

## HYPERBARIC OXYGEN THERAPY IN THE TREATMENT OF SUDECK'S SYNDROME

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### SUMMARY

The decrease in tissue hypoxia obtained with Hyperbaric Oxygenation (HBO) counteracts the effects of reflex vasomotor disturbances caused by an injury in post-traumatic Sudeck's Syndrome.

In reflex sympathetic dystrophy, after an initial vasospasm, a loss of vascular tone with persistent vasodilatation causes increased osseous vascularity and rapid bone resorption.

Chronic edema results from venous overload and passive capillary repletion; local lack of oxygen and acidosis cause demineralization and bone protein catabolism. The hypoxic state induces undifferentiated mesenchymal cells and younger fibroblast to a rapid maturation, with abnormal production of fibrous tissue, retraction, adhesions and joint stiffness.

In our experience HBO proved to be very effective, even after a few treatments, to resolve local swelling and to relieve pain in 13 of 15 patients affected by Sudeck's Syndrome who had not positively reacted to other therapies. In 14 patients the sympathetic dystrophy affected the lower limb. Strict diagnostic criteria based on history, physical examination and radiological picture have been respected.

Technetium scintigraphy was performed and confirmed diagnosis in 7 cases.

A second Tc scintigraphy carried out after 20 sessions of HBO 2.5ATA was available in 5 patients and demonstrated normalization of the vascular phase in 4 patients, and amelioration of the late (bone) phase in 3.

Post-traumatic Sudeck's Syndrome is a reflex sympathetic dystrophy which consists of pain and tenderness, usually in a distal extremity, associated with vasomotor instability, swelling and trophic skin changes arising after trauma.

The severity of the syndrome is frequently unrelated to the severity of the injury, and the dystrophy often appears after minor trauma.

The classic radiographic picture shows acute, patchy bone demineralization. Technetium scintigraphy displays augmented periarticular radionuclide activity.

In its early manifestations Sudeck's Syndrome is unrecognized or misdiagnosed and mistreated in many cases, so the patient may have a prolonged and severe

re disability.

No treatment, hitherto, has proved to be very successful, once the disease become established: various forms of physiotherapy, systemic administration of drugs ( antiinflammatory agents, vasodilators, steroids, calcitonin), peripheral chemical sympathectomy, infiltration of painful areas with local anesthetics, sympathectomy and sympathetic blocks, section of the sensory nerves or of the dorsal roots or of the spinothalamic tract (in intractable cases) have been reported in the literature.

Despite any or all of these measures, many patients improve little or not at all, so that their symptoms persist for months or years. Some patients have attempted suicide because of all the psychological and economic problems related to the disease.

The etiopathology of the condition is uncertain. The present pathogenic hypothesis is that after an injury to the limb there is an initial vasomotor reflex spasm and, in a second phase, a loss of vascular tone with persistent vasodilatation and rapid bone resorption.

The increased osseous vascularity appears on the radiogram as a mottled rarefaction caused by increased porosity and a decrease in size, thickness and number of trabeculae.

Chronic irritation of peripheral sensory nerve secondary to trauma and soft tissue damage determines increased afferent input, abnormal activity of internucial neuronal pool and continuous stimulation of sympathetic motor efferent fibers.

Accordingly to the "gate control theory", predominant small fibers input could result in the unchecked transmission of pain through an "open gate" and create the potential for summation, suppressing the influence of the substantia gelatinosa.

Capillary bed repletion, venous overload, opening of the arterovenous shunts provoke tissue hypoxia, catabolite formation, chronic edema and acidosis.

Acidosis, inactivity and vascular stasis determine bone resorption of the cortical haversian system. Hypoxia and acidosis lead undifferentiated mesenchymal cells and younger fibroblast to proliferation and quicker maturation ( a state which requires lower oxygen consumption) with abnormal fibrous tissue production, edema organization and joint stiffness.

Reflex vasomotor disturbances, resulting in hypoxia, catabolite production and acidosis stimulate sensory nerve termination and close a vicious self sustaining cycle.

The use of HBO in the treatment of post-traumatic Sudeck's Syndrome is rational. In fact hyperbaric oxygenation induces vasoconstriction and reduce edema: this counteracts vascular stasis and venous repletion, increases depressed osteoblast activity and mineralization, reduces fibrous tissue formation.

HBO therapy seems to break the vicious self sustaining cycle of the reflex sympathetic dystrophy, because normalization of local tissue oxygen tension, PH and water interstitial content stops abnormal sensory nerve stimulation

and efferent vasomotor phenomenons.

#### MATERIAL AND METHOD

Fifteen patients (11 men and 4 women ) suffering for reflex post - traumatic dystrophy have been treated with HBO therapy. In 14 of the 15 cases the trauma affected the lower limbs. The average age was 44.4 years.

Initial injury was in 4 cases a calcaneus fracture, in 3 cases a malleolus fracture; in the remaining patients Sudeck's Syndrome followed tibial shaft fracture (2 cases), supracondylar femur fracture, multiple metatarsal bone fractures, multiple metacarpal bone fractures and in 3 cases only an history of minor trauma was collected.

The disease involved foot and ankle in 13 cases, the knee in one case and the hand and the wrist in one case.

10 patients had immobilization in cast as the treatment of choice; in 3 cases (supracondylar femur fracture, multiple metacarpal bone fractures, malleolus fracture) the patient underwent surgical treatment.

Time elapsed between trauma and diagnosis was 2- 8 months. Strict diagnostic criteria for inclusion in the study has been based on history of injury to an extremity, physical examination and radiological picture.

Technetium scintigraphy was performed in 7 cases to confirm diagnosis and in 6 cases assessed the evolution of the disease.

Clinical diagnosis was based on the presence of pain, tenderness, swelling, vasomotor instability and joint stiffness long lasting after a trauma.

Radiographic criteria included patchy bone demineralization, osteoporosis and cortical cavitation. All the patients were in the acute phase of the syndrome. No case of treatment of the initial or of the atrophic stage has been included in the present study.

HBO protocol consisted in 20 sessions at 2.5 ATA (5 sessions a week). A further series of 10 sessions was performed in patients (3 cases ) presenting partial clinical recurrence during the week ensuing the termination of the 20 session protocol.

A previous calcitonin regimen, although of very limited efficacy, was maintained during HBO therapy in 5 subjects. No patient used analgesic drugs during HBO treatment.

Avoidance from weight bearing, functional limb rest and use of an elastic stocking were strongly counseled in patients with lower limb involvement.

Tc scintigraphy was performed at the end of the 20 HBO sessions in 6 cases. Radiographic controls were scheduled at 2 and 4 months.

#### ILLUSTRATIVE CASE REPORTS

a- A 50 year old bricklayer sustained a sprain to his left ankle which remained untreated. After two months ankle pain, quite slight at the beginning, get increasing with paroxysmal exacerbations, extending to the forefoot and forcing the patient to suspend his work.

The radiogram showed the classical picture of reflex sympathetic dystrophy.

Pharmacologic agents and physiotherapy remained for months ineffective.

Presenting to our observation, 6 months after the injury, the patient was unable to walk without crutches, suffered of intense and unduly pain and was severely depressed, lacking of confidence in any form of treatment.

Clinical examination revealed minimal swelling of the ankle, cutaneous hypersensitivity and a 50% decrease in movements of the subtalar and tibio-talar joints.

After the first week of HBO therapy the patient referred significant decrease in pain which, after the second week, almost disappeared. A progressive and complete recovery of the movements of the joints involved was recorded. After 20 sessions of HBO patient was free of any symptom and walked normally.

Tc scintigraphy demonstrated normalization of the vascular phase, and clear reduction of hypercaptation in the late phase.

Resolution of radiographic picture was slow.

b-58 year old man, pensioner; after an untreated left forefoot distortion the patient complained of persistent refractory pain, swelling, limitation of motion in the extremity and marked disability to walk.

On the basis of clinical, radiologic and Tc scintigraphic findings diagnosis of reflex algodystrophy was formulated 5 months after trauma.

After only four HBO treatments pain and swelling disappeared; at the completion of the schedule the patient walked correctly without crutches and was very satisfied.

Tc scintigraphy at the end of the therapy demonstrated significant reduction in the hypercaptation of the forefoot.

At the 2 month control discrete amelioration in the radiologic pattern was observed.

## RESULTS

After the first week of HBO a marked reduction of pain and tenderness in the extremity was observed in 9 patients; discrete clinical improvement has been recorded in 3 cases.

Reduction of swelling and restoring of movements in the affected extremity has been progressive during the course of HBO therapy.

At the completion of the first HBO cycle complete recovery (no pain, complete restoration of movements in the affected joints, no swelling) has been observed in 4 cases (26.7%). Marked clinical improvement (occasional light pain, minimal swelling at the evening, almost normal movements in the affected joints) was present in 5 cases (33.3%). Moderate clinical improvement (reduction of pain and swelling, partial restoration of movements) has been present in 4 cases (26.7%). In 2 patients (13.3%), in spite of some reduction of swelling, a significant pain persisted; in one of these patients, however, pain was present only during weight bearing on the affected extremity and in part could be referred to progressive subtalar degenerative changes after a calcaneus fracture.

In 4 cases partial relapse of the symptoms in the weeks ensuing the

completion of the first 20 sessions lead to a second 10 session HBO cycle with complete recovery.

In the 6 cases controlled at the Tc scintigraphy after the 20 HBO sessions normalization of the vascular phase was observed in 4 patients, and reduction in the hypercaptation in the late (bony) scintigram was present in 3 cases. No case of worsening of the scintigraphic picture has been recorded. Resolution of the classic radiologic pattern has been generally slow: in a few patients significant improvement at the 2 month control has been observed.

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