Biowave White Paper on Use of a Neuromodulation Pain Therapy Device ("BiowavePRO®") to Treat Acute Sports Injuries

Sunil J. Panchal, M.D.
Joseph Pergolizzi, M.D.

Introduction:

A high percentage of both acute and chronic sports related pain is associated with back or extremity injuries. It is estimated that greater than 70% of all sport injury related pain is treated with traditional analgesic medications in an outpatient setting. Although there is a considerable documentation of the incidence and severity of both acute and chronic pain using these traditional methods in the general population, there is very little data regarding the utilization of non-invasive medical devices. Because professional athletes depend on their physical abilities to generate financial income and achieve professional advancement, it is imperative that their pain be addressed in an optimal manner. Optimal analgesia encompasses the notion of providing optimal reductions in pain with increasing patient comfort, maximum patient satisfaction, and minimum related side effects for the prescribed treatment. Various treatment algorithms for the management of nonmalignant pain have been proposed which include a stepwise approach at managing pain with emphasis on utilizing the least invasive strategies whenever feasible. Still, pure opioid agonists continue to be the most commonly prescribed regimen for moderate to severe pain in many situations. A significant number of patients experience opioid related side effects, which limit their ability to achieve optimal analgesia and preclude them from various normal activities. This is especially relevant to professional athletes who rely on both physical and mental abilities to be able to remain competitive in their profession. Moreover, many of these athletes are subject to various substances testing in order to maintain eligibility to practice in the sport, and therefore it is assumed they would rather bear the pain and avoid treatment than potentially be prohibited to play. This can lead to under-reporting and under-treatment of pain in this particular setting. Thus there is an unmet need for therapies that may lessen the pain related to sports injuries and the side effects related to traditional treatment modalities.

Biowave Corporation's BiowavePRO® Neuromodulation Pain Therapy Device ("BiowavePRO" or the "Device") utilizing Sportswave® Noninvasive Reusable Electrodes has been studied in an open label manner in regard to efficacy and tolerability in the treatment of pain associated with injury in a professional sports environment. The BiowavePRO device has been tested on injuries affecting the players of the NY Giants professional football team.

Methods:

Inclusion criteria:

1. Patients must be male of any race
2. American Society of Anesthesia Physical Classification: ASA 1-3 [American Society of Anesthesiologists (ASA): New Classification of physical status. Anesthesiology 24:111, 1963]
3. Ages 18- 40 yr
4. Patients must have a baseline score of ≥30 mm on the VAS pain scale
5. If taking analgesics, patients must agree to maintain a steady regimen for the duration of the study
6. Patients must be able to understand and be willing to cooperate with study procedures
7. Able to provide written and verbal informed consent

Any football player in training camp and active and practice squad members during the playing season who were injured were eligible to participate. Treatment would be offered on a daily basis until the condition resolved, or until the subject was no longer able to participate (i.e. dismissal as a member of the team).

Exclusion Criteria:

1. Allergy or intolerance to adhesive materials
2. Surgical intervention during the past month for the treatment of the painful site or its underlying etiology
3. Clinical evidence of cardiovascular (history of cardiac arrhythmias), pulmonary, renal, psychological, hepatic, neurological (seizures), hematologic, or endocrine abnormalities
4. History of any substance abuse or dependence within the last 6 months
5. Patients with pending Worker's Compensation claims, pending civil litigation pertinent to the cause of pain, currently receiving monetary compensation for the injury resulting in pain, or currently involved in out-of-court settlements for claims pertinent to their pain
6. History of pacemaker, implantable devices (AICD, pump, etc.)
7. Patients who have received an investigational drug or device in the past 30 days.

Treatment Algorithm:

If all of the inclusion criteria were met and none of the exclusion criteria were met, the informed consent form was reviewed with the patient for signature. The patient was then enrolled into the study treatment group. The patient's demographics (date of birth, race), brief medical history, vital signs (blood pressure, heart rate, temperature, and respiratory rate), focused physical examination (including range of motion [ROM]), and concomitant medications were noted on the CRFs. As part of the brief medical history, the patient indicated the date and site of injury, and marked the area of perceived pain on a front and rear view human figure. A member of the study team instructed the patient on how to use

a Visual Analog Scale (VAS), where "0" is none and "100" is worst pain possible. The patient then indicated the intensity of pain with a visual analog scale (VAS) score.

Prior to the treatment session, the patient completed the initial pain evaluation (VAS). The patient's range of motion (ROM) was assessed. To measure ROM, a goniometer was used to measure the angle of the range of motion. For back pain, the patient was asked to bend forward at the waist, bend to the right and to the left at the waist and to arch their back. For joint pain, the patient was asked to extend the joint to its greatest range of motion (extension), and then flex the joint as far as possible (flexion). ROM measurements were made accordingly. Treatment was initiated with the device after adequate placement of the electroconductive pads. The investigator controlled the amplitude of the signals. Patients would ask the investigator to increase the signal strength until a strong but comfortable sensation was obtained, from which point treatment will continue for twenty (20) minutes. Patients may ask the investigator to increase or decrease the strength of the signal at any time during the treatment.

Treatment with the BiowavePRO device was administered with a mixed feed frequency signal equal to 3.878 kHz + 4.000 kHz. The investigator recorded Voltage and Percent of Maximum Power achieved from the LCD display before turning off the device.

The electrode pads consisted of a large Feed Electrode placed opposite the pain site and a smaller Pain Site Electrode, placed directly over the source of pain. These pads were placed initially as per the manufacturer's directions, but were adjusted based on the feedback from the study subjects. For joint pain, the initial electrode configuration consisted of placing a 1.25" diameter Pain Site Pad over the site of pain complaint, with a 2.25" x 4" Feed Pad positioned 180 degrees in opposition to the first pad, or in as much of an opposing manner as possible. For subjects with low back pain or hip pain, a 2" diameter Pain Site Pad was placed over the site of pain, with a 5" x 8" Feed Pad placed over the abdomen or quadriceps, respectively. Treatment was performed with continued increase in power output to the maximally tolerated level, and then maintenance at that level for a 20 minute session. BiowavePRO was utilized as part of a first-line treatment algorithm in conjunction with anti-inflammatories and ice. The majority of the subjects received ice during the treatment session, which is the facility standard of care when utilizing any electro-therapy equipment.

The subjects received the initial treatment, which was initiated between 6:30 am and 7:00 am, prior to the practice session. Pain assessments took place immediately post-treatment, 4 hours post-treatment, after practice session (10-12 hours post-treatment), and 24 hours post-treatment (next morning). Some of the subjects received a second treatment after the conclusion of the practice session, especially those who had suffered a new acute injury during that practice session. The subjects were allowed to perform exercise or receive rehabilitation treatments while undergoing treatment with the BiowavePRO device. Examples of this concurrent activity includes the use of upright and recumbent exercise bikes, use of elliptical machines, VersaClimber, and active leg extensions up to 40 degrees.

After the device was turned off and the electrodes removed, VAS pain evaluations, ROM tests, and patient global impression of change were obtained at 0, 6 and 24 hours following discontinuation of therapy. ROM test were not performed at 6 and 24 hours. Assessments of tolerability and acceptability were performed at the 0 hour interval. Questions were focused to the acceptability of the treatment procedure and overall satisfaction with treatment.

Results:

Over a two-year period, approximately 160 players were available to participate in the study. Ninety players participated in training camp, 53 active players and 7 practice squad members during the season, and 25 players on injured reserve. Eighty individuals had received at least one BiowavePRO treatment, approximately 50% of the eligible population. The treatment subjects were enrolled with a diagnosis that included one of the following: foot sprain, ankle sprain, knee sprain, tendonitis of the knee, hamstring injury, cervical discogenic pain, lumbar discogenic pain, anterior cruciate ligament contusion, osteoarthritis of the knee, labral tears of the hip, quadriceps contusion, shoulder injury, and cervical pain/ neck injuries. Achille's tendonitis, patella femoral, calcaneal fasciitis, plantar fasciitis, and OCD knee defect were also included.

A total of 600 treatments were provided to the study participants. The majority of participants, 66%, received treatment for 7 to 10 days. 17% of participants received treatment up to one month, 12% received treatment up to three months, and 5% received treatment for as long as 6 months. The patients who required treatment for 6 months did not report a decline in efficacy over time. These individuals had diagnoses including low back pain, post ACL repair, leg fracture, patella tendonitis, and Achilles tendonitis. Shoulder injury patients represented the majority of individuals who received treatment for up to 3 months.

Efficacy:

Less than 5% of the participants reported no benefit from the treatment. The majority of subjects reported significant relief immediately following treatment, with maintenance of the benefit for 4 to 6 hours. The majority of players either aggravated the existing injury or incurred a new injury, which necessitated a repeat treatment after the practice session was concluded for the day. This significantly reduced the number of participants who would be able to give a 12 hour and 24 hour post-treatment assessment.

In regard to patient global impression, the majority of subjects would request the BiowavePRO treatment with a perceived superiority in comparison to other electro-therapy devices they had used. None reported a decline in treatment effect with repeated use, even the patients who had utilized BiowavePRO for a 6 month duration.

In regard to clinician global impression, the team trainer rated BiowavePRO as "much more effective than TENS or the RICHMAR Interferential device". The team physician also was impressed by BiowavePRO as a superior treatment, adding that it enabled the

participants who had tendonitis or tendonosis to continue training, which is unusual with currently available therapy.

Adverse Events:

There were no reports of any burns, or any electro-thermal injury. A small number of players reported a "shock-like" sensation, but did not feel that this was different from the sensations perceived when using other electric stimulation devices.

Conclusions:

This is the first study of the use of the BiowavePRO device to treat the pain associated with sports-related injuries. The device was found to be well tolerated by the majority of study subjects. The subjects expressed great satisfaction with the treatments, and requested repeat treatments. The clinicians global impression was very favorable, which led to a request and use of the device for the U.S. Olympic swim team prior to and during the 2004 Olympics, as well as continued use of BiowavePRO for a third year with the NY Giants. This device, with very little downside from a risk perspective, is well suited to be used as a first line treatment for the treatment of pain from sports related injuries. Future studies to be performed in professional basketball and baseball players will give needed additional information in regard to the applicability of our results to athletes in general.