

# Electrotherapy and hyperbaric oxygen: Promising treatments for postradiation complications

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**Electrotherapy and hyperbaric oxygen therapy have been added to physical therapy to treat patients with postsurgery and radiation sequelae. Problems of reduced oral opening and range of head movement, soft tissue necrosis, osteoradionecrosis, and delayed wound healing were addressed in 37 patients over a 3-year period. Of this group, 16 irradiated maxillary resection patients were specifically followed up to determine the effectiveness of the new modalities on improving reduced oral opening. Although healing and the quality of the soft tissues showed marked improvement there was no significant improvement in oral opening. (J PROSTHET DENT 1989;62:331-4.)**

Patients treated for head and neck cancer have developed postradiation problems since radiation was first

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used as anticancer therapy. Although radiation therapists have made great improvements in minimizing exposure of healthy tissues to the radiation beam, postradiation complications continue. The acute problems encountered during radiotherapy and the problems associated with the progressive ischemia of irradiated tissues are usually treated symptomatically.

The major postradiation problems that the maxillofacial prosthodontist tries to resolve or prevent are radiation caries, xerostomia, reduced vertical opening, and a decreased range of head and neck motion. Of these, reduced vertical opening is the most perplexing. Histologically,

dentists have used a variety of mechanical devices such as stacked tongue blades, plastic screws, and dynamic bite-openers to overcome this reduction. Encouraging patients to perform mouth exercises to regain a normal opening after surgery and radiation has met with results that vary with patient compliance and the circumstances of disease and treatment.

Results of attempts to increase vertical opening are often disappointing. Therefore, during the past 3 to 4 years, dental oncologists and physical therapists at The University of Texas M. D. Anderson Cancer Center have worked together to develop new ways of resolving postradiation morbidity. The modalities most often used are traditional physical therapy, electrotherapy, auriculotherapy, and hyperbaric oxygen therapy.

Physical therapy alone has little new to offer. Manual stretching and massaging and home exercises are used to free adhesions, restore free-moving facial planes, and improve circulation. However, in an irradiated field, circulation is improved only minimally by physical therapy. However, various combinations of physical therapy and the other modalities have had some success in restoring a more normal range of motion and neuromuscular health. This article will discuss the use of these modalities in managing patients with a reduced vertical opening.

## ELECTROTHERAPY

Electrotherapy has been applied empirically for many years in many ways. Its use by charlatans and quacks at the turn of this century led the medical community to almost entirely abandon its use.<sup>1</sup> Fortunately scientists (primarily neurophysiologists) in the 1940s began to study the effects of direct current and electromagnetic fields on living organisms and organ systems.<sup>2,3</sup>

In the 1960s external voltage was found to stimulate bone growth,<sup>4</sup> and in the 1970s electromagnetic energy was applied to bone-healing problems.<sup>5,6</sup> During this period it was also discovered that an electromagnetic field could alter cell-membrane permeability.<sup>7</sup> In contrast to the milliamperes currents used for transcutaneous electrical nerve stimulation, therapeutic currents are applied at microampere levels.

Interestingly, auriculotherapy is related in principle to acupuncture, which has been practiced in China for thousands of years. Acupuncture has only recently been accepted by Western medicine, and its mechanism of action is still not understood.<sup>8</sup> It is recognized, however, that by stimulating specific acupuncture points, a neurophysiologic effect is produced on the body by altering the electrical-control system.<sup>9</sup>

More recently Nogier<sup>10</sup> discovered and developed what is now called auriculotherapy. Auriculotherapy is similar to acupuncture, but the only points stimulated are those on or about the ear. Nogier found that the pinna resembles an inverted fetus, and, when points on the fetus are stimu-

lated, corresponding organs and areas on the body are affected. His discoveries were verified by the Chinese; differences correspond to differences between the philosophies of Chinese and Western medicine.<sup>11</sup> Although the mechanism involved is not fully understood, investigators recognize that an abnormal change in the body, such as disease or pain, can be detected at its corresponding point on the ear. Stimulation of that ear point and other appropriate points, depending on the physiology involved, effects a corresponding change in the body.<sup>12</sup>

This form of therapy gained attention for its efficacy in treating sports injuries during the 1984 Olympics in Los Angeles. A study done by the Department of Anesthesiology at the University of California at Los Angeles, School of Medicine showed that physical problems could be detected by scanning ear points with an electric probe. Where pathosis existed, the corresponding ear point was hyperactive and elicited an electrically detectable response.<sup>13</sup>

The treatment of sports injuries has shown that subjecting an injured region to an electromagnetic field of low intensity results in rapid dispersion of edema and hematoma. This type of treatment is referred to as bioconductive therapy. In this therapy, electrodes are placed on either side of an injured region and an electromagnetic field is directed through it.

## HYPERBARIC OXYGEN THERAPY

The use of hyperbaric oxygen for irradiated patients who have osteoradionecrosis or need surgery in heavily irradiated bone enhances wound healing.<sup>14-16</sup> Soft-tissue oxygen partial pressure (tension) can be restored to approximately 80% of normal after 20 1.5-hour "dives" at 2.4 atmospheres of 100% oxygen. Hyperbaric oxygen treatment requires approximately 4 weeks and results in a revascularization of the irradiated tissue beds. Hyperbaric oxygen enhances the prognosis for carefully performed reconstructive surgery, although additional dives after surgery may be needed to ensure a successful outcome.

The major difficulties of hyperbaric oxygen treatment are time and expense. The plight of cancer patients with osteoradionecrosis and the cost of hyperbaric oxygen treatment are recognized by insurance companies. However, other modes of payment must be found for patients without insurance.

## PATIENTS AND METHODS

### Patients

Over a 3-year period, the Dental Oncology Department monitored 37 patients with head and neck cancer with sequelae of surgery and radiation therapy. Sixteen had undergone a maxillary resection followed by radiation therapy. All of the 16 patients experienced a decreased oral opening, and some developed osteoradionecrosis.

## Treatments

Initially each patient was referred to the Physical Therapy Department to receive auriculotherapy. This therapy was done with an Alpha Stim 2000 (Electromedical Products, Inc., Hawthorne, Calif.) instrument. Each patient was also given exercise instructions to attempt to retain or regain vertical oral opening.

After Bauer\* and Boswell and Bauer<sup>17</sup> reported that auriculotherapy of irradiated patients could be enhanced by bioconductive therapy (directing electromagnetic fields in microamperage current across the fields being treated), the Dental Oncology Department acquired Alpha Stim 350 units (Electromedical Products, Inc.) and began to routinely treat irradiated regions in this manner. After some empirical adjustments it was found that a 50  $\mu$ A current at 0.5 Hz provided the best results. Stronger currents seemed to enhance fibrous tissue regeneration and actually made the area "tighter."

In time, a treatment protocol evolved whereby all patients with postradiation complications were sent to the physical therapists to receive exercise instruction, physical therapy, and electrotherapy, including both auriculotherapy and bioconductive therapy. Records were maintained on all 37 patients. The initial plan was to treat each patient daily for 3 weeks for a total of 15 treatments. Only six patients received the planned 15 treatments. Because of the diversity of the entire group, the 16 maxillary resection patients were selected to determine the effectiveness of the treatment protocol in preserving or regaining vertical oral opening after maxillary resection and radiation therapy.

Patients with osteoradionecrosis or soft tissue necrosis, or patients who needed teeth extracted from irradiated bone were referred for hyperbaric oxygen therapy. A single-place Seachrist Chamber (Seachrist Industries, Inc., Medical Products Division, Anaheim, Calif.) was used. Three of the 16 maxillary resection patients developed osteoradionecrosis. Two received hyperbaric oxygen therapy and the third refused hyperbaric oxygen therapy and received electrotherapy only.

## RESULTS

The conditions and treatments of the 16 irradiated maxillary resection patients were so varied that a valid comparison of the results of their treatment modalities was not possible.

The patients did not uniformly receive 15 treatments. Their treatments ranged from 1 to 57. A total of 57 treatments were given to one patient for palliation, and he died of his disease. Five patients had more than 20 treatments. Four patients chose to terminate their care after one to nine treatments. The patient who received nine treatments died of his disease; the patient who had three treatments had

residual disease and died later. One patient had seven treatments, increased his oral opening from 11 mm to 16 mm, and has no evidence of disease. The patient who had only one treatment left the study after learning to use the Alpha Stim 350 bioconductive electrotherapy instrument. Osteoradionecrosis was resolved in the three patients treated with hyperbaric oxygen and/or electrotherapy. Retaining or regaining decreased oral opening did not prove to be enhanced specifically by the treatment protocol.

## DISCUSSION

One of the first patients treated by auriculotherapy alone had received 70 Gy external-beam radiation bilaterally to metastatic disease in the neck after a marginal maxillary resection for squamous cell carcinoma of the gingiva. Her face and neck had the typical darkly pigmented, hard, alligator-hide texture where she had been irradiated. In addition to the normally prescribed head and neck exercises, she received 10 treatments of auriculotherapy over a period of 2 weeks.

At the end of the 2-week period, a marked change had occurred in the texture and color of the irradiated tissues. During the auriculotherapy her neck and lower face became warm, to the point that one could believe hot compresses were being applied. Apparently there was a marked increase in blood flow and cellular metabolism within this area. This warmth led to the assumption that the combination of increased blood flow and increased cell-membrane permeability was allowing tissues to repair and revascularize in an area that would otherwise experience progressive ischemia and fibrosis.

Hyperbaric oxygen therapy has produced impressive results in a number of patients. Commonly, the texture of the irradiated soft tissues improves markedly. Patients may perceive the change as feeling their tissues swell, and dentists must frequently adjust obturators to accommodate these changes. Patients also report increased mucous secretions and sensation in irradiated areas. Draining fistulas heal. Surgeons can remove teeth in irradiated mandibles and achieve good healing.

Although hyperbaric oxygen therapy has improved soft-tissue quality, it has not helped to increase vertical oral opening significantly. Efforts to restore decreased oral opening have been disappointing. Patients who receive postmaxillary resection radiation usually have a preoperative oral opening, measured between incisors, of 40 to 50 mm. If patients do not exercise vigorously enough to regain the original vertical opening between surgery and the beginning of radiation therapy, they frequently find their opening reduced to approximately 20 mm when radiation therapy begins. At the end of the radiation treatment the oral opening has usually decreased to approximately 10 mm. By using exercises and electrotherapy, the oral opening may be increased to approximately 20 mm at best. If necrosis or residual or recurrent disease is present in the

\*Bauer W. Personal communication, 1985.

pterygoid muscles, the patient may continue to lose oral opening. No more than 2 to 3 mm can be regained for these patients.

The clinical impression at M. D. Anderson Cancer Center is that electrotherapy and hyperbaric oxygen is achieving a degree of tissue repair and revascularization of the irradiated field. Patients who have experienced wound breakdowns, oral-facial fistulas, soft tissue necrosis, or osteoradionecrosis in irradiated fields have had enhanced wound-healing after 3 to 4 weeks of electrotherapy and hyperbaric oxygen therapy. In some patients both treatments were applied simultaneously, with electrotherapy after each hyperbaric oxygen treatment.

## CONCLUSION

Electrotherapy and hyperbaric oxygen therapy have been used at M. D. Anderson Cancer Center to combat some sequelae of radiation to the head and neck. Although it is still unclear what is specifically occurring physiologically and histologically, the irradiated soft tissues appear to become revascularized. It is apparent that these modalities have relieved discomfort, enhanced healing of irradiated hard and soft tissues, and improved the quality of the irradiated soft tissues. Unfortunately they have not been effective in restoring decreased oral opening. Further clinical and basic research is needed to increase understanding and potential applications of each of these modalities.

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