EFFECTS OF DIODE LASER IRRADIATION ON SUPERFICIAL BLOOD FLOW IN COLLEGE SUMO WRESTLERS: A PRELIMINARY STUDY

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Sumo wrestling is a very powerful and competitive contact sport played by extremely fit and highly trained competitors. Due to the extremely competitive nature of the sport and the required training, injuries are common both during training and the actual competition. Long-term lay-up of the competitor has to be avoided in order to maintain the level of muscle tone and mental concentration generated by the grueling training, so postinjury recovery time is kept to a minimum. A noninvasive therapy is therefore required, and the recent interest in the successful application of low level laser therapy (LLLT) in pain attenuation for a large number of pain types suggested that it might offer a new tool for sumo-related injuries. The current trial, with ten sports university sumo wrestlers, examined the effect of LLLT on injuries of the knee (five subjects) and foot (five subjects), using laser speckle flowmetry to assess the possible increase in superficial blood flow which has been associated with both pain attenuation and accelerated wound healing. An 830 nm 60 mW GaAlAs diode LLLT system was applied on one point for 5 min (approximately 15 J/cm²), and laser speckle flowmetry was performed before, during, immediately after, at 30 min and 60 min after irradiation. Decreased blood flow was seen intrairradiation, but an increase, significant in 7 of the 10 subjects was seen immediately postirradiation. This was maintained at significantly elevated levels in 4 subjects, while the remaining six decreased slightly, but in all ten subjects elevated levels of superficial blood flow were seen at one hour postirradiation, compared with preirradiation. LLLT is noninvasive, easy to apply, well tolerated and adverse side effect free. It is suggested that, following further trials to elucidate dosimetry and possible wavelength specificity, LLLT may well offer an exciting new tool to the sports clinician treating injured sumo wrestlers.

Key words: GaAlAs diode laser, sumo wrestlers, laser speckle flowmetry, muscle tone

Introduction

Sumo wrestling is one of the most competitive and powerful of the so-called ‘contact’ sports. In sumo, the contact involves two extremely mentally prepared, physically fit, heavy and well-trained wrestlers who collide with each other at the maximum velocity they can achieve from the start line, whereafter the two challengers expend the utmost energy to attempt to throw their opponent down on the ring surface, which is extremely hard packed sand, or out of the ring. Because of the high level of effort expended and the high level of competitiveness of the sport, sumo wrestlers are very prone to injury both during training and in the actual contest.

However, with even a short term lay-off their performance may deteriorate significantly both physically and mentally, so injured sumo wrestlers are given very little time to recover from an injury. Ideally, therefore, some form of noninvasive but effective therapy is required to treat injured sumo wrestlers. In the past few years, acute and chronic pain of many aetiologies has been reported as being successfully treated with low level laser therapy (LLLT), such as, amongst others, rheumatoid arthritis, polyarthritis, neuralgias and sports injuries.(1-3) All of the exact pathways and mechanisms by which LLLT work on pain attenuation and healing of injured tissues remain unclear, but one pathway which has been well demonstrated is the improvement of the superficial blood flow in injured or painful areas following LLLT.(4,5) The purpose of the present study was to investigate the efficacy of LLLT in increasing the superficial blood flow in injury sites on college sumo wrestlers.

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Subjects and Methods

Subjects
The trial subjects consisted of 10 male college sumo wrestlers from the Nippon Sport Science University in Tokyo. The subjects’ ages ranged from 19 to 21 years with an average age of 20.0 yrs. All subjects had injuries to the foot (5 subjects) or the knee (5 subjects) sustained while sumo wrestling.

Methods

Laser and application
The laser system used was a GaAlAs diode laser, model MDL-1002 (Mochida Pharmaceutical Co., Ltd, Osaka, Japan) delivering a continuous wave 830 nm beam at a power density of 18 mW/cm² over a 3.2 cm² spot. Subjects received 5 minutes of LLLT at a point on the dorsum of the foot or the extensor side of the knee, depending on the site of the injury, (energy density of approximately 15 J/cm²). Figure 1 shows a knee injury being treated with the probe applied in contact mode to the skin on the extensor side of the knee.

Blood flow measurement
Superficial blood flow in the subjects was measured using a laser speckle flowmeter (model LMAP-10 from M and M Co., Ltd, Japan, utilizing a 20 mW beam), at 5

Fig 1: The laser probe is placed on the point at the extensor side of the knee.

Fig 2: Superficial blood flow of the knee as assessed by laser speckle flowmetry; a: before irradiation; b: during irradiation; c: immediately after irradiation; and d: 60 minutes after irradiation. The interesting drop in blood flow during irradiation is probably due to sympathetic system-mediated vasoconstriction, followed thereafter by parasympathetic controlled vasodilation which increases the blood flow in most subjects in a time-dependent manner.
different times, namely before irradiation, during irradiation, immediately postirradiation and 30 and 60 minutes postirradiation.

Results

Table 1 summarizes the results in all 10 subjects. Generally, it can be seen that during the irradiation period, the blood flow was reduced. Immediately after irradiation there was a rise in the blood flow, which remained elevated for 60 minutes at which period it was typically even higher in the irradiated area. Figure 2 shows a typical example of the flowmetry image, in which increased blood flow is depicted on a television monitor in a similar fashion to thermography images. Figure 2a shows the preLLLT findings, with an area of slightly elevated blood flow corresponding to the injury site. In Figure 2b, intraLLLT, blood flow is decreased, with significant increases in Figures 2c (immediately postLLLT) and 2d (60 min postLLLT).

Discussion

The study clearly demonstrated an increase in superficial blood flow in LLLT-irradiated tissue which was sustained from 30 min to 60 min post irradiation in all ten cases. In four cases, the increase was significant, and was sustained at significant or greater levels until 1 hr postirradiation, and in three cases, the immediate postirradiation increase was significant, but decreased slightly at 30 min and one hour postirradiation (Table 1). No readings were taken in our preliminary study after the one hour period, but Asagai and coworkers(5) demonstrated a continued rise in superficial skin temperature following LLLT, as measured by fine plate thermography, past the 90 minute postirradiation point. This was associated with increased blood flow in the superficial dermis, and was believed to be mediated by the enhancement of parasympathetic control resulting in vasodilation in the superficial vasculature. We have every reason to believe that our subjects would have demonstrated a similar extended period of increased blood flow.

The decreased blood flow during the LLLT session is most likely due to a brief boost to vasoconstriction mediated by transient influence of the autonomic sympathetic system,(6) followed by the period of enhanced parasympathetic control.

Increased blood flow is associated with pain control through the action on the oedema often accompanying acute musculoskeletal injuries in sumo wrestling and other contact sports. The pain in such injuries is due to the actual insult to the soft tissues, plus the pressure

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**Table 1:** Changes in blood flow during and following laser irradiation, as assessed by laser speckle flowmetry.

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<th>SUBJECT</th>
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↓ Decrease  ↑ Increase  ↑↑ Significant Increase
pain caused as lymphatic fluid floods the affected joint to act as a biological splint. The increased blood flow provides a high level of nutrients to the injured tissues, and also brings mast cells and leukocytes into the area as a response to the inflammatory stage of the wound healing process.

In addition to the increased blood flow, there is also an elevated rate of lymphatic drainage, which helps remove the excess lymph from the oedematous area, thereby reducing the pressure pain while at the same time removing detritus caused by the inflammatory response of the repair process. Increased blood flow in addition stimulates endorphin synthesis and enkephalin production, bringing about narcotic and nonnarcotic analgesia, as a result of LLLT enhanced serotonin signalling in the spinoreticular tract.

There is no doubt that other mechanisms are also involved, including nerve transmission control, algheassic substance reduction and control of the inflammatory response and associated irritative substance release, but as a simple and easily demonstrated effect, enhanced superficial blood flow was shown following LLLT in injured sumo wrestlers. With the enhancement of superficial blood flow, there will narturally be an increase in the oxygen tension values, and the importance of the role of oxygen in initiating and sustaining wound healing has recently become even more apparent than before, and the oxygen gradient into injured areas, along which reparative cells migrate, has been measured.

Conclusions

In our preliminary study, 830 nm LLLT was shown to increase postirradiation superficial blood flow significantly in sites of injuries sustained to the ankle and knee by college sumo wrestlers. It has been stated that LLLT is noninvasive, well tolerated and has no reported adverse side effects. This therapeutic modality may therefore offer a good tool to enable sumo wrestlers to return as quickly as possible to their training and competition thereby minimizing the loss of muscle tone associated with long periods of lay-up following injury. On the other hand, the ideal dosimetry has yet to be elucidated, and whether wavelengths other than 830 nm could have a better effect or otherwise. In the future we plan to study these varied parameters in a larger number of cases.

References