteotomes or chisels. Consequently even thinner ridges can be expanded. This article will describe a new approach for alveolar ridge-splitting using microsaw blades. The objective of this study was to clinically evaluate and to present a new surgical technique that, thanks to the use of microsaw blade, permits the expansion of the extremely thin ridge.

II. Materials and methods

A. Experimental design

All patients were pre-medicated with amoxicillin (500 mg tid) starting one day pre-operatively and for a total of 7 days. Patients were asked to rinse with chlorhexidine 0.1% oral rinse twice daily starting 1 day preoperatively and for the first 2 weeks post-operatively. Surgery was carried out under local anaesthesia, using lidocaine with 1:100,000 epinephrine.

For the 31 patients, three types of implants as specified below were placed in conjunction with ridge-splitting using microsaw blades (Table 1). In 24 of the patients, the implants were placed simultaneously with ridge expansion, while in 7 patients where the ridge width was less than 2.5 mm, implant placement was delayed until one month after the ridge-splitting step. All 75 implants placed in the 31 patients reported here achieved osseointegration and have been in function for periods of 24 to 52 months. Of the 75 implants placed, 39 were Frialit-2 (Friadent, Mannheim, Germany), 30 were ITI (Strauman, Waldenburg, Swizerland) and 6 were Restore (Lifecore biomedical Inc., Chaska MN, USA) (Fig 1-3).

Table 1. Distribution of patients according to gender and age

Gender	Age(years)				
	20-29	30-39	40-49	50-60	Total
Females	2	2	5	8	17
Males	0	3	5	6	14
Total (n)	2	5	10	14	31

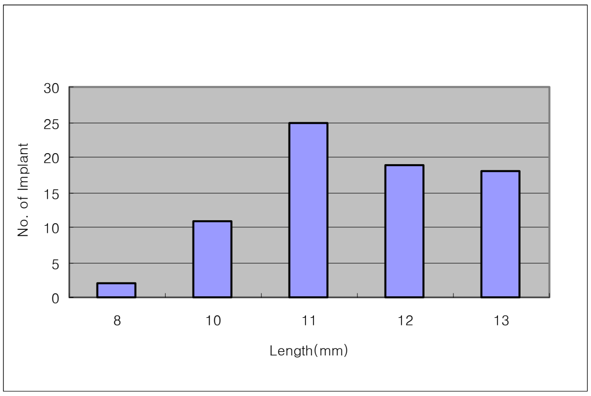

Fig 1. Distribution of implants by length

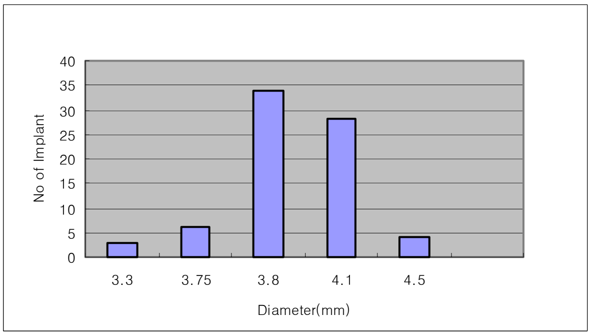

Fig 2. Distribution of implants by diameter

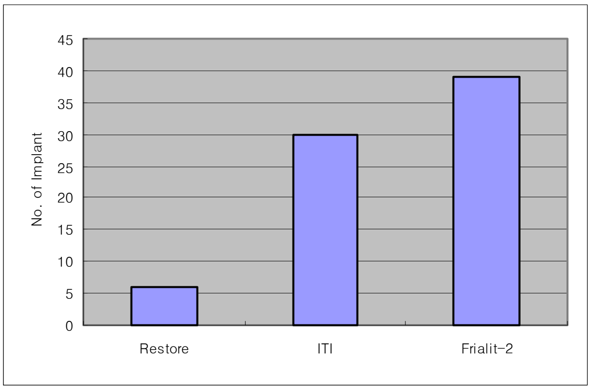

Fig 3. Distribution of implants system

B. Surgical protocol

For maxillary anterior sites, the initial incision was made on the crest of the ridge slightly towards the palate. A partial thickness flap dissection was done to expose the buccal aspect of the alveolar ridge in the operative site. Vertical incisions, as required, were placed remotely from the narrow ridge segment to be split in order to avoid post-op complications. In the anterior mandible, a horizontal incision was placed in the labial mucosa just apical to the mucogingival junction, and a partial thickness flap dissected just to the crest of the ridge. Thereafter the flap was converted to a full thickness from the crest of the ridge towards the lingual. The remaining steps outlined below were similar for both maxillary and the mandibular sites (Fig 10).

A #330 straight fissure bur was used to create a series of perforations along the crest of the alveolar ridge to a depth of 2 mm. These perforations were made1 mm apart and with care to ensure that they were at least 1.5 mm from the buccal cortical plate. Next, the microsaw (Friadent, Mannheim, Germany) was used to create a horizontal cut in the bone connecting these perforations (Fig 11 and 16). The microsaw was used to its maximum depth, which is 4 mm (the radius of the cutting diamond disc).

At this point, a #15 surgical blade in a scalpel handle was inserted into the cut created by the microsaw, and using light tapping with a surgical mallet, advanced to the desired depth for implant placement. As the blade was advanced into the ridge, small buccolingual motions were used to expand the ridge, taking care not to fracture the blade. With increasing depth, the bone is likely to become more cancellous compared to the crest of the ridge, providing needed elasticity for the ridge expansion.

A blade is preferred over a chisel since it is much thinner allowing more gentle expansion and less risk of fracture. By slowly proceeding along the length of the microsaw cut, the ridge can be expanded to receive the required number of dental implants. It is important to eliminate any sharp edges that become exposed during the expansion step in order to avoid perforation of the soft tissue flap following wound closure.

As an additional aid, one or two vertical grooves, 2mm deep can be placed through the periosteum of the buccal plate with the microsaw. These grooves allow the buccal plate to move more freely as the ridge is

expanded. Occasionally, it also may be necessary in the anterior mandible to create a shallow horizontal cut to join the apical extensions of these vertical grooves (Fig 11) since the bone in the mandible is more cortical and therefore less flexible than in the maxilla.
Once the full depth and some initial expansion has been achieved with the #15 blade, a series of flat chisels with increasing widths are introduced into the site to further expand the ridge. By this time, the buccal plate should expand quite easily without risk of fracture (Fig 11-15). In the situation where simultaneous implant placement is planned (Fig 17), after the ridge has been expanded sufficiently to allow the use of implant burs, these can be used as needed to develop osteotomies in the more apical bone for the apex of each implant.

The authors prefer to use tapered endosseous dental implants such as Frialit-2 implant system in order to minimize stress on the expanded bone after implant placement. Bone chips harvested from the surgical site are used to fill any gaps in the ridge between the implants, and the flap replaced and sutured in a tension-free state.

C. Clinical and radiographic analysis

In the maxilla, a healing period of 5 months was allowed prior to stage II surgery (Fig 16), while in the mandible re-entries were done at 3 months. Radiographs of the implant site were taken at the time of first surgery, healing caps were placed, at prosthesis placement, and then at 6 month intervals until third year recall. Radiographic examination was carried out using periapical radiographs using a paralleling long-cone technique. The radiographic distance from implant shoulder to first bone contact was calculated (Bragger et al. 1998). The implant features, with design characteristics of known size, facilitated radiographic measurements of crestal bone level.

III. Results

A. Bone width

The mean bone width was 2.8 mm at the time of first surgery (Fig 4). During the second surgery, the bone ridge appeared to be stabilized at the thickness of 5.7mm (Fig 5). At the second surgery, the mean value increased by 2.9 mm compared to the time of first surgery (Fig 6). The implants were stable and osseointegrated. The bone fracture line of releasing incisions appeared secure. Autogenous bone graft appeared to be mineralized. The buccal and palatal cortical bone did not show signs of dehiscence or fenestration.

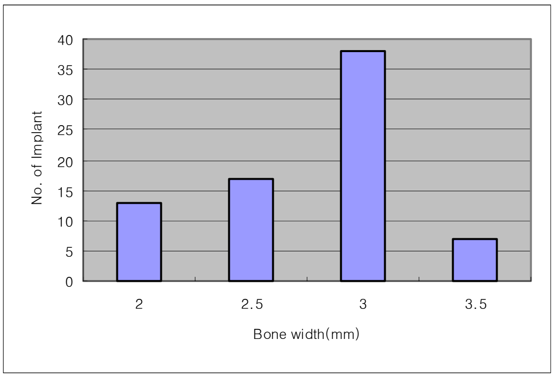

Fig 4. Distribution of crestal bone width (first surgery)

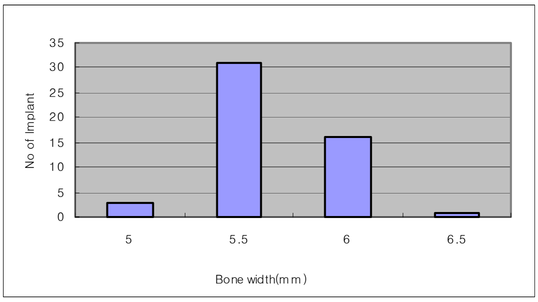

Fig 5. Distribution of crestal bone width (second surgery)

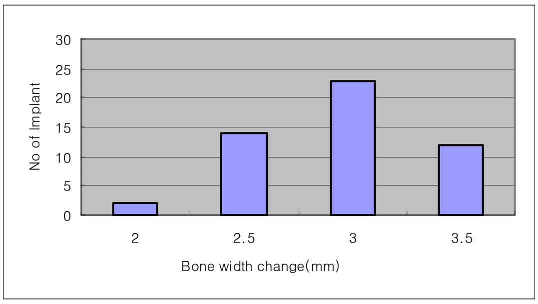

Fig 6. Distribution of values for crestal bone width change

B. Crestal bone level change

A radiographic view of maxillary anterior site treated using ridge splitting and simultaneous implant placement reveals stable bone levels around the implants (Fig 21). The mean amount of peri-implant bone loss compared to the initial postsurgical value was between 0.4 and 0.7 mm during the observation period (Fig 7). At prosthesis placement, the mean value increased by 0.5 mm compared to the time of surgery. This had increase to 0.9 mm by 1 year and remained stable afterward.

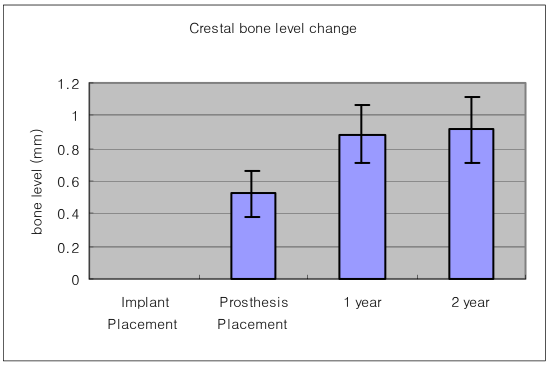

Fig 7. Distribution of values for crestal bone level change

C. Success rate and complications

There were two implant lost due to buccal bone fracture. There was no implant lost after loading (Table 2). The cumulative success rate of microsaw technique for ridge splitting in atrophic alveolar ridge was 97.3%. The cumulative success rate of microsaw technique for ridge splitting at one stage approach was 96.4% (24 to 52 months follow-up) (Fig 8, 9).

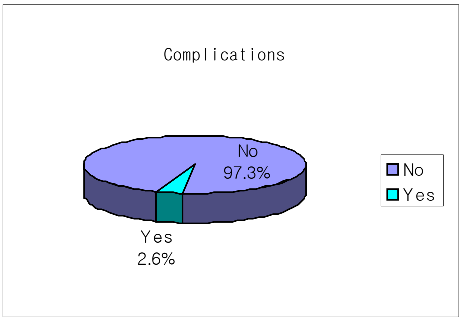

Fig 8. Complications of ridge splitting

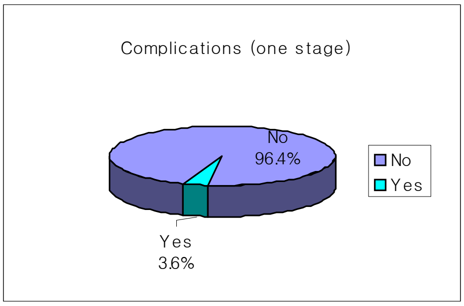

Fig 9. Complications of ridge splitting (one stage approach)

Table 2. Data of ridge splitting and complications

Patient	Age	Sex	Location (Teeth No)	Length (mm)	Operation (No)	Failures (Site No)
1	50	F	12,13,21,23	13,13,13,13	1	0
2	43	F	36	12	1	0
3	54	F	32,42	13,10	2	0
4	56	F	12,21	10,10	1	1(#12)
5	56	F	33,34,35	10,10,10	1	0
6	56	F	44,45,46,34,35,36	11,11,10,8,8	2	0
7	48	M	11,21	11,11	1	1(#21)
8	27	F	45,46,36	12,10,11	2	0
9	19	F	21,22,23	13,13,13	1	0
10	58	F	17	10	1	0
11	51	M	45,46	10,10	1	0
12	64	M	32,43,45	12,12,12	1	0
13	34	M	32,33	13,13	1	0
14	52	M	22,11,12	11,11,11	1	0
15	37	M	43,44,45	12,12,12	1	0
16	46	M	11,12,21,22	12,12,12,12	1	0
17	55	F	44,45,46	11,11,11	1	0
18	54	M	32,33	13,13	2	0
19	47	F	12,13,21	13,13,12	1	0
20	49	M	43,45	12,12	1	0
21	48	M	11,21	11,11	1	0
22	33	F	21,22	13,13	2	0
23	49	M	12,13	11,11	2	0
24	54	F	46	11	1	0
25	47	F	36	12	1	0
26	38	F	36	12	1	0
27	52	M	45,46	12,12	1	0
28	37	M	11,21,22	11,11,11	2	0
29	47	F	12,13	11,13	1	0
30	39	F	44,45	11,11	1	0
31	44	F	45,46	11,11	1	0

IV. Discussion

An enough volume of bone tissue at recipient sites is a prerequisite for a good prognosis of osseointegrated implant. The patterns of bone resorption following tooth loss have been well documented (Atwood 1973; Cawood et al. 1988, 1991; Sethi et al. 1995; Sethi 1993; Tallgren 1972). Maxillary bone resorption as a result of disuse atrophy takes place predominantly at the expense of the labial plate. Consequently, there is minimal loss in ridge height accompanying the significant reduction in ridge width. Restoration of the edentulous maxillary ridge with implants often requires the ridge width to be augmented. Two techniques that have been reported to recreate the width are guided bone regeneration and the use of autogenous onlay grafts (Misch 1997; Augthun et al. 1995; Fugazzotto 1988).

The ridge expanding and positioning implants in single stage surgery has been reported. The ridge expansion osteotomy of Summers permits the positioning of standard implants in ridges of about 4mm in thickness. This technique provides for the expansion of single implant site, making use of the characteristics of bone elasticity. In the case of very dense cortical bone, this method is limited by the physical nature of the bone, which lacks the elasticity that can be overcome by the mechanical pressure of the instrument.

Microsaws have traditionally been used in implant dentistry for procedures such as collection of autogenous block grafts needed for alveolar ridge reconstruction. However, as shown here, they can also be effectively used for the expansion of narrow alveolar ridges offering advantages over previously reported methods for alveolar ridge-splitting and ridge expansion(Scipioni et al. 1994, 1999; Summers 1994; Duncan 1997; Engelke et al. 1997; Rossi 1999; Sethi et al. 1998; Silverstein et al. 1999; Simion et al. 1992). The primary advantage is that microsaw blades are very thin. Consequently, less bone is removed from the already narrow ridge and with less trauma. The guiding action provided by the microsaw's disk also permits a more controlled cut and allows the clinician to manage ridges as narrow as 2.5mm with this technique. Crucial to success, however, is preserving the periosteum on the expanding buccal plate of bone by the use of a partial thickness flap elevation. This allows rapid revascularization of the expanded bone plate even with the use of the vertical and horizontal releasing cuts described here.

Scipioni *et al.*(1994, 1999) suggested that a minimal buccal thickness of bone of 1 to 1.5 mm under this retained periosteum is also a prerequisite for success with ridge-splitting. This can easily be achieved with the microsaw approach.

During the first surgery, the mean bone width was 2.8mm this had increased to 5.7mm at the time of second stage surgery. The mean bone width change was 2.9mm. The mean amount of crestal bone loss compared to the initial postsurgical value was between 0.4 and 0.7 mm during the first observation period (Fig 7). At prosthesis placement, the mean value was 0.5 mm compared to the time of surgery. This had increase to 0.9 mm by 1 year and remained stable afterward. The decrease in crestal bone loss after implant surgery has been observed by other authors(Gomez-Roman 2001; Mericske-Stern et al. 2002; Buser et al. 1999; Pamqvist et al. 1996; Hermann et al. 2000). This mean value is similar to other study (Bragger et al. 1998; Wijs et al. 1997).

In addition to achieving sufficient alveolar ridge width for dental implant placement, ridge expansion also allows for better implant positioning and the avoidance of compromised prosthetic outcomes such as the need to use ridge-lap crowns (Fig 19 and 20). A broad range of success rates, ranging from 85% to 100 % has been reported(Adell et al. 1990; Albrektsson 1998; Albrektsson et al. 1998; Babbush et al. 1993; Buser et al. 1997; D'Hoedt et al. 1989; Gomez-Roman et al. 1997; Grunder et al. 1999; Higuchi et al. 1995; Larkin et al. 2000; Nevins et al. 1993). The success rate of microsaw technique for ridge splitting in atrophic alveolar ridge was 97.3%. The cumulative success rate of microsaw technique for ridge splitting at one stage approach was 96.4%. Where the crest width was very thin, 20 implants was placed in two stage approach. There was no complication in two stage approach. This results with the 31 patients reported here suggest that the use of microsaw blades to facilitate ridge-splitting offers promise for dealing with the very narrow alveolar ridge that would otherwise require more complicated and time-consuming preparatory augmentation procedures with autogenous block grafts.

Ⅴ. Conclusions

A technique for expanding thin alveolar ridges utilizing microsaw blades was introduced. Compared to other methods of ridge-splitting, the use of a microsaw allows thinner ridges to be treated, better control during instrumentation, less trauma to the bone and less risk of fracturing or perforating the expanding plate of bone. All 75 implants placed in the 31 consecutively treated patients reported here became successfully integrated and have been in function for periods ranging from 24 to 52 months. The results of clinical and radiographic analysis of new ridge splitting technique using microsaw are as follows:

1. The mean bone width was 2.8 mm at the time of first surgery. This had increased to 5.7 mm at the time of second stage surgery. The mean bone width change was 2.9 mm.

2. The mean amount of peri-implant bone loss was 0.5 mm at the time of prosthesis placement compared to the time of surgery. This had increase to 0.9 mm by 1 year and remained stable afterward.

3. The cumulative success rate of microsaw technique for ridge splitting in atrophic alveolar ridge was 97.3%.

This results suggest that microsaw technique for ridge splitting in atrophic alveolar ridge is a predictable procedure with a considerably high success rate.

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Figure Legends

Fig 1. Distribution of implants by length.

Fig 2. Distribution of implants by diameter.

Fig 3. Distribution of implants system.

Fig 4. Distribution of crestal bone width (first surgery).

Fig 5. Distribution of crestal bone width (second surgery).

Fig 6. Distribution of values for crestal bone width change.

Fig 7. Distribution of values for crestal bone level change.

Fig 8. Complications of ridge splitting.

Fig 9. Complications of ridge splitting (one stage approach).

Fig 10. Vertical and horizontal incision bellow the mucogingival junction. Partial thickness flap dissection to the crest and full thickness flap reflection past the crest towards the lingual. The crest was less than 2.5 mm wide, and had a 1 mm undercut was present apical to the crest.

Fig 11. Microsaw used to connect the perforations at full depth.

Fig 12. Buccal vertical cuts minimum of 2 mm from the teeth. Additional horizontal cut joining the two verticals cut at their apical extent using the microsaw.

Fig 13. View of the expanded ridge. Autogenous bone graft was used to fill in the space between the buccal and lingual plates.

Fig 14. View of the expanded ridge following one month of healing, at the time of implant placement.

Fig 15. Conventional implant placement in two stages.

Fig 16. Use of the microsaw to make a horizontal cut at the crest of the maxillary ridge. The initial width at the crest was 2.5 mm.

Fig 17. Simultaneously implant placement with ridge expansion. Sharp edges at the vertical cuts were rounded.

Fig 18. Stage II re-entry after 5 months of healing in the maxilla.

Fig 19. The normal resorptive pattern of the maxillary ridge can be seen in the example above, where the crest of the anterior maxillary arch has been displaced palatally relative to the anterior mandibular teeth.

Fig 20. Proper maxillary-mandibular relation is restored in the anterior dentition.

Fig 21. Radiographic view of implants placed simultaneously with ridge expansion in the anterior maxilla.

Figures

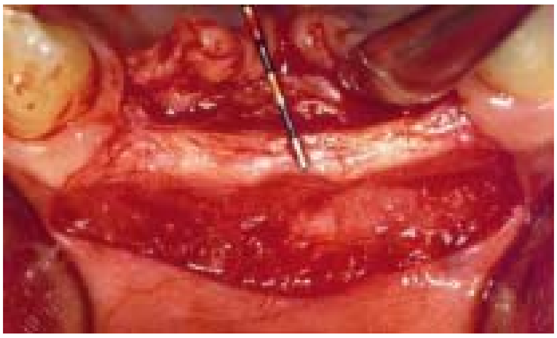

Fig 10. Vertical and horizontal incision

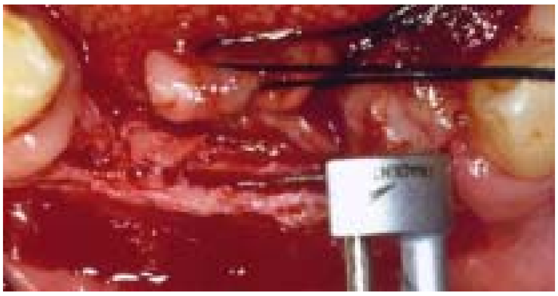

Fig 11. Microsaw used to connect the perforations at full depth

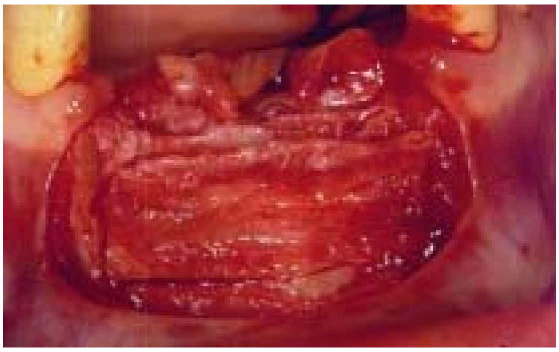

Fig 12. Buccal vertical cuts & horizontal cut

Fig 13. View of the expanded ridge

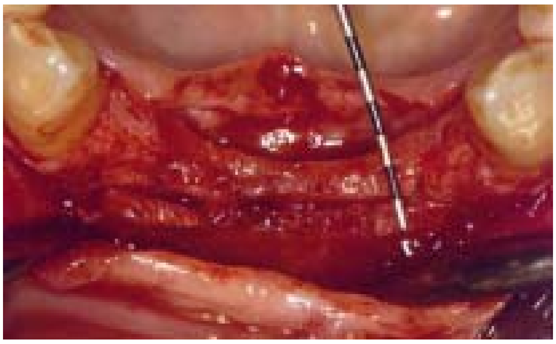

Fig 14. View of the expanded ridge following one month of healing

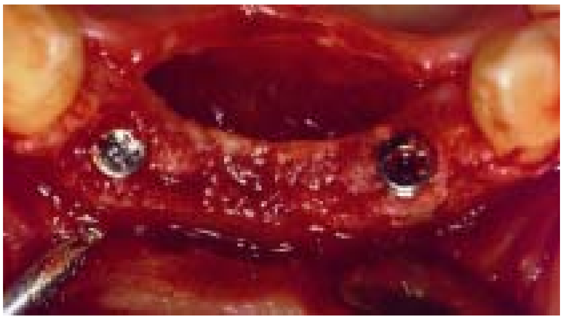

Fig 15. Conventional implant placement in two stages

Fig 16. Use of the microsaw to make a horizontal cut at the crest

Fig 17. Simultaneously implant placement with ridge expansion

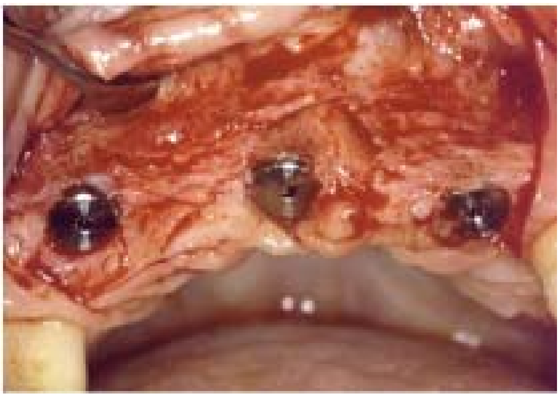

Fig 18. Stage II re-entry after 5 months of healing in the maxilla

Fig 19. Significant resorption in a palatal direction

Fig 20. Proper maxillary-mandibular relation

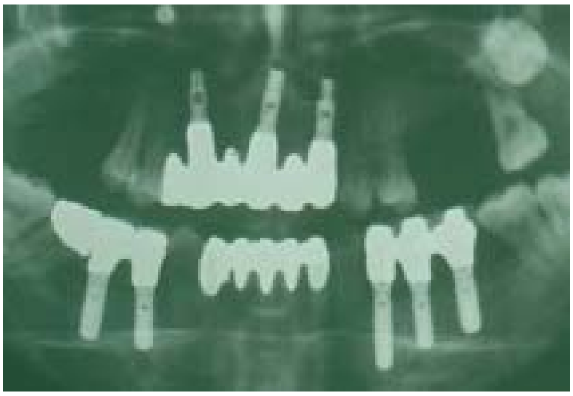

Fig 21. Radiographic view of implants placed

국문요약

위축된 치조골에서 마이크로소우를 이용한 새로운 Ridge splitting technique에 관한 임상연구

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서 종 진

성공적인 임플란트 시술을 위해서는 임플란트가 식립될 골조직이 충분해야 한다. 임플란트 주위의 골조직이 충분하지 못한 경우 자가골 이식술이나 차폐막을 이용한 골재생술식이 필요하나, 환자나 술자에게 모두 시간과 경비가 많이 든다는 단점이 있다. 이를 극복하기 위해 오스테오톰을 이용한 ridge expansion법이나 bone flap을 형성한 후 치즐을 이용해 치조골을 벌리는 테크닉이 고안되었다. 이 두 가지 방법은 모두 치조골이 3-4mm 정도의 넓이가 되고 어느 정도 bone elasticity가 있는 경우에 가능하며, 치조골의 폭이 2.5mm 이하로 좁아 cortical bone만 존재할 경우 bone elasticity가 없어 치조골파절이 발생되어 실패할 가능성이 커진다.

이 연구는 마이크로소우를 이용한 새로운 ridge splitting technique을 이용해 심하게 퇴축된 치조골을 분할하여 치조골의 폭경의 증가와 임플란트 주위 치조골의 수직적 골흡수를 임상적, 방사선학적으로 관찰하였다. 이 테크닉은 2.5mm 치조골을 분할하여 동시에 임플란트를 식립할 수 있으며, 경우에 따라서는 치조골을 분할하고 한달 후에 식립하는 2회법을 할 수도 있

다. 이 테크닉의 장점은 0.25mm의 얇은 디스크를 사용함으로 골손실을 최소화하며 치조골을 분할 할 수 있고, 절제된 힘으로 외상을 최소화하여 치조골을 splitting하여 기존의 방법으로는 불가능한 2.5mm 이하의 얇은 골을 분할하여 임플란트를 식립할 수 있다는 것이다. 31명의 환자에 microsaw technique으로 75개의 임플란트를 식립하였으며 24-52개월 간 관찰하여 다음과 같은 결과를 얻었다.

1. 일차수술 시 치조골 폭경은 2.8 mm 이었으며 이차수술 시 5.7 mm로 증가하였으며. 평균 골 폭경의 증가량은 2.8 mm 이었다.
2. 임플란트 식립 시와 비교해 보철물 장착 시 임플란트 주위의 수직골흡수는 0.5mm 이었다. 1년 후에는 0.9mm로 증가하였으며 그 이후에는 안정적인 소견을 보였다.
3. 위축된 치조골에서 마이크로소우를 이용한 새로운 ridge splitting technique의 성공률은 97.5%이었다.

이상의 결과로 위축된 치조골에 마이크로소우를 이용한 새로운 ridge splitting technique은 비교적 높은 성공률을 나타내는 예견 가능한 수술법이라고 할 수 있다.

KEY WORDS : 임플란트; 위축된 치조골; ridge splitting; 마이크로소우.