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Clinical study on success rate of microscrew implants for orthodontic anchorage

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To provide some guideline for microscrew implants, 73 patients that received a total of 180 mini- or microscrew implants were scrutinized. The overall success rate was 93.3% (168 among 180 mini- or microscrew implants) and the mean period of utilization was 15.8 months. Microscrew implants in the UB group (maxillary buccal area) succeeded at a rate of 94.6% (87 among 92), mini- or microscrew implants in the LB group (mandibular buccal area) succeeded 96.6% of the time (56 out of 58), while microscrew implants in the UP group (maxillary palatal area) had a 100% success rate (11 out of 11), and mini- or microscrew implants in the LR group (retromolar area) succeeded in 73.7% of cases (14 among 19). This study might indicate that microscrew implants can be used successfully as orthodontic anchorage in daily orthodontic practice.

Key words : Microscrew implants, Success rate, Orthodontic anchorage

Since the advent of modern orthodontics, many practitioners have paid close attention to the various methods and techniques of anchorage control. However, every method has demonstrated its advantages as well as disadvantages. Intraoral dental appliances have been considered unable to provide appropriate anchorage in maximum anchorage cases. Instead, extraoral appliances were commonly relied upon to provide maximum anchorage, as dependent upon the patient's compliance. One attempt at seeking suitable anchorage without the need to solicit the patient's compliance would be implant orthodontics. Among these methods, mini- or microscrew implants have been considered as the most efficient, economic, and simple way to provide absolute anchorage, and have thusly garnered much notice from orthodontists.

After proposing this variety of implants as a possibility [1], Kanomi[2] and Costa et al.[3] attempted to use them for anchorage. Park[4], Oh et al.[5], Park et al.[6-9], Lee et al.[10], and Bae et al.[11] have also utilized and proven the

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possibility of microscrew implants as viable orthodontic anchorage.

However, regarding the success and failure of microscrew implants as orthodontic anchorage, as well as mitigating factors influencing their success, such topics have not been intensively studied and are still not fully understood. In the progress of developing microscrew implants as orthodontic anchorage, the author would like to discuss their success and failure on a clinical basis.

MATERIALS AND METHODS

The subjects involved in this study were 73 patients (47 females, 26 males) that visited the Department of Orthodontics and Dentistry from 1998 to 2000 (Table 1). Every patient received at least one mini- or microscrew implant for the purposes of anchorage control.

The total number of mini- or microscrew implants were 180, including 174 microscrew implants of 1.2 mm in diameter (152 from Osteomed Co. USA; 20 from Leibinger Co. Germany; and 2 from Avana Co. Korea) and 6 miniscrews of 2.0 mm in diameter (Martin Co. Germany)(Table 2). The locations in which mini- or microscrew implants were placed were divided into four areas: UB (maxillary buccal alveolar bone), LB (mandibular buccal alveolar bone), UP (maxillary palatal alveolar bone), and LR (mandibular retromolar area or alveolar bone distobuccal to mandibular second molar). In addition, 4 microscrew implants were placed into the buccal plate of the edentulous ridge on the maxillary anterior teeth area, and 4 microscrew implants were placed into the infrazygomatic ridge; these were included in the UB group. As well, 1 microscrew implant into the maxillary tuberosity was included in the UP group, and 5 microscrew implants placed into the alveolar bone between the mandibular canine and first premolar were included in the LB group. Finally, 1 miniscrew placed in the edentulous ridge mesial to the external oblique ridge was included in the LR group.

All mini- or microscrew implants were placed following surgical procedures.[6-9] With the patient under local anesthesia, a 3 to 5 mm vertical stab incision was made on the alveolar mucosa between the upper second premolar and first molar for maxillary buccal microscrew implants, and between the first and second molars for mandibular microscrew implants. A small pit was made by a #2 round bur under saline coolant irrigation after reflecting the mucoperiosteal flaps. In the mandibular retromolar area or from the alveolar bone distobuccal to mandibular second molars, a hole was bored with a pilot drill under coolants after the application of a horizontal incision without making a pit. Drilling was performed with a 0.9 mm diameter drill for 1.2 mm microscrew implants, and 1.5 mm diameter drill for 2.0 mm miniscrew implants under saline cooling. In the maxillary palatal alveolar bone, drilling was done without incision and by making a pit[10]. Titanium microscrew implants were placed with a screwdriver.

Table 1. The age distribution of the patients

	Female	Male
10-14 year-old	20	8
15-19 year-old	4	6
20-30 year-old	19	11
Over 30 year-old	4	1

Microscrew implants in the UB and UP groups were placed 30-40 degrees to the long axis of the teeth, while microscrew implants in the LB group were inserted 10-20 degrees to the long axis of the teeth. Microscrew implants in the LR group were placed perpendicular to the bone surface, and two periapical radiographs were taken to check whether the microscrew was correctly interred between the adjacent roots.

Microscrew implants in the UB group were used for the retraction of anterior teeth or whole dentition, while those in the UP group were used for the retraction of anterior teeth in lingual orthodontics or intrusion of molars. Microscrew implants in the LB group were used for uprighting or intruding lower molars, while those in the LR group were placed for the retraction of anterior teeth or whole mandibular dentition.

Table 2. The distributions of mini-or microscrew implants according gender, age, locations, and manufacturer, and number of screws with failure.

Gender	Age(Number of screws)	Manufacturer (Number of screws)	Location	Dimension of screws (diameter, Length)	Number	Number of failure
Female	10-15(43)	Osteomed(36)	UB	1.2mm, 8mm	18	0
			LB	1.2mm, 6mm	12	0
			UP	1.2mm, 10mm	2	0
			LR	1.2mm, 6mm	6	2
		Leibinger(4)	UB	1.2mm, 5mm	4	0
		Martin(1)	LR	2.0mm, 12mm	1	0
	15-20(14)	Osteomed(12)	UB	1.2mm, 8mm	2	0
			LB	1.2mm, 6mm	6	0
			UP	1.2mm, 10mm	2	0
			LR	1.2mm, 6mm	2	0
		Avana(2)	UB	1.2mm, 8mm	2	1
	20-30(49)	Osteomed(39)	UB	1.2mm, 8mm	24	0
			LB	1.2mm, 6mm	13	0
			UP	1.2mm, 10mm	1	0
			LR	1.2mm, 6mm	1	0
		Leibinger(8)	UB	1.2mm, 5mm	6	2
			UP	1.2mm, 5mm	2	0
		Martin(2)	LR	2.0mm, 12mm	2	1
	Over30(10)	Osteomed(10)	UB	1.2mm, 8mm	7	1
			LB	1.2mm, 6mm	2	0
			UP	1.2mm, 10mm	1	0
Subtotal					116	7
Male	10-15(20)	Osteomed(20)	UB	1.2mm, 8mm	8	0
			LB	1.2mm, 6mm	7	0
			LR	1.2mm, 6mm	3	1
		Leibinger(2)	UB	1.2mm, 5mm	2	0
	15-20(18)	Osteomed(14)	UB	1.2mm, 8mm	8	0
			LB	1.2mm, 6mm	6	0
		Leibinger(4)	UB	1.2mm, 5mm	2	0
			LB	1.2mm, 5mm	2	0
	20-30(25)	Osteomed(20)	UB	1.2mm, 8mm	7	1
			LB	1.2mm, 6mm	8	1
			UP	1.2mm, 10mm	4	0
			LR	1.2mm, 6mm	1	0
		Leibinger(2)	LB	1.2mm, 5mm	2	1
		Martin(3)	LR	2.0mm, 12mm	3	1
	Over30(1)	Osteomed(1)	LR	1.2mm, 6mm	1	0
Subtotal					64	5
Total					180	12

Orthodontic force ranging from 150-200 gm was applied for 2-3 weeks after placement. In general, NiTi closing coil springs were used for applying a retracting force to both maxillary and mandibular arches, and elastomeric threads (Super thread RMO, USA) were used for the intrusion or uprighting of posterior teeth. However, power chains were used in several cases to retract anterior teeth in both arches.

The microscrew implants, which maintained in the bone over one year under orthodontic force during treatment and removed at the end of treatment even though those were removed within one year, were considered as a success. Overall success rates were calculated, as was the success rate according to location, age, and manufacturer of the microscrew implants.

RESULTS

The mean period of utilization for mini- or microscrew implants as tools of orthodontic anchorage was 15.8±6.2 months.

The overall success rate was 93.3% (168 among 180 mini- or microscrew implants).

The success rate of the Osteomed microscrew implants, Leibinger microscrew implants, Avana, and Martin miniscrew implants were 96% (146 out of 152), 85% (17 among 20), 50% (1 out of 2), and 69% (4 among 6), respectively.

Microscrew implants in the UB group succeeded at a rate of 94.6% (87 among 92), mini- or microscrew implants in the LB group succeeded 96.6% of the time (56 out of 58), while microscrew implants in the UP group had a 100% success rate (11 out of 11), and mini - or microscrew implants in the LR group succeeded in 73.7% of cases (14 among 19).

The success rate for females in the 10 to 20 year-old age group showed 97.3% (37 out of 38), while females over 20 years old were 84.6% successful (22 out of 26). Males in the 10 to 20 year-old age group enjoyed a 94.7% success rate (54 out of 57), and males over 20 years old were 93.2% successful in treatment (55 out of 59).

Regarding the occasions of failure after placement, 2 miniscrew and 4 microscrew implants failed within a 2 month period after placement, 3 microscrew implants failed during the 2 to 6 month period, and 3 microscrew implants failed at 6, 7, and 10 months after placement.

DISCUSSION

Since microscrew implants began regular employment as orthodontic anchorage they have drawn great attention, and these implements now stand poised to become one of the most important and powerful means of orthodontic treatment. However, it is also quite true that there is still some apprehension as to the stability of microscrew implants in regard to orthodontic force. Can they withstand orthodontic force during treatment? If so, how long can they withstand it for? What percentages of success can we expect? How much force is suitable for tooth movement and for the stability of the microscrew implants themselves?

To provide some clues to these questions, the author has scrutinized treated and treating cases with microscrew implants which were maintained in the bone at least one year or maintained well to the end of treatment.

The mean period of utilization for microscrew implants was 15.76 months, which might prove to be sufficient time for providing proper anchorage in most orthodontic cases. The most critical and important time for successful orthodontic treatment is the anterior teeth retraction period for extraction cases, which usually takes 6-10 months. In nonextraction treatment, distal movement of the posterior segment can be obtained within 7-8 months because the posterior teeth segment can be distalized all together, not merely one-by-one[8]. Therefore, microscrew implants seemed to provide a suitable anchorage for all sorts of tooth movement.

The overall success rate was 93.3%, although there were some differences encountered according to manufacturer. If the replacement of microscrew implants is taken into account, the overall success rate approaches 100%.

The Leibinger microscrews used at the beginning of this study were replaced by Osteomed microscrews. As the longest Leibinger microscrew is 5 mm long, to enlarge the selection of microscrew length the author began to use Osteomed microscrews instead, which were available in models from 12 mm to 4 mm long. Once Osteomed microscrews were adopted, 8 mm microscrews were used for maxillary buccal use, and 10 mm microscrews were used for maxillary palatal use, while 6 mm microscrews were used for the mandibular buccal and retromolar area. Technical dexterity and differences in length might explain the disparity in success rates.

Regarding success rates according to the location of placement, the UP group demonstrated 100% success. The firm masticatory mucosa of the palatal area might be more resistant to inflammation than the buccal flaccid oral mucosa, which was thought to be contributory to the success rate. The UB and LB groups showed a similar success rate, defying the presumption that the LB group would be expected to show a much higher success rate than the UB group because of thick cortical bone located in the mandibular arch. On the contrary, the LB group experienced a lower success rate than both the UB and UP groups. This result might be explained by the excessive heat[12-13] and pressure[14-15] generated between the microscrew implants and bone during placement, which resulted in bone necrosis. These results should be elucidated by further well-designed studies. The LR group showed a much lower success rate as compared with the other groups. It might be assumed that the occlusal force or movement of covering the oral mucosa, or inflammation around the wire extension, endangers the stability of the mini- or microscrews. Thereafter, the author shifted the microscrew implants position from the retromolar area to the buccal alveolar bone between the mandibular first and second molar for retracting anterior teeth or whole mandibular dentition.

The success rate according to age was different from the presumed expectation of a higher success rate in the adult group than in the young adolescent group. Indeed, the success rate in the over-20 group was lower than that of the under-20 group in both male and female subjects. This might be explained by a higher metabolism in the young adult group than in the adult group, which may influence the success rate. This finding should also be elucidated by further studies.

Regarding the occasion of failure after placement, 50% of failure occurred within the first two months, meaning that surgical procedures are an important factor in microscrew success. A further 25% of failure occurred during the 2-6 month period while the remaining 25% occurred in the 6-10 month period, indicating that the management of microscrew implants is also important for their successful use.

Even though a fairly high rate of success was observed in microscrew implants anchorage there are still some problems that must be addressed, such as the fracture of microscrew implants, localized inflammation, soft tissue impingement around canine eminence, and difficulty in applying heavy force to the microscrew implants.

To solve these problems, a team (including the author) has sought to develop new types of micro-implants[7-11]. Further studies on microscrew implants should be performed to improve and extend the use of microscrew implants as orthodontic anchorage.

SUMMARY

The success rate for microscrew implants as orthodontic anchorage was high enough to recommend their usage as a powerful and essential part of orthodontic treatment.

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국문초록

교정치료 고정원으로서 Microscrew implants의 성공율에 대한 임상적 연구

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치아이동의 고정원으로 사용되고 있는 miniscrew and microscrew implants의 임상 적용의 유용성을 알아보고자 73명의 환자에 식립된 180개를 대상으로 성공율을 연구하였다.

1년 기간의 전반적인 성공율은 93.3%(180개의 miniscrew and microscrew implants중 168개 성공)이었고, UB군(상악 협측치조골)은 96.6%(92개중 87개 성공), LB군(하악 협측치조골)은 96.6%(58개중 56개 성공), UP군(상악 구개측 치조골)은 11개중 11개가 모두 성공하여 100%를 보였고, LR군(하악 후구치 부위)은 19개중 14개가 성공하여 73.7%의 성공율을 보였다.

이 연구를 통하여 볼 때 miniscrew and microscrew implants는 교정치료의 고정원으로 성공적으로 사용될 수 있을것으로 생각된다.

주요 단어 : Miniscrew and microscrew implants, 성공율, 고정원