LOW-LEVEL LASER THERAPY (LLLT) AS AN ADJUNCT TO THE STANDARD IVRA:

BACKGROUND: The use of intravenous regional anesthesia (IVRA) is limited by pain resulting from the application of tourniquets and postoperative pain.

OBJECTIVE: To assess the efficacy of low-level laser therapy added to IVRA for improving pain related to surgical fixation of distal radius fractures.

METHODS: The present double-blinded, placebo-controlled, randomized clinical trial involved 48 patients who were undergoing surgical fixation of distal radius fractures. Participants were randomly assigned to either an intervention group (n=24), who received 808 nm laser irradiation as 4 J/point for 20 s over ipsilateral three nerve roots in the cervical region corresponding to C5–C8 vertebrae, and 808 nm laser irradiation as 0.1 J/cm² for 5 min in a tangential scanning mode over the affected extremity, or a control group (n=24), who underwent the same protocol and timing of laser probe application with the laser switched off. Both groups received the same IVRA protocol using 2% lidocaine.

RESULTS: The mean visual analogue scale scores were significantly lower in the laser-assisted group than in the lidocaine-only group on all measures during and after operation (P<0.05). The mean time to the first need for fentanyl administration during the operation was longer in the laser group (P=0.04). The total amount of fentanyl administered to patients was significantly lower in the laser-assisted group (P=0.003). The laser group needed significantly less pethidine for pain relief (P=0.001) and at a later time (P=0.002) compared with the lidocaine-only group. There was no difference between the groups in terms of mean arterial pressure and heart rate.

CONCLUSION: The addition of gallium-aluminum-arsenide laser irradiation to intravenous regional anesthesia is safe, and reduces pain during and after the operation.

Key Words: Distal radius fracture; Intravenous regional anesthesia; Low-level laser therapy; Postoperative pain; Tourniquet

Intravenous regional anesthesia (IVRA) is mainly used in surgical operations with predicted durations of <1 h. Although this technique is useful for fractures of the upper extremity, especially distal to the elbow, and relieves the need for general anesthesia, it is limited by pain resulting from the application of tourniquets and postoperative pain (1-3). Increasing the efficacy of pain control in IVRA has been attempted by several authors, who have studied the addition of drugs, such as dexametomidine, dexamethasone, ketorolac and melatonin, to lidocaine in IVRA protocols, and reported enhanced anesthesia time and reduced pain perceived by patients (4-7).

Rather than these pharmacological interventions, we have used low-level laser therapy (LLLT) as an adjunct to the standard IVRA protocol. In recent years, and following Food and Drug Administration approval of LLLT (8,9) for pain relief, the practice has become relatively common. Although the exact mechanism of LLLT is not fully understood, there is evidence that LLLT activates many local analgesic mechanisms to affect perception of pain (10,11). Thus, some researchers have implemented the LLLT protocols in their studies to determine whether this approach is effective in pain management. For example, low-power irradiation was successfully used to treat pain due to lateral elbow tendinopathy (12) and pain associated with knee osteoarthritis (13). Postoperative pain management has also been studied in attempts to provide evidence in favour of or against the efficacy of LLLT in surgical settings. For instance, pain management and administration of analgesics were improved after low-power red laser irradiation in breast augmentation surgery (14), crosurgical

Le traitement au laser à basse énergie améliore-t-il l'efficacité de l'anesthésie régionale intraveineuse?

HISTORIQUE: L'anesthésie régionale intraveineuse (ARIV) est limitée par la douleur découlant de l'application des tourniquets et par la douleur postopératoire.

OBJECTIF: Évaluer l'efficacité du traitement au laser à basse énergie ajoutée à l'ARIV pour soulager la douleur liée à la réduction chirurgicale d'une fracture du radius distal.

MÉTHODES: La présente étude clinique aléatoire à double insu contrôlée contre placebo portait sur 48 candidats qui subissaient une réduction chirurgicale de fracture du radius distal. Les participants ont été répartis au hasard entre un groupe d'intervention (n=24) qui ont reçu une irradiation au laser de 808 nm à 4 J/point pendant 20 secondes sur trois racines nerveuses ipsilatérales de la région cervicale, correspondant aux vertèbres C5 à C8, et une irradiation au laser de 808 nm à 0.1 J/cm² pendant 5 minutes en mode de numérisation tangentielle sur le membre touché. Le groupe témoin (n=24) a subi le même protocole et la même durée d'application de la sonde laser, mais le laser était éteint. Les deux groupes ont été soumis au même protocole d'ARIV à l'aide de lidocaine 2 %.

RÉSULTATS: Les indices moyens de l'échelle analogique visuelle étaient considérablement plus faibles dans le groupe ayant subi le traitement au laser que dans celui ayant reçu seulement de la lidocaine à l'égard de toutes les mesures pendant et après l'opération (P<0,05). Le délai moyen avant qu'il soit nécessaire d'administrer du fentanyl pendant l'opération était plus long dans le groupe ayant reçu le traitement au laser (P=0,04). La quantité totale de fentanyl administrée aux patients était beaucoup plus faible dans ce groupe (P=0,003), qui avait besoin de beaucoup moins de pethidine pour soulager la douleur (P=0,001) et en prenait plus tard (P=0,002) que le groupe n'ayant reçu que de la lidocaine. On ne constatait pas de différence entre les groupes pour ce qui est de la pression artérielle moyenne et du rythme cardiaque.

CONCLUSION: L'ajout d'une irradiation au laser à l'arséniure de gallium et d'aluminium à l'ARIV est sécuritaire et atténue la douleur pendant et après l'opération.

Does low-level laser therapy enhance the efficacy of intravenous regional anesthesia?

Sholeh Nesioonpour MD1,2, Reza Akhondzadeh MD1,2, Soheila Mokmeli MD3, Shahnam Moosavi MD4, Mandana Mackie MD1,2, Morteza Naderan MD5


BACKGROUND: The use of intravenous regional anesthesia (IVRA) is limited by pain resulting from the application of tourniquets and postoperative pain.

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from the surgical site, the affected upper limb was elevated for 2 min
infuse crystalloid fluids and 0.03 mg/kg midazolam. To vacate blood
To inject anesthetics. Another IV line was placed in the other hand to
vein of the fractured extremity as distal as possible to the surgical site
both groups. An intravenous (IV) line was established in the dorsal
operator of the LLLT was aware of the study group.
blinded to the patient groups and did not know the study groups. Only
administration in the surgical fixation of distal radius fractures.

**METHODS**

The present study was a double-blinded, placebo-controlled, random-
adjunct to IVRA in terms of the pain perceived by patients during and
operation. If the VAS score was ≥3, 20 mg pethidine was injected intra-
severity was measured using a visual analogue scale (VAS) within the
first request for pain relief by the patient was recorded. Moreover, pain
were measured before and immediately after inflation of the distal cuff,
patients received 4 J/point contact laser irradiation with the laser switched off. Sensory block
scanning irradiation on the affected limb for a total of 5 min from the
lower border of the tourniquet through the forearm, wrist and fingers
(Figure 1). The control group received the same protocol and timing of
time to first request for pain relief and the
postoperative VAS score was >3, 20 mg pethidine was injected intra-

Patients were evaluated for possible side effects such as hyperten-
sion or hypotension, bradycardia or tachycardia, hypoxia, tinnitus,
headache, nausea and vomiting, vertigo, fatigue, arrhythmia, somno-
lence, bleeding at the site of operation and paresthesia.

The aim of the present study was to assess the efficacy of pretreat-
ment with gallium-aluminum-arsenide (Ga-Al-As) irradiation as an
adjunct to IVRA in terms of the pain perceived by patients during and
the need for opioid administration in the sur-

The following statistics were used for calculating sample size:

\[ N = \frac{\left( Z_{1-\alpha/2} + Z_{1-\beta} \right)^2 \left( P_1(1-P_1) + P_2(1-P_2) \right)}{(P_1-P_2)^2} \]

95% confidence with 80% power was assigned and, according to previous studies, \( P_1 = 74 \) and \( P_2 = 37 \) (13).

and then wrapped with an elastic band. Subsequently, a double-cuffed
tourniquet was applied around the upper arm. The proximal cuff was
infated to 300 mmHg immediately before removing the elastic band. The absence of radial artery pulses and pulse oximetry waves were
considered to be evidence of the success of this procedure. Both groups
received 2% lidocaine (3 mg/kg, diluted by normal saline to 40 mL) through an intravenous line in the affected extremity (Aburaihan
Pharmaceutical Co, Iran).

The laser-assisted group received irradiation via a continuous-
wave Ga-Al-As device (Canadian Optic and Laser Production Center, Canada). The specifications of this device include the following:
wavelength 808 nm, power 200 mW, power density 0.8 W/cm² and
contact area 0.25 cm². Immediately after the proximal cuff was
infated, patients received 4 J/point contact laser irradiation over three nerve roots from C5 to C8 vertebral on the affected side, for
20 s over each point. Furthermore, they received 0.1 J/cm² tangential

**TABLE 1**

<table>
<thead>
<tr>
<th>Exclusion criteria for the study population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reynaud’s phenomenon</td>
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<tr>
<td>Systemic sclerosis</td>
</tr>
<tr>
<td>Sickle cell anemia</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
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<tr>
<td>Renal failure</td>
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<tr>
<td>Hepatic dysfunction</td>
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<tr>
<td>Pregnancy</td>
</tr>
<tr>
<td>Malignancy</td>
</tr>
<tr>
<td>Benign tumours with malignant potential</td>
</tr>
<tr>
<td>Photosensitivity (eg, systemic lupus erythematosus)</td>
</tr>
<tr>
<td>History of convulsions</td>
</tr>
</tbody>
</table>

**TABLE 2**

<table>
<thead>
<tr>
<th>Baseline characteristics of the study population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristic</td>
</tr>
<tr>
<td>---------------------------------</td>
</tr>
<tr>
<td>Age, years</td>
</tr>
<tr>
<td>Height, cm</td>
</tr>
<tr>
<td>Weight, kg</td>
</tr>
<tr>
<td>Duration of inflation, min</td>
</tr>
</tbody>
</table>

**Figure 1** The points and locations irradiated in the patients.

Data presented as mean ± SD unless otherwise indicated.
TABLE 3
Heart rate and mean arterial pressure of the participants during operation

<table>
<thead>
<tr>
<th>Time interval</th>
<th>Heart rate</th>
<th>Mean arterial pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Laser assisted</td>
<td>Lidocaine only</td>
</tr>
<tr>
<td>Before inflation</td>
<td>87.5±9.13</td>
<td>84.7±9.07</td>
</tr>
<tr>
<td>After inflation</td>
<td>89.04±9.34</td>
<td>87.1±9.16</td>
</tr>
<tr>
<td>5 min</td>
<td>89.7±7.08</td>
<td>86.7±9.01</td>
</tr>
<tr>
<td>10 min</td>
<td>87.87±6.47</td>
<td>87.29±8.81</td>
</tr>
<tr>
<td>20 min</td>
<td>90.29±6.5</td>
<td>88.9±5.7</td>
</tr>
<tr>
<td>30 min</td>
<td>89.6±6.1</td>
<td>86.5±7.4</td>
</tr>
<tr>
<td>40 min</td>
<td>90.2±8</td>
<td>87.9±7.1</td>
</tr>
<tr>
<td>50 min</td>
<td>90.95±7.6</td>
<td>87.7±6.7</td>
</tr>
</tbody>
</table>

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The clinical application of LLLT for the treatment of acute and chronic pain is now well documented. Whereas the analgesic effects of LLLT has been studied for management of musculoskeletal pain and postoperative pain (10-16), our search revealed no published clinical trials regarding the addition of a laser protocol to IVRA in hand surgery. It has been shown that the pretreatment of the skin with a low-level laser followed by a 5 min topical lidocaine 4% diminished the pain of intravenous cannulation in adult and pediatric patients (19,20). Laser therapy on surgical sites has been suggested to reduce the amount of analgesic drug consumption during surgery and pain after surgery. Jackson et al (14) studied 104 patients in Russia who underwent breast augmentation surgery and found that irradiation with a 630 nm to 640 nm low-power laser at the beginning and at the end of operation resulted in less postoperative pain and less analgesic consumption during the first week after surgery. In a controlled study by Moore et al (16) in England, 22 patients underwent cholecystectomy and received Ga-Al-As (830 nm) irradiation in a continuous mode. The results revealed a significant 50% reduction in postoperative pain in the laser group, with less analgesic consumption.

Kosowski et al (21) reported the comparison of analgesic effect of magnetic and laser stimulation before oral procedures. Laser stimulation and alternating magnetic field applied directly before oral surgery were shown to be effective as analgesic agents to decrease intra- and postoperative sensations. Patients with high levels of stomatological fear were found to be more prone to sensation of pain; however, even in this group, laser and magnetic stimulation significantly reduced this complication. Results of a pilot study by Jonsson (22) demonstrated that fewer patients returned for postoperative redressing and complained of postoperative pain when laser therapy was offered as a part of surgical regimen to assist with postoperative healing after digital surgery (Winograd-type partial matrixectomy of the hallux).

The Food and Drug Administration’s approval of the analgesic effect of laser therapy was motivation to assess its application as part of a perioperative plan for pain management. The most commonly used analgesic drugs after surgery are opioids and nonsteroidal anti-inflammatory drugs (NSAIDs). All opioids have been used to produce synergism with sedatives, anticonvulsants and local anesthetics that may increase their respective side effects. The most common recovery complications are attributed to narcotics. NSAIDs are typically used after surgery and it is recognized that the use of NSAIDs increases the risk of gastrointestinal bleeding, heart attacks and strokes. Finding a safe analgesic method with no side effects is always a main goal for anesthesiology. Laser therapy is an approved safe and noninvasive method for pain control, according to various studies. It appears that the summation of the analgesic effect of laser therapy and local anesthetic can increase the duration of anesthesia and the analgesic effect of drugs, while reducing drug consumption and, thus, eliminating complications due to drugs.

One limitation to our study was that we could not document the exact onset of sensory and motor block because of the elapsed time resulting from irradiation. Our study also did not determine whether long-term mobility outcomes were different between groups.

Over the past decade, considerable evidence has emerged for the positive effects of LLLT in the field of pain management. Here, we assessed this therapy in distal radius fractures and, according to our results, determined that addition of Ga-Al-As laser irradiation to lidocaine-induced regional anesthesia is an effective and safe means to reduce pain and analgesic consumption during hand surgery.

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