FUNCTIONAL RECONSTRUCTION OF MANDIBULAR DEFECTS WITH FREE BONE GRAFT

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Mandibular discontinuity defect due to benign tumor, malignant tumor, infection, or truma results in major esthetic and biologic compromise. The primary goal of reconstruction is full restitution of function, which secondarily lead to normalization of the cosmetic deformity. The authors make a clinical study of 61 consecutive bone graft cases for mandibular reconstruction of discontinuity defect which were studied retrospectively using clinical data and radiographic findings. The cases were reviewed to evaluate the clinical success in the period from 1981 to 1990 in the Dept. of Oral & maxillofacial Surgery, Seoul National University Hospital. The criteria of the success in bone graft, are no residual infection, graft in with maintain its integrity, and remain over a half of its original size of graft in the radiographic features. The purpose of this clinical survey is to study of the mandibular discontinuity defects and success rate of free bone graft in mandibular defects.

To summarize the clinical study of free bone graft, the main type of autogenous bone graft is iliac bone and corticocancellous type. Overall success rate is 80.3% in 61 followup cases over 6 months. Wire fixation and Extraoral approach has realtively better prognosis than other methods. It showed relatively poor prognosis in symphysis defects than other recipient site.

Key Word : Mandibular Reconstruction-Free Bone Graft.

INTRODUCTION

Mandibular discontinuity defect due to benign tumor, malignant tumor, infection, or truma results in major esthetic and biologic compromise. The primary goal of reconstruction is full restitution of function, which secondarily lead to normalization of the cosmetic deformity. The mandible is the most important part of the masticatory system. And this mandible is the most functional unit and the most movable part in the skull. So, on loading stress on this mandible, some part is loaded tension stress, other part is loaded compression stress. It is due to stress loaded three dimensionally on functional movement. This mandible may be affected by patholgy and trauma. For this reason, the mandibular defects which is either discontinuity or continuity pattern may occur. The ideal goal of the mandibular defects is a rehabilitation of the anatomic, esthetic, psychologic and functional problems.

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The reconstruction of this mandibular defects has been a difficult field to Oral and Maxillofacial Surgeon. The purpose of this clinical survey is to study of the mandibular discontinuity defects and success rate of free bone graft in mandibular defects.

MATERIALS AND METHODS

The authors make a clinical study of 61 consecutive bone graft cases for mandibular reconstruction of discontinuity defect which were studied retrospectively using clinical data and radiographic findings. The cases were reviewed to evaluate the clinical success in the period from 1981 to 1990 in the Dept. of oral & maxillofacial Surgery, Seoul National University Hospital. The criteria of the success in bone graft, are no residual infection, graft in situ with maintain its integrity, and remain over a half of its original size of graft in the radiographic features.

RESULTS

The main cause of mandibualr defects in 94 cases of free bone graft is benign tumor. It shows 69.1% of causes of mandibular defects. The causes of mandibular defects in free bone graft showed malignant tumor, TMJ disease, infection in the order, next to benign tunor.(Table 1)

Main stream of autogenous bone graft is iliac bone graft, and success rate according to donor site showed costochondral, iliac and rib bone in the order.(Table 2, 3)

Next tables show clinical survey of surgical approach and its success rate. 63.8% of cases was operated by extraoral approach, and success rate by surgical approach showed extraoral approach, intraoral approach and combined approach in the decreasing order.(Table 4, 5)

Table 1. Clinical Review of Underlying Causes of 94 Patients

Dx	Immed.	2nd.	Total
BT	38	27	65
MT	0	12	12
TMJ Ds	9	2	11
Inf.	1	5	6
Total	48	46	94

*Dx : Diagnosis, Immed. : Immediate Reconstruction
2nd. : Secondary Reconstruction
Ds : Disease BT : Benign Tumor
Inf. : Infection MT : Malignant Tumor

Table 2. Clinical Data Donor Site 94 Cases

Donor site	Immd.	2nd.	Total
Ilium	35	37	72
Rib	6	7	13
Costochondral	7	2	9
Total	48	46	94

*Immed. : Immediate Reconstruction,
2nd. : Secondary Reconstruction

Table 3. Follow-up Data Donor Site : 60 Cases of Success Rate

Donor site	Immd.	2nd.	Total(%)
Ilium	19/22	19/23	38/45(84.4)
Rib	2/5	4/5	6/10(60)
Costochondral	3/3	2/2	5/5(100)
Total(%)	24/30(80)	25/30(83.3)	49/60(81.7)

*Immed. : Immediate Reconstruction,
2nd. : Secondary Reconstruction

Table 4. Clinical Data Surgical Approach : 94 Cases

Approach	Immed.	2nd.	Total
I/O	5	11	16
E/O	28	32	60
I/O+E/O	15	3	18
Total	48	46	94

*Immed. : Immediate Reconstruction,
2nd. : Secondary Reconstruction
I/O : Intraoral E/O : Extraoral

Table 5. Follow-up Data Surgical Approach : 60 Cases of Success Rate

Approach	Immed.	2nd.	Total(%)
I/O	4/5	5/7	9/12(75)
E/O	11/12	20/22	31/34(91.2)
I/O+E/O	9/13	0/1	9/14(64.3)
Total(%)	24/30(80)	25/30(83.3)	49/60(81.7)

*Immed. : Immediate Reconstruction,
2nd. : Secondary Reconstruction

Grafting methods was mainly corticocancellous type. Because the defect is that of discontinuity type, the coricocancellous type is profitable in providing structural strength. The success rate is the highest using the particulated marrow and cancellous bone.(Table 6, 7)

Table 6. Clinical Data Grafting Methods : 60 Cases of Success Rate

Methods	Immed.	2nd.	Total(%)
CC	35	36	71(75.5)
PMCB	3	3	6(6.4)
CC+PMCB	7	5	12(12.8)
Etc	3	2	5(5.3)
Total(%)	48(51.1)	46(48.9)	94(100)

*Immed. : Immediate Reconstruction,
2nd. : Secondary Reconstruction
CC : Corticocancellous
PMCB : Particulated marrow and cancellous bone

Table 7. Follow-up Data Grafting Methods : 60 Cases of Success Rate

Methods	Immed.	2nd.	Total(%)
CC	19/25	19/23	38/48(79.2)
PMCB	1/1	2/2	3/3(100)
CC+PMCB	2/2	3/3	5/5(100)
Etc	2/2	1/2	3/4(75)
Total	24/30(80)	25/30(83.3)	49/60(81.7)

*Immed. : Immediate Reconstruction,
2nd. : Secondary Reconstruction

The fixation method was performed by using wire fixation, plate and screw, screw alone and titanium tray in the order. Wire fixation has good prognosis compared to plate and screw fixation. The reason may be that functional stress is concentrated on the plate, so the functional stimulation on the graft is eliminated. And also it can be thought that the prerequisite is different in each case.(Table 8, 9)

Table 8. Clinical Data Fixation Method : 94 Cases

Fixation	Immed.	2nd.	Total(%)
Wire	32	20	52(55.3)
Plate & Screws	15	19	34(36.2)
Scews	1	5	6(6.4)
Titanium tray	0	2	2(2.1)
Total(%)	48(51.1)	46(48.9)	94(100)

*Immed. : Immediate Reconstruction,
2nd. : Secondary Reconstruction

Table 9. Follow-up Data Fixation Methods : 60 Cases of Success Rate

Fixation	Immed.	2nd.	Total(%)
Wire	17/21	16/18	33/39(84.6)
Plate & Screws	6/8	6/8	12/16(75)
Screws	1/1	3/4	4/5(80)
Total(%)	24/30(80)	25/30(83.3)	49/60(81.7)

*Immed. : Immediate Reconstruction,
2nd. : Secondary Reconstruction

The location of the defect of mandible was body, ramus, symphysis, condyle in the decreasing order. It showed relatively poor prognosis in the symphysis defects rather than any other recipient sites. (Table 10, 11)

Table 11. Follow-Up Data Success Rate of Recipient Site : 60 Cases

Recipient	Site	Cases(%)
Mandible	1. Symphysis	2/3(66.7)
	2. Body	4/5(80)
	3. Angle	10/11(90.9)
	4. Condyle	5/5(100)
	5. Symphysis and body	9/13(69.2)
	6. Body and angle	10/13(76.9)
	7. Body and condyle	3/3(100)
	8. Hemimandible	5/7(71.4)
Total		94

Table 10. Clinical Data Recipient Site : 94 Cases

Recipient	Site	Cases
Mandible	1. Symphysis	6
	2. Body	8
	3. Angle	15
	4. Condyle	5
	5. Symphysis and body	26
	6. Body and angle	20
	7. Body and condyle	3
	8. Hemimandible	11
Total		94

DISCUSSION

The reconstruction of the bony defects has been performed by bone graft procedure which is the most freqently transplanted human tissue, next to blood. Bone graft is a necessary component in many reconstructive procedures performed by surgeons. Orthopedic surgeons, plastic surgeons and neurosurgeons as well as oral and maxillofacial surgeons realize that bone grafts are indispensable in their efforts to restore injured or diseased skeletal structure. Isolated cases of clinical bone grafting have been described as early as the 17th century when Job van Meekeren, a Dutch surgeon, inserted a portion of a dog's skull to repair a soldier's cranium in 1668[11]. In 1820, Philips von Walter, a German, described on autograft by replacing surgicallly removed parts of a skull[25]. However it is not until after Albee's publication of the book, "Bone Graft Surgery", in 1915[1] the bone grafting become a commonly used surgical procedure. Over the last 100 years, multiple methods of reconstruction of mandible have been performed.

Since McCullogh reported free vascularized costal bone graft[7] for reconstruction of mandibular defect, free vascularized bone graft has been tried to reconstruct defect of maxillofaical region as well as mandible.

The available bone grafting sources in current use are divided into three main category. The first type is autogenous bone graft. The autogenous bone graft is used by three mehods ; non-vascularized autogenous bone graft, free vascularized autogenous bone graft and pedicled bone graft. Vascularized mandibular reconstruction has been described using both pediculed and free composite flaps. Those raised on pedicles include clavicle[4,22], scapular[24], sternum[13], rib and temporal bone[3]. Free composite transfers include radius[23], rib[19], ulna[17], iliac crest[29], second metatarsal[2] and fibular[14].

The second type is allogenic bone graft which has been deep frozen or freeze dried for preservation and diminished immunogenicity. Finally, bone synthetic materials is used in reconstruction of the bony defects. Autogenous bone grafts have some advantages which are good in bone take, no immunological problem and easy to use, etc. But, autogenous bone grafting procedure requires more operation time and can lead to donor site morbidity and such problems as insufficient bone amount in child.

The major donor for free bone grafting is iliac crest, rib and unusually, tibia. Iliac crest provides not only both cortical and cancellous bone but also its good curvature. Its curvature is similar to that of mandible so the main stream of autogenous bone graft has the use of ilium as donor site in reconstruction of the mandible. All have vascular pedicles

of sufficient length and caliber in free vascularized autogenous bone graft. They can by transferred alone or as a composite with skin and muscle. Pedicled autogenous bone graft is limited by the distance, so cranial bone and clavicle are main part of donor site in maxillofacial region.

When massive bone grafts are needed, adequate amount of autogenous bone is frequently not available. In esthetic surgery, allograft can be used rather than autograft for avoiding additional scarring. These grafts are generally inferior to autografts as the repair process takes longer and replacement is less complete. Hydroxyapatite and tricalcium phosphate are synthetic preparations that have been clinically used as graft substitutes. Tyey are mainly used to fill cystic defects for their mechanical strength is inferior to other bone grafts.

Fresh, non-vascularized free autogenous bone grafts continued to be the standard technique for judging all other osteogenic method. The donor site may be cortical, cancellous, or a combination of both. The cortical graft offers the advantage or strength but delayed revascularization. The cancellous bone graft allow for earlier revascularization and earlier incorporation, but is inherently weaker.

Grafting methods was mainly corticocancellous type in our study. Because the defect is that of discontinuity type, the corticocancellous type is profitable in providing structural strength. The success rate of the following are particulated marrow and cancellous bone graft 100%, corticocancellous bone with particulated marrow and cancellous bone graft 100%, corticocancellous bone graft 79% and others 75%.

Although a few osteocyte and osteoblasts may survive in the donor graft, the vast majority of the donor tissue does not survive and must replace the dead bone and simultaneous replacement by new bone as creeping substitution[20,31]. The cortical bone transplant become mechanically weaker than normal bone during the early months of resorption and replacement. It may take two years before the mechanical strenghth becomes equal to that of the normal bone. The mechanism by which these autogenous marrow cells induce osteogenesis in the grafting procedure, has been the subject of a great deal of research investigations during the past decade, and there has been a marked controversy concerning the mechanism by which osteogenesis is induced by such bone grafts or transplants. Bone induction system are primarily autogenous in nature. The cancellous bone matrix containing the marrow spaces has the ability to interact with the cells in the marrow particularly pluripotential cells of the marrow itself. Osteoconduction implies that any cellular system which has the ability to influence other cells which have already been programmed to become osteoblasts to differentiate more efficiently and more expeditionarily in producing bone formation. The bone conduction occuring in intraosseous defect, can lead to a complete regeneration of the defect in a more expeditious fashion, than if the intraosseous defect was allowed to regenerate by the simple process of bone forming from the peripheral surfaces of the deficient area.

The types of free autogenous bone graft according to developing osteogenesis are intramembranous bone and endochondral bone. Some study are made for comparison of these two types as free bone graft. The result is that intramembraneous bone graft is superior to that of endochondral bone graft. The result of these studies is based on the formation of the same type of bone. In microscopic finding, there is more revascularization of the graft in that of the intramembraneous bone than that of the endochondral bone.

Basic requirements of the graft bone are stimulation in bone formation, no rejection phenomenon, revascularization and replacement of new bone. And bone resorption factors are overloaded stress on graft, blood supply on recipient bed, bony contact between graft and host bone, and fixation. The fixation method was performed by using wire fixation, plate and screw, screw alone and titanium tray in

the order in our study. Wire fixation has good prognosis compared to plate and screw fixation. The success rate of the following are wire fixation 84.6 %, screw fixation 80% and plate with screw fixation 75%.

In some aspects, the pedicled bone graft and free vascularized bone graft have the same purpose in use. The differences in these two types of autogenous bone graft, is the point of vascularization of the graft. So, the pedicled bone graft is limited by distance for length of its feeding vessel. Free vascularized bone graft has technical difficulty and length of the procedure. These type of bone graft are the ideal bone graft since it carries its own blood supply as well as osteoinductive, osteoconductive, and osteoprogentitor capacities. These methods of bone grafting is especially beneficial when massive segmental bone defect is present or the surrounding vascular supply has been compromised, for example in such cases as severe trauma, infection stage, or irradiation. These methods are able to provide primary bone healing, or at least secondary bone healing.

SUMMARY

To summarize the clinical study of free bone graft, The main type of autogenous bone graft is iliac bone and corticocancellous type.

Overall success rate is 80.3% in 61 followup cases over 6 months.

Wire fixation and Extraoral approach has relatively better prognosis than other methods. It showed relatively poor prognosis in symphysis defects than other recipient site.

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—국문초록—

유리골 이식을 통한 하악골 결손부의 기능적 재건술

김종원 · 남일우 · 김명진 · 정필훈 · 서병무 · 유준영 · 남기원 · 송민석

서울대학교 치과대학 구강악안면외과학 교실

양성 종양, 악성 종양, 감염, 외상 등에 의한 하악골 결손은 중대한 심미적, 생물학적 결과를 일으킨다. 재건술의 일차적 목적은 완전한 기능 회복이며 이는 이차적으로 심미적 변형의 정상화를 유도한다. 저자들은 1981년에서 1990년까지 서울대학교 치과대학 구강 · 악안면외과에 내원하여 하악골 재건술을 시행받고 6개월 이상 추적조사가 가능한 61증례의 임상적 자료 및 방사선 검사를 통해 부위별 임상적 성공률을 조사하였다. 본 임상 논문의 목적은 하악골 결손부위와 부위에 따른 유리골 이식의 성공률을 연구하는데 그 의의를 두겠다.

유리골 이식의 임상적 연구를 요약해 보면 유리 자가골 이식의 대부분은 장골이었고 망상피질골이었다. 6개월 이상 추적조사가 가능한 61명의 환자에 있어 전체적 성공률은 80.3% 였다. 강선고정과 구외 접근법이 다른 방법보다 그 예후에 있어 훨씬 더 좋은 결과를 나타냈고 다른 부위보다 하악 정중부위가 그 예후에 있어 훨씬 나쁜 결과를 보였다.