Anaesthesia for shock wave therapy in musculoskeletal disorders: a preliminary report


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Abstract. – The potential for using external applied energy to rectify or ameliorate musculoskeletal disorders has been explored for decades. A shock wave is a pressure disturbance: tissue effect is cavitation, producing microtrauma or microfracture and haematoma formation, inducing, as to date is thought, increase in vascularization, increased soft callus and faster enchondral ossification.

Anaesthesiological interest in this field is focused in non-union or delayed osseous union, joint stiffness or osteochondrosis and femoral head necrosis in adults. Actually, because of the pain associated with high energy extracorporeal shock wave therapy on bones, anaesthesia is necessary, but, since almost all patients have no complaint after treatment, there is no need of postoperative analgesia.

Therefore, short duration anaesthetic techniques and agents should be preferred.

Loco-regional anaesthesia or general anaesthesia are both suitable to the purpose.

Fifty patients have been treated nowadays in our institution with shock wave therapy needing anaesthesia. 18 patients (36%) received general anaesthesia. Since patient’s stay in hospital was expected to be short, short duration agents have been used, avoiding those causing unpleasant side effects, first emesis. We used Propofol or Remifentanil by continuous infusion, titrated to maintain stable haemodynamics and an appropriate level of anaesthesia. The short duration of action of Propofol depends on its rapid elimination, whereas Remifentanil undergoes rapid biotransformation to minimally active metabolites.

32 patients (64%) received regional anaesthesia. We avoided long acting agents or high concentration drugs. Spinal blocks have been performed with 0.5% hyperbaric bupivacaine; brachial plexus blocks, sciatic-femoral blocks and an epidural block have been performed with 0.5-1% xylocaine or 1% mepivacaine.

Shock Wave Therapy has been done during a 3-day hospital stay. With suitable anaesthesiological treatment and preparation, almost all patients could be treated as outpatients or with an overnight hospital stay.

Key Words:

Shock wave therapy, Musculoskeletal disorders, General anaesthesia, Regional anaesthesia.

Introduction

Interest in focused shock waves began during WWII, when observers became interested in patterns of injuries in tank crews when the turrets were struck by shells; similarly it was observed that the lung tissue of castaways was disrupted because of the explosion of waterbombs (depth charges), even though no external symptoms of violence existed.

In the ’50s, first systemic investigations for the use of shock waves were undertaken: these investigations led to the concept of disintegrating kidney stones with extracorporeal-generated shock waves.

The potential for using different types of externally applied energy to rectify or ameliorate musculoskeletal disorders has been explored for decades. A shock wave is a transient pressure disturbance that propagates in three-dimensional space: a significant tissue effect is cavitation consequent to the negative phase of the wave propagation. To date, the exact working mechanism of shock waves on bones and joints is not understood: it is thought that shock wave application produces microtrauma or
microfracture and haematoma formation, which induces an increase in vascularization, increased soft callus and faster enchondral ossification.

Many musculoskeletal problems are treated with extracorporeal shock wave therapy. Disorders not needing a true anaesthesiological support, but at the most local anaesthesia, analgesic drugs or sedation include plantar fasciitis, calcific tendinitis of the shoulder, lateral epicondylitis, trochanteric bursitis and other enthesopathies. In fact superficial dyscomfort and deep pain are not likely to be severe when low energy (14-16 kV) is used.

A anaesthesiological interest on shock wave therapy on orthopaedic and trauma patients is focused on the following conditions: non union or delayed osseous union, joint stiffness (mostly post-traumatic), or osteochondrosis and femoral head necrosis in adults. A ctually, because of the pain associated with high energy (greater than 20 kV) extracorporeal Shock Wave Therapy on bones, anaesthesia is necessary, but, since almost all patients have no complaints immediately after treatment (20-40 min) and on the day of discharge, there is no need of postoperative analgesia. Therefore, short duration anaesthetic techniques and agents should be preferred, especially when a short patient's stay in hospital is expected.

Loco-regional anaesthesia and general anaesthesia are both suitable to the purpose. A anaesthetics will depend on the site of shock wave application, on patient's preference or on specific indications.

A dvantages and eventual disadvantages of single techniques will be discussed in this paper after the presentation of the cases we collected from the start of Shock Wave Therapy in our Institution.

Patients and Methods

50 patients (M/F:34/16), aged 13-81 years, A SA status I-III, have been treated from early February to mid October 2002 with Shock Wave Therapy needing some kind of anaesthesia.

A ll patients have been treated using an OssaTron orthotriptor (High Medical Technologies, Kreuzlingen, Switzerland). Shock Wave Therapy was done at 28 kV in femoral head necrosis cases, at 24 kV in other cases.

The duration of treatment was 20 min (3500-4000 impulses of shock waves) for one site orthopaedic disorders, 40 min (20 min + 20 min) for bilateral femoral head necrosis cases.

All treatments have been performed in an operating theatre and all patients have been monitored as per surgical operations (ECG, H r, Nipb, pulse oximetry in regional anaesthesia cases, plus analysis of inspired and expired gases to determine end-tidal carbon dioxide in general anaesthesia cases).

Table I lists osteoarticular disorders, number of treatments and anaesthetic procedures.

Figure 1 shows a treatment.

<table>
<thead>
<tr>
<th>Osteoarticular disorders</th>
<th>Treatments</th>
<th>General anaesthesia</th>
<th>Regional anaesthesia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Femoral head necrosis (mono- or bilateral)</td>
<td>15</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Elbow stiffness, osteochondrosis and/or non-union</td>
<td>15</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Ankle non-union</td>
<td>5</td>
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<td>4</td>
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<tr>
<td>Clavicle non-union</td>
<td>3</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>18</td>
<td>32</td>
</tr>
</tbody>
</table>

Table I. Osteoarticular disorders, number of treatments, kind of anaesthesia.
Results

18 patients received general anaesthesia: TIVA with Remifentanil (in average 0.5 mg/kg/min) or Propofol (0.1 mg/kg/min). Dosages were titrated to maintain stable haemodynamics and an appropriate level of anaesthesia. A larynx was controlled via a laryngeal mask when the treatment duration was 20 min, otherwise tracheal intubation was preferred. See Discussion for further details.

32 patients received regional anaesthesia. A spinal block was performed in 12 patients with 0.5% hyperbaric Bupivacaine; one patient received a single shot epidural block with 1% Mepivacaine.

13 patients received axillary brachial plexus block with 1% Mepivacaine. Finally, 6 patients received peripheral lower limb block (sciatic-femoral nerve block) with 0.5-1% Xylocaine or 1% Mepivacaine with the aid of an insulated atraumatic needle and a nerve stimulator.

Recovery from all regional techniques accomplished in almost all patients within 2-2,5 hours. No complications related to anaesthesia have been observed.

Discussion

In our series 36% of patients received general anaesthesia. Indications to general anaesthesia should depend on the site of application of shock wave therapy (body areas where regional anaesthesia cannot be performed), on patient’s request, on specific contraindications to regional anaesthesia (e.g., local anaesthetics intolerance), on failure of a peripheral block.

Since patient’s stay in hospital is normally expected to be short, short duration agents should be used, avoiding those causing unpleasant postanaesthetic side effects, first emesis.

This “minor” complication has an incidence of 20-40% in the general surgical population and sometimes may last more than 24 hours. Opioids and inhalational anaesthetic drugs likely have an important responsibili-
Even Sevoflurane, the most suitable between anaesthetic vapors in this field of application, thanks to a rapid outcome from anaesthesia, does not seem to differ significantly from chemically similar agents in causing emesis.

Many antiemetic drugs are now available for emesis prevention and/or as rescue medication, acting on specific receptors. A nti-5HT3 serotoninergic receptors drugs seem to be at this moment the most effective. Nevertheless, a “background noise” of emetic symptoms cannot be eliminated, even in emesis low risk patients as orthopaedic ones. For this reason, classic opioids (e.g., Fentanyl) and inhalational agents are not included in our orthotripsy protocol.

Our attention in this field of application on general anaesthesia is at this moment focused on intravenous agents.

It is now 70 years since the introduction into clinical practice of intravenous anaesthetic agents, with the use of Hexobarbitone in 1932, followed 2 years later by the first use of Thiopentone.

In the past, the use of intravenous agents was limited to induction of anaesthesia only, to be followed by a maintenance technique using inhalational agents with or without neuromuscular blocking agents.

The introduction of new intravenous agents with a far more rapid clearance from the body than Thiopentone, with a short and predictable duration of action and no-significant post-anaesthetic side effects, rekindled interest in continuous intravenous anaesthesia.

We selected for general anaesthesia for shock wave therapy two agents: Propofol and Remifentanil.

The simplest and most widely used technique is that of an initial loading dose followed by continuous infusion, titrated to maintain stable haemodynamics and an appropriate level of anaesthesia.

Propofol is a phenol short-acting agent effective for induction and maintenance of anaesthesia; its short duration of action depends on its rapid elimination. A 1-3 mg/kg is suitable for induction in almost all patients, and continuous infusion rate varies between 0.1 mg/kg/min and 0.17 mg/kg/min. Recovery times from infusions of Propofol supplementing nitrous oxide-oxygen anaesthesia vary from 9 to 14 min. Furthermore, several studies in the 1980s have shown a reduced propensity for postoperative emesis, or even a specific antiemetic effect of the drug. Oestman and coworkers demonstrated that antiemetic effect does not depend from Intralipid, the lipid in the emulsion formulation of Propofol.

Remifentanil is a mu-opioid receptor agonist representing a new pharmacokinetic class of opioids named Esterase Metabolised Opioids (EMO). It undergoes rapid biotransformation to minimally active metabolites, showing a short and predictable duration of action with no accumulation of effect, even when a relative overdose occurs. A anaesthesia is induced by a loading dose (1 µg/kg i.v. over 30 sec), followed by a continuous infusion (meanly 0.5 µg/kg/min, reduced by 50% 5 min later).

Both Propofol and Remifentanil in full dosage may give rise to respiratory depression; in this case patients need a closer control, and infusion speed should be adjusted, otherwise there is the need of controlling airway and ventilate the patient.

We prefer the latter solution, in our opinion safer. A laryngeal mask of appropriate size is used for procedures, tracheal intubation is performed for longer.

A 0.5% mg/kg Atracurium besilate is given to facilitate airway control and mechanical ventilation. A tracurium besilate is an intermediate-activity nondepolarizing neuromuscular blocking agent; it is spontaneously inactivated by Hofmann elimination and ester hydrolysis, with an elimination half-life of about 20 min. It is, therefore, useful for procedures lasting 20 min or little more. As Atracurium lacks cumulative effects, it can be administered by continuous infusion.

64% of our patients received regional anaesthesia. Regional anaesthesia finds its best application in orthopaedic procedures, where most of those on the limbs can be carried out after suitable nerve block, or central block (spinal or epidural) if lower limbs are involved.

Older people and others fearing general anaesthesia may prefer to have a local anaesthetic.

We perform our blocks under light sedation. Many agents have been used for this...
purpose, but currently the most interesting are Midazolam and Propofol given as increments or as infusion.

Comparing Midazolam and Propofol there is a greater variability of dose required for Midazolam but better sedation, whilst Propofol gives a quicker recovery²⁰.

Midazolam has the advantage of being a potent anticonvulsivant, so that any potential for seizures arising from the local anaesthesia agent is countered.

Several local anaesthetic agents are used in clinical practice. Since in the Shock Wave Therapy field of application there is no need of analgesia after the procedure, long acting agents (e.g., Ropivacaine) or high concentration drugs should be avoided.

Spinal blocks are performed with 0.5% hyperbaric Bupivacaine via a 27G Whitacre atraumatic needle, remembering that most of patients requiring bilateral block (i.e., bilateral femoral head necrosis) are relatively young.

A xillary brachial plexus blocks are performed with 1% M epivacaine; an epidural block, and sciatic-femoral blocks have been performed with 1% M epivacaine or 0.5-1% Xylocaine.

Sciatic nerve block is performed by a posterior approach²¹, femoral block by the paravascular technique beneath the inguinal ligament²². A nerve stimulator is used for both nerve blocks (and for brachial plexus block as well) using atraumatic insulated 70-150 mm needles.

In conclusion, as the primary advantage of extracorporeal shock wave therapy is its noninvasive nature and seemingly minimal complications when applied to musculoskeletal tissues, the same goal should be reached as far as anaesthetics are concerned.

In our series all patients received treatments during a 3-day hospital stay. With suitable anaesthetic agents and techniques almost all patients could be treated as outpatients or with an overnight hospital stay.

References


19) Shanks CA. Pharmacokinetics of the non-depolarizing neuromuscular relaxants applied to calculation of bolus and infusion dosage regimens. Anesthesiology 1986; 64: 72-78.

