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SHORT COMMUNICATION

Pilot study of the effect of therapeutic photobiomodulation on postoperative pain in knee arthroplasty

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Abstract Nine participants undergoing primary TKA submitted to spinal anesthesia, sedation, ultrasound-guided obturator and Femoral nerve Block analgesia, and photobiomodulation Therapy (FBMT) were evaluated regarding postoperative pain and morphine consumption. FBMT sessions were performed in the Immediate Postoperative period (IPO) and after 24 hours. Participants received 16.7±15 mg of morphine up to the third postoperative day. At IPO, mean pain score was 4.8±3.2 and 5.6±3.5, at rest and on movement, respectively. Photo biomodulation therapy can be considered an option for mitigating pain for patients undergoing TKA.

Methods for controlling postoperative pain in patients submitted to Total Knee Arthroplasty (TKA) for treatment of Knee Osteoarthritis (KOA), reducing morphine use to decrease side effects, have been sought[1-3]

Photobiomodulation Therapy (FBMT), formerly described as Low-Level Laser Therapy (LLLT), has both anti-inflammatory and tissue repair stimulatory actions that alleviate pain, and, when associated with physical exercise, improve joint range of movement and muscle strength in patients presenting KOA[4]

We report the findings of a pilot study assessing the effect of FBMT in the TKA postoperative period, aiming to establish

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a safe and effective multimodal opioid-sparing analgesia approach.

We included in the pilot study men and women presenting bilateral KOA with comorbidities, aged between 60 and 75 years, with no past medical history of previous lower limb arthroplasties, infiltrations in the six months prior to the study, inflammatory arthritis, prior regular use of strong opioids, and without cognitive disfunctions that precluded performing the study.

During enrollment, age, gender, ethnicity, Body Mass Index (BMI), and comorbidities of the participants were recorded.

Participants were submitted to spinal anesthesia with the subdural injection of 15 mg of isobaric bupivacaine associated with 20 mcg of fentanyl, and sedation with continuous infusion of propofol (controlled target) and oxygen administration via laryngeal mask. Participants received prophylactic antibiotic therapy (cefuroxime 1.5 mg intravenous [IV] every 12 hours), 8 mg ondansetron IV to prevent nausea, and 1g tranexamic acid IV for bleeding management.

The surgery was performed with the aid of a tourniquet placed on the thigh, inflated to 100 mmHg above participant's systolic blood pressure. The surgeon used the medial parapatellar approach and implanted Iconacy Orthopedic Implants® prostheses. The femoral and tibial components were fixed with antibiotic-free orthopedic cement (Bone Cement for Orthopedics G1 Standard Viscosity — G21). Fifteen minutes before tourniquet deflation, tranexamic acid (1g IV) was administered for bleeding management. Cefuroxime 1.5 mg was repeated when tourniquet was released. Before wound closure, the tourniquet was deflated to enable hemostasis review and putting a 3.2 vacuum drain in two planes. Finally, skin incision and surgical drains were dressed.

Postoperative analgesia was performed using:

1. Ultrasound-guided femoral and obturator nerve block with the injection of 20 mL of 0.5% ropivacaine in each nerve block. All nerve blocks were performed by the same anesthesiologist.
2. Photobiomodulation therapy using the Light Aid device manufactured by Bright Photomedicine — Brasil®, with parameters as shown in Table 1. PBMT was applied at the Immediate Postoperative Period (IPO) and 24 hours after surgery over the femoral nerve, for 240 seconds, and alongside the surgical wound, medially and laterally, for 120 seconds.
3. Sodium dipyrone 30 mg.kg^{-1} IV every 6h and ketorolac 30 mg IV 12/12h.
4. Rescue analgesia with 2 mg morphine via PCA pump if severe pain.

Standard in-hospital physical rehabilitation consisted of isometric exercises, active and passive knee mobilization limited by pain, and gait training with a walker as soon as quadriceps motor control was recovered.

We recorded morphine consumption, static and dynamic pain using the Visual Analog Scale (VAS), adverse effects, and satisfaction with analgesia.

Seven women and 2 men (mean age 69 years, BMI 31.83) received FBMT and were followed up until hospital discharge on the 3rd PO. All participants had at least one comorbidity (hypertension, dyslipidemia, type II diabetes, depression, obesity, chronic renal failure, gout), and affected contralateral knee. Two were brown, the others were white.

Table 1 Optical parameter of the photobiomodulation therapy.

Therapy photobiomodulation parameters		
Application anatomic site	Knee femoral nerve	Surgical wound
Treated area (cm^2)	40	80
Wavelength (nm)	850	850
Power (mW)	450	150
Power/density ($mW.cm^{-2}$)	45	15
Irradiation time (s)	300	120
Energy/session (J)	135	18
Energy density ($J.cm^{-2}$)	2.275	0.225
Session	24h	48h
Total energy (J)	270	36

Mean total morphine consumption was 16.7 ± 15 mg. At the IPO, 1st PO, 2nd PO and 3rd PO, mean morphine consumption was 3.5 ± 4.8 mg, 8.4 ± 5.32 mg, 1.56 ± 2.37 mg, 0 mg, respectively.

At the IPO, participants presented average static and dynamic pain scores of 4.8±3.2 and 5.6±3.5, respectively.

On the 1st PO, at 06:00 AM, participants showed a mean static pain score of 3 ± 3.1 and mean dynamic pain score of 4.2 ± 2.9; at 12:00 PM, 2.3±2.3 for static pain and 3.7 ± 2.1 for dynamic; and at 06:00 PM, 1.6 ± 1.2 for static pain and 2.4±1.6 for dynamic pain.

On the 2nd PO, at 06:00 AM, participants showed a mean static pain score of 1.2 ± 1.6 and mean dynamic pain score of 3.5 ± 1.8; at 12:00 PM, 1.2 ± 1.4 for static pain and 3.5 ± 2.9 for dynamic; and at 06:00 PM, 0.4 ± 1 for static pain and 2.2 ± 1.8 for dynamic pain.

Mean satisfaction of the participants was 7.88 ± 2.36.

On the 1st PO, participants scored an average of 9.3 ± 1.3. On the 2nd PO, participants scored 9.4 ± 0.88.

Five participants presented mild side effects. Among them, two participants complained of nausea and pruritus, two complained of nausea only, and one presented only pruritus. In all cases, the symptoms were reversed with regular medications and did not result in lengthier hospital stay or requirement of additional procedures.

Postoperative 72-hour accumulated morphine consumption in patients submitted to TKA under general anesthesia ranged from 59.6 mg to 94.1 ± 10 mg[21] The association of spinal anesthesia with continuous adductor canal block during surgery, followed by infiltration with local anesthetic and adductor canal block for postoperative analgesia, can reduce morphine consumption to 4 mg in 12 hours, 6 mg in 24 hours, and 8 mg in 48 hours, provided the concomitant administration of intravenous and oral anti-inflammatory analgesic and pregabalin[3] In this pilot study, participants showed mean morphine consumption of 3.5 mg in the IPO

(12 hours), 8.4 mg in the 1st PO, 1.56 mg in the 2nd PO, and 0 mg in the 3rd PO, analogous to the results reported by Kampitak et al.,[3] who administered 75 mg of pregabalin once a day. The choice for the association of FBMT was based on the analgesic, anti-inflammatory and repairing properties of FBMT already described in the treatment of osteoarthritis[4]

Participants reported static pain scores of 4.8 in the IPO (6 hours after surgery), 2.3 at 24 hours and 1.2 at 48 hours after surgery. At IPO, Kampitak et al[3] reported pain scores of 5 and 4, at 4 and 8 hours after the surgery.

Reported dynamic pain was 5.6±3.5 at 6 hours (IPO), 3.7±2.1 at 24 hours after surgery, and 3.5±2.9 at 48 hours after surgery. These results are analogous to those described in meta-analyses comparing adductor canal block to femoral nerve block with pain ranging from 0.69 to 5 at 6 hours, 3.6 to 5 at 24 hours, and 3.27 to 5.51 at 48 hours[5] Continuous adductor canal block, associated with the administration of pregabalin and anti-inflammatory and analgesics drugs, has also revealed dynamic pain scores between 3 and 4, at 24 and 48 hours postoperatively[3]

Our results support the use of FBMT as an analgesia adjuvant tool, that contributes to the multimodal pain management concept and might reduce adverse drug effects by decreasing postoperative pain.

Authors' contribution

MUR conceived and designed the study, collected, analyzed and interpreted the data, wrote and reviewed the manuscript; BBV and DFM wrote the manuscript and collected data; GPO collected data; GMGF: conceived and designed the study, wrote and reviewed the manuscript; MVPS and NCP conceived and designed the study. All authors approved the final version of the manuscript submitted to the journal.

Conflicts of interest

MVPS owns shares in Tergos Pesquisa e Ensino and subsidiaries, including Bright Photomedicine. NCP is Bright Photomedicine employee. The other authors declare no conflicts of interest.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.bjane.2021.07.040.

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