DIODE LASER LLLT-ENHANCED BONE FUSION OF FEMORAL SHAFT FRACTURE COMPLICATED BY CHRONIC OSTEOMYELITIS: A CASE REPORT

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Low reactive-Level Laser Therapy (LLLT) has been reported in the literature as enhancing bone generation and bone fusion in experimental animal models. This paper presents the application of LLLT for treatment of a fracture in an older patient with the added complication of chronic osteomyelitis of more than 20 years' standing. While further experimental work is necessary to pinpoint the mechanisms and pathways by which LLLT works on the production of bone callus of a more mineralized quality and stronger matrix, the author feels that LLLT immediately offers the orthopaedic surgeon a non-invasive and effective tool to enhance bone fusion for the treatment of fractures, especially with added complications such as osteomyelitis.

KEY WORDS: LLLT, Laser bioactivation, Bone fusion, Osteomyelitis

Case Report

A 72-year-old female presented at the author's clinic in June of 1989 for treatment of severe pain in the left thigh following a fall. At the age of 48, she presented at the Fukuoka Red Cross Hospital complaining of constant pain in the left thigh, and was diagnosed as having chronic osteomyelitis of the left femur. She received a course of treatment, but even after treatment, she still complained of pain with accompanying heat and inflammation after working or walking for an extended period. Blood tests revealed leukocytosis. Following a course of antibiotics, the symptoms decreased. On June 28th, 1989 she tripped and fell while in the toilet, and suffered a severe blow to her left thigh. Soon after the accident, although the thigh was painful, she was able to walk, but the pain increased in severity, and finally she presented at the author's clinic.

Status and Treatment

On the first day, the patient was able to walk with difficulty using crutches, although with severe pain. There was swelling and extreme tenderness in the lower left thigh. On manipulation, abnormal motion of the femur could be detected and crepitation was

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Figure 1. (June 28th) (Figures 1, 2 and 3 all from rear of leg, proximal to top). View of fracture site in initial consultation X-ray

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present. X-ray examination revealed a fracture of the lower left femur, with bony hypertrophy of the compact bone with narrowing of the marrow consistent with chronic osteomyelitis. There was no torsion displacement of the bone at the fracture site. The patient was admitted as an inpatient because of the severe pain and problem with walking. The usual treatment in these cases is open reduction, but the patient was unwilling to undergo conventional surgical methods because she was afraid that there would be a recurrence of her chronic osteomyelitis. Accordingly the fracture area was irradiated with a diode laser (Leukotron, Mochida Pharmaceutical Company, Tokyo) giving 60 mW at 830 nm in continuous wave (power density approx. 3 W/cm²) for 10 min per treatment session (energy density 30 J/cm²). There were four or five sessions per week, with a total of 140 sessions. The LLLT system is equipped with twin laser probes, and both probes were used simultaneously at opposite sites of the fracture region in the contact method. The limb was immobilized with a plaster cast articulated at the knee joint to allow easier walking.

Figure 1 shows the condition as demonstrated by roentgenogram prior to LLLT on June 28th. Orientation is as shown, frontal/occipital aspect. Thickening of the cortex and narrowing of the marrow region are visible, more pronounced on the right, consistent with her history of chronic osteomyelitis. The fracture site is clearly visible with an associated bony defect. A roughly circular osteomyelitic bony defect is also visible at the bottom of the print. Following the first session, the patient reported lessening of the pain.

Figure 2 (same orientation and aspect as Figure 1) is the roentgenogram taken on August 13th, approximately 7 weeks after the first session. Reduction of the fracture defect with bone fusion can be seen. The osteomyelitic defect is also smaller. There is a reduction in the cortex hypertrophy, with an increase in the bone marrow width. Patient was able to walk with the aid of a single walking stick. Pain was considerably less.

Figure 3 (same orientation and aspect is the condition on September 25th, 6 weeks later. Continued reduction of both fracture and osteomyelitic defects can be seen, with widening of the marrow and continued reduction in cortex hypertrophy.

Figure 4 is the condition on October 17th, approximately 3 weeks after previous figure. The orientation is as shown, X-ray from lateral/median
aspect. Thickening of the periosteum is visible, frontal worse than occipital, giving distortion from frontal to occipital. The fracture defect is much smaller with evident bony regrowth and fusion. The osteomyelitic defect is still visible at the bottom of the figure.

Figure 5 (same orientation and aspect as Figure 4) shows the condition on November 20th (1 month later). Both fracture and osteomyelitic defects are reduced by bony regrowth. Calcification of the periosteum is visible, perhaps as part of the remodelling process.

Figure 6 (same orientation and aspect, December 12th—1 month after previous session, 26 weeks after initial consultation) shows continued improvement with good fusion at the fracture site, and reduction of the osteomyelitic defect. Pain on walking was almost completely gone.

Discussion

Especially in the older patient with chronic osteomyelitis, a fracture treated by conventional surgical open reduction is often followed by recurrence of the osteomyelitis, with possible adverse effects on the speedy reduction of the fracture defect by fusion, bony regrowth being already much slower in the older patient. For further surgical intervention in such patients, bone transplant is often the only available method, and the success is not guaranteed. In the case of chronic osteomyelitis, long term rigid plate fixation is often required, with the problems associated with atrophy of the muscles in the fixed limb. Alternatively, electromagnetic or magnetic wave therapy can be used, but it takes a very long time to achieve a good effect.

In patients similar to this case study, the author recommends the use of contact LLLT instead of conventional surgical techniques. The literature reports well-documented improvement in the quantity and quality of new bone following LLLT irradiation in animal models. The case reported in this paper shows the results in man, even in an older patient in whom bone regeneration and fusion are usually much slower compared with the younger patient. The author proposes the success of diode laser LLLT in the reported case may well be due to the systemic action of LLLT on the blood supply, causing an increase in blood flow and volume.
coupled with local photoactivation of the osteoblasts. Further clinical experimentation is necessary to elicit the exact mechanisms, but the author feels that LLLT offers the orthopaedic surgeon a viable and effective alternative to open reduction in those patients for whom such surgical intervention might have undesirable sequelae.

Figure 6. (December 12th) Bony defect well filled front and rear with radiopaque bone callus, defect in centre closing well