

RECONSTRUCTION COMBINED WITH HBO THERAPY AND ILIAC BONE GRAFT IN MANDIBULAR FRACTURE SITE OSTEOMYELITIS

Su - Nam Kim, D.D.S., M.S.D., Ph.D., Dong - Kuen Lee, D.D.S., M.S.D., Ph.D
Chang - Joon Lim, D.D.S., M.S.D., Ph.D. Seong - Pill, Yun, D.D.S.

Department of Oral and Maxillofacial Surgery, School of Dentistry, Wonkwang University

Fracture site osteomyelitis begins rarely with an acute event but rather has a subacute onset. It develops almost exclusively in the mandibular region. The treatment principles of mandibular fracture site osteomyelitis are complete removal of inflammatory tissue and drainage, rigid fixation with or without autogenous bone graft and specific antibiotic therapy.

But hyperbaric oxygen used as a modality in the treatment of intractable osteomyelitis. In this paper, we reported that the three patients who have osteomyelitis accompanying secondary infection after mandibular fracture.

I . INTRODUCTION

Stable fixation of segments, prevention of infection and complicated healing are the ultimate goals in the treatment of jaw fracture¹⁾.

The osteomyelitis relation to jaw fracture result from local factor such as inadequate fixation and reduction, infection, altered blood supply and general factor such as patient's age, metabolic disturbance, primary bone disease, nutritional disturbance. But, primary cause is a dead space on account of primary condition of preoperative patient accompany with open fracture, severe loss of bone and soft tissue injury and tooth infection in the fracture line. Generally, because of the effect of hyperbaric therapy in improving healing is based on altered bone physiologic function and its influence on the bacterial organisms involved, recently used it in maxillofacial region for treatment of chronic osteomyelitis, osteoradionecrosis, non - healing wounds and after bone graft or recon-

structive surgery²⁾. The operative procedure of bone graft in the inflammatory tissue was critical subject to scholars. In the studies investigated by Champy et al. 1978, Lindqvist et al. 1986, internal plate fixation in cases of infected fractures is said to be contraindicated^{1,11)}.

Increased risks of mandibular osteomyelitis in patients with chronic alcoholism (Silberman et al. 1974) might also contraindicate the use of internal plate fixation in infected fractures¹⁾. Despite this, Beckers (1979), Kai Tu and Tenhulzen (1985) reported good results which have used bone plates in infected mandibular fractures^{1,3)}. In Maxillofacial region the effect of hyperbaric oxygen therapy was reported by several authors (Mainous et al. 1973, Marx and Johnson, 1986)²⁾. The beneficial effect of hyperbaric oxygen therapy include vascular proliferation or neovascularization, osteogenesis, enhancement of antibiotic activity and possibly a bacteriostatic or bacteriocidal action on pathogenic bacterial organism^{6, 9, 25, 26, 28)}.

We report the reconstruction combined with HBO therapy & iliac bone graft in mandibular fracture site osteomyelitis.

CASE REPORT

1. Case I

A 31-year-old male patient was visited to emergency room for intraoral bleeding and malocclusion complaints due to traffic accident. Radiological examination demonstrated comminuted fracture of the mandible in the symphysis regions with bony deviation of inferior border (Fig. 1). Emergency open reduction

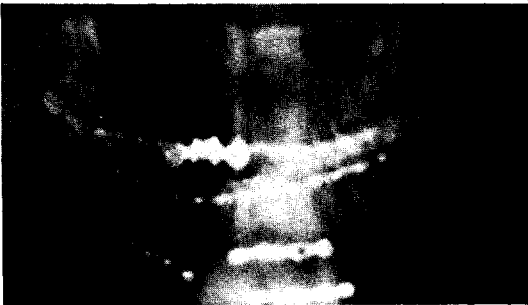


Fig. 1: Emergency postoperative panoramic view



Fig. 2: Five months after secondary operation, showing normal remodeling of grafted iliac bone

with miniplate fixation and close reduction was done. Intermaxillary fixation was sustained for one week. After two weeks of the operation submental swelling was developed due to poor oral hygiene and tooth infection of fracture line. First of all, extraoral incision and drainage carrying out and maintained drainage. After four weeks of the operation, internal rigid fixa-

tion with iliac bone graft was performed. Excessive osteolytic change was existed around to line of fracture. Four day after operation, the HBO therapy was continued two weeks. After two weeks of second operation, the patient have improved status with resolving drainage. After four month of reoperation, a postoperative x-ray film showed a good results (Fig. 2).

2. Case II

A 47-year-old female was visited to our oral and maxillofacial department for jaw mobility and painful swelling complaints. She has experienced fall down about three weeks ago, therefore persist pain were existed. At that time, treatment was not practiced. Orthopantomogram showed osteolytic change with pathologic fracture line on mandible body area (Fig. 3,4). Intraoral incision and drainage performed, the drainage maintained. After two weeks, internal rigid fixation with iliac bone graft was performed (Fig. 5).

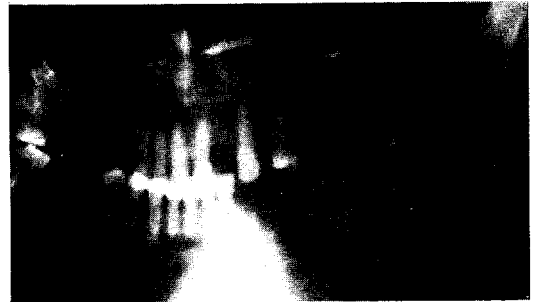


Fig. 3: Preoperative panoramic view

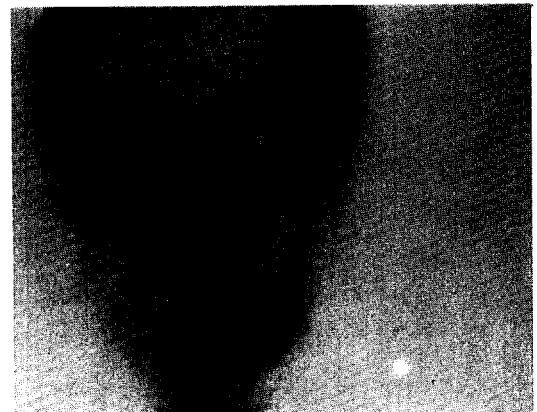


Fig. 4: Preoperative bone scanning image



Fig. 5: Two weeks after postoperative panoramic view



Fig. 6: Six months after postoperative panoramic view

Of course, any sequestra and inflammatory tissue and fragment ends were removed. After fourth operation, HBO therapy was performed for two weeks. And then, there were not infection signs. After six months, the postoperative radiograph showed a good results (Fig. 6).

3. Case III

A 34-year-old patient had a fracture in the area of the symphysis that had been treated primarily with miniplate osteosynthesis. but, after three months of the operation, fractures that have not healed due to premature contact and reduced host defense mechanism that originated tuberculosis. Osteolytic change in area of a fracture gap was developed. After four months of the operation, internal rigid fixation with iliac bone graft was performed. Four day after operation, the HBO therapy was continued two weeks. Three months after second operation, there was not

complication.

In protocol for HBO therapy, which we used, 45 to 90 minute a day, 5 days per week at 2.0 atmospheric pressure absolute (ATA) with applied 100% pure oxygen in monochamber system. To prevent the oxygen toxicity, prehyperbaric oxygen work-up for all patients consists of a chest radiograph, electrocardiogram, complete blood count, sedimentation rate, platelet count, immunoelectrophoresis and analysis for total lipids with fractions, serum glutamic oxaloacetic transaminase, serum glutamic pyruvic transaminase, serum calcium, serum phosphorus, serum potassium and serum alkaline phosphatase, pulmonary function test and ophthalmologic consultation was done. Also we administered the vitamin E (Vivapherol) to prevent oxygen toxicity during HBO therapy.

Table 1. Protocol for HBO Therapy

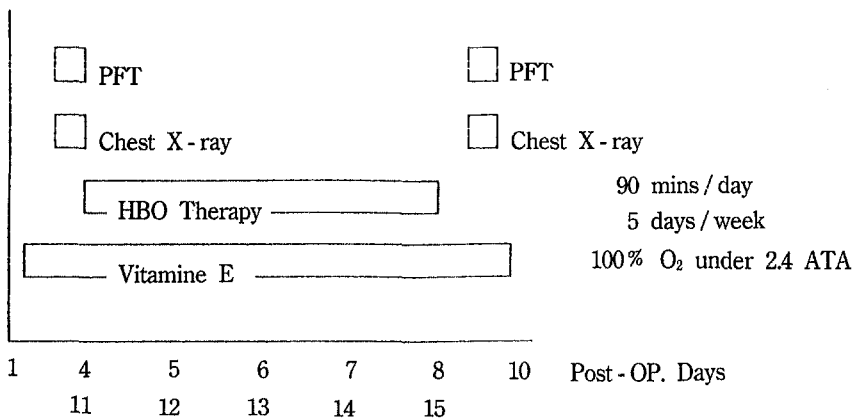


Table 3. Clinical Effect of the HBO Therapy in Our Patients

Case	Age / Sex	Diagnosis	Complication	Treatment	HBO day	Effect
1	31 / M	Man. comminuted fracture	continuative pus discharge	Iliac bone graft and rigid fixation	2 weeks	resolving pus discharge
2	47 / M	Man. fracture	pus discharge with osteolytic change	Iliac bone graft and rigid fixation	2 weeks	rapid healing
3	34 / M	Man. fracture	Nonunion	Iliac bone graft and rigid fixation	2 weeks	improved

Discussion

There were increased great number of open fracture, severe bone loss, soft tissue injury in recent years accompanied by industrial development and high speed transport facilities appearance, thus it was difficult to treatment. Whereas infected mandibular fractures are usually a consequence of absence of treatment of fractures open to the oral cavity, osteomyelitis in the area of the fracture gap can occur after conservative or operative therapy^{4, 5, 7, 22, 24}. The osteomyelitis relation to jaw fracture result from local factor such as inadequate fixation and reduction, infection, altered blood supply and general factor such as patient's age, metabolic disturbance, primary bone disease, nutritional disturbance. The treatment principles of fracture site osteomyelitis are complete removal of inflammatory tissue, drainage, rigid fixation with or without autogenous bone graft and specific antibiotic coverage^{1, 4, 8, 21, 23, 24, 27}. Depending on the defect zones that may develop, the reosteosynthesis that is usually necessary must be accompanied by a graft¹¹. Because of supported bone formation bone graft was used mainly in the fracture site on which delayed healing or nonunion, bone defect with discontinuity has occurred. The operative procedure of bone graft in the inflammatory tissue was critical subject to scholars. In the studies investigated by Champy et al. 1978, Lindqvist et al. 1986, internal plate fixation in cases of infected fractures in said to be contraindicated¹¹.

Increased risks of mandibular osteomyelitis in patients with chronic alcoholism (Silverman et al. 1974) might also contraindicate the use of internal plate fixation in infected fractures^{1, 11}. Despite this, Becker (1979), Kai Tu and Tenhulzen (1985) reported good results which have used bone plates in infected mandibular fractures^{1, 4, 11}. Also Obwegeser (1960, 1963) and Bethmann (1961), Luer (1978) reported good results which have used autogenous cancellous bone graft in treatment of mandibular osteomyelitis^{3, 11}. If autogenous bone graft is success, complete infection control, scar tissue removal for effective antibiotic infiltration and development of vascular beds, lap joint formation for maximum surface contact between recipient and donor bony surface, maximum conservation of periosteal integrity, complete oral hygiene care are required. Main factors of bone graft failure are infection that caused by wound contamination or instability ability of grafted bone fragments. Other factors are improper contact between donor and recipient bone, insufficient blood supply on recipient bed, instability of bony fragment. Since Boerema (1956)¹² have explained to theological background of HBO therapy, Brummelkamp¹³ have used in treatment of gas gangren. Also Smith³⁰ reported good results which have used in CO intoxication. Recent hyperbaric oxygen therapy has been used therapeutically in oral and maxillofacial region for the treatment of osteomyelitis, osteo - radionecrosis of the mandible and to promote osteogenesis in bone graft of the

mandible at Long Beach Naval Hospital²⁾. The rationale for hyperbaric oxygen therapy is threefold. First, adequate tissue tension are necessary for fibroblastic proliferation and new capillary synthesis. Collagen provides the framework for capillary bed formation, capillary arcading and obliteration of avascular or ischemic space. Second, optimal oxygen tension is necessary for bone osteogenesis. In tissue culture studies, Shaw and Basset³⁾ have shown that osteogenesis and collagen fiber formation is suppressed in hypoxic condition. Third, growth of aerobic and anaerobic organism is enhancement in ischemic or avascular tissue. The slightly increased or normal tissue oxygen tension produced by hyperbaric oxygen have a direct effect on anaerobic organisms^{6, 9, 25, 26, 28, 29)}.

The beneficial effect of HBO therapy include vascular proliferation or neovascularization, osteogenesis, enhancement of antibiotic activity and possibly a bacteriostatic or bactericidal action on pathogenic bacterial organism^{6, 9, 25, 26, 28, 29)}. But oxygen also may be toxic under hyperbaric conditions greater than 3 atm absolute²⁾. The neurological effects of such toxic dose are convulsion and progressive constriction of the peripheral vision. The effects on respiratory tissue of oxygen toxicity are congestion edema and patchy collapse separated by areas of normal lung tissue. But hyperbaric oxygen used as a modality in the treatment of intractable osteomyelitis produced a favorable response by shortening healing time in terms of closure of draining fistulas, elimination of sequestrums with the formation of beds of healthy granulated tissue over the viable bone, and reduction in the destruction of hard and soft tissue. It must be emphasized that hyperbaric oxygen is adjunctive therapy.

SUMMARY

We reported that the three patients who have mandibular fracture site osteomyelitis was treated with HBO therapy and iliac bone graft and obtained good results.

The obtained results were as follows ;

1. HBO was considered to be a useful adjunctive me-

thod in the treatment of intractable osteomyelitis.
2. Also in infected jaws, HBO was considered to be a useful method for accelerating the bone graft healing.

REFERENCES

1. Johansson, B.Kreknav, L and Thomsson, M. : Miniplate osteosynthesis of infected mandibular fractures. J. CMS. 16 : 22 - 27, 1988.
2. Elgene G. mainous, P. J. Boyne, G. B. Hart : Hyperbaric oxygen treatment of mandibular osteomyelitis. JADA. 87 : 1426 - 1430, 1973.
3. Beckers, H.L. : Treatment of initially infected mandibular fractures with bone plates. J Oral Surg 37 : 310 - 313, 1979.
4. Prein J., Beyer M : Management of infection and nonunion in mandibular fractures. OMS 90 : 187 - 194.
5. Laskin, D.M. : Oral and maxillofacial surgery. Vol 2 : 258 Mosby, 1985.
6. Mader J. T. : Phagocytic killing and hyperbaric oxygen : antibacterial mechanisms. HBO Rev 2 (1) : 37 - 49, 1981.
7. Rowe, N. L., Williams, J.U. : Maxillofacial injuries. Edinburg, London. and New York, Churchill Livingstone Vol 2, 1985.
8. 김근우, 김명호, 김상립, 오철, 정두영 : 장관골의 감염된 불유합의 치료. 대한정형외과 학회지 19 : 357 - 365, 1984.
9. Martin, B. M., Gimbrone, M. A., Jr., Unanue, E. R., Cotran, R. s., Immunol. 126, 1510 (1981) : Thakral, K.K., W.H., Hunt, T.K., J.Surg. Res., 26 : 430, 1979.
10. Thoma, K.H. : Oral surgery. 5th ed. C.V.Mosby Co. P 622 - 635, 1969.
11. Luhr : Infections of the fracture line, pseudoarthroses, and defect fractures. Trumatology 2 : 423 - 426.
12. Boerema, I. et al. : Life without blood. J. cardio-vasc. surg., 1 : 113 - 146, 1960.
13. Brummelkamp, W.H. et al. : Treatment of anaerobic infections by drenching the tissues with oxygen under high atmospheric pressure. surg., 49 :

- 299, 1961.
14. Davis, J. C. et al : Hyperbaric oxygen therapy, Undersea Medical Society, Inc. Bethesda, Maryland, 1977.
 15. Deppenbusch, F. L., Thompson, R. E., Hart, G. B. : use of hyperbaric oxygen in the treatment of refractory osteomyelitis : A preliminary report.
 16. Donald, K.W. : Oxygen positioning in man, 1 & 11, Brit. Med J., i : 667 - 672, 712 - 71, 1947.
 17. Dork, Ro Yun : Chemical environment & hyperbaric medicine. Dept. of preventive college of the medicine, Seoul National University, 1984.
 18. Joanny, P. et al : Hyperbaric oxygenation effects on metabolism & ionic movement in cerebral cortex slices. Science, 167 : 1508 - 1509, 1970.
 19. Goldhaber, P. : The effect of hypoxia on bone resorption in tissue culture. A.M.A. Archives of pathology, 66 : 635 - 641, 1968.
 20. Penrod, K.E : Pulmonary damage in high oxygen pressure. Fed. Proc., 15 : 143, 1956.
 21. Green, S.A. and Dlabal, T. : The open bone graft for septic nonunion. Clinical Orthopedics and Related Research. 180 : 117 - 124, 1983.
 22. Moore J.R. : Surgery of the mouth and jaws. Oxford London Edinburgh Boston BLACKWELL SCIENTIFIC PUBLICATIONS. 290 - 291, 1985.
 23. Malkawi, H., A. and Sunna, P. : Active treatment of segmental defects of long bones with established infection. Clinical orthopaedics and Related Research. 184 : 241 - 248, 1984.
 24. Mathog, R.H. : Maxillofacial Trauma, Baltimore, London, Williams & Wilkins. 162 - 194.
 25. Hunt, T.K., Pai, M. P. : The effect of varying ambient oxygen tensions on wound metabolism and collagen synthesis. Surg Gynecol. Obstet, 135 - 561, 1972.
 26. Ketchum, F.A., Thomas, A. N., Hall, A.D. : Audiographic studies of the effects of hyperbaric oxygen on burn wound revascularization. In Wada, J., Iwa, T. (eds) : Proceedings of the Fourth International Congress on Hyperbaric Medicine, 383 - 394. Baltimore (MD), The Williams & Wilkins Co., 1970.
 27. Kai Tu, H.O. : Compression Osteosynthesis of mandibular fracture : a retrospective Study, J Oral Maxillofacial Surg. 43 : 585, 1985.
 28. Mader, J. T., Brown, G. L., Guckian, J.C., Wells, C.H., Reinartz, J. A. : A mechanism for the amelioration by hyperbaric oxygen of experimental staphylococcal osteomyelitis in rabbits. J. Infect. Dis, 142 (6) 915 - 922, 1980.
 29. Niinikoski, J., Hunt, T.K. : Oxygen tension on human wounds. J. Surg. Res., 12 : 77 - 82, 1972.
 30. Smith, W.W. et al. : Hyperbaric oxygenation, Mongogr. Surg. Sei, 2 : 1, 1965.
 31. Bassette, C.A.L. : Current concepts of bone formation J. Bone Joint Surg, 44 A : 1217 - 1244, 1962.

하악골 골절후 이차감염으로 인한 골수염시 유리 장골 이식술과 고압산소 요법을 이용한 재건 치험례

원광대학교 치과대학 구강악안면외과학교실

김수남 · 이동근 · 임창준 · 윤성필*

하악골 골절시 감염으로 인한 합병증에는 비유합, 부정유합, 감염에 의한 골수염, 치아 및 지지골 상실, 국소부위로부터 인접부위로 감염확장 등이 있다. 그 원인으로는 크게 국소요인과 전신요인으로 분류되는데 국소요인으로는 부적절한 고정과 수복, 감염 및 개조된 혈액공급을 들 수 있고 전신요인으로는 부적절한 고정과 수복, 감염 및 개조된 혈액 공급을 들 수 있는 전신요인으로는 환자의 나이 및 대상장애 질환이나 primary bone disease, 영양결핍을 들 수 있다. 악골골절과 관련된 골수염은 조기에 적절한 고정 및 치료, 항생제 요법, 골절선상의 치아에 대한 치료, 전신적 저항성을 향진 시킴으로서 예방할 수 있다.

본 저자들은 하악골 골절후 이차감염으로 인한 골수염에서 골 이식의 일반적인 원칙인 감염이 없는 부위가 아닌 염증이 존재한 부위에 유리장골 이식술과 고압산소 요법을 병행하여 양호한 결과를 얻었기에 이에 보고하는 바이다.