Rev Bras Anestesiol. 2015;65(3):163–169

REVISTA BRASILEIRA DE ANESTESIOLOGIA
Official Publication of the Brazilian Society of Anesthesiology
www.sba.com.br

SCIENTIFIC ARTICLE

Minimum effective concentration of bupivacaine for axillary brachial plexus block guided by ultrasound☆

Alexandre Takeda, Leonardo Henrique Cunha Ferraro*, André Hosoi Rezende, Eduardo Jun Sadatsune, Luiz Fernando dos Reis Falcão, Maria Angela Tardelli

Department of Anesthesiology, Pain and Intensive Care, Escola Paulista de Medicina, Universidade Federal de São Paulo (UNIFESP), São Paulo, SP, Brazil

Received 21 September 2013; accepted 26 November 2013
Available online 16 February 2015

KEYWORDS
Regional anesthesia;
Brachial plexus block;
Bupivacaine;
Ultrasound;
Axillary block;
Minimum effective concentration

Abstract
Introduction: The use of ultrasound in regional anesthesia allows reducing the dose of local anesthetic used for peripheral nerve block. The present study was performed to determine the minimum effective concentration (MEC90) of bupivacaine for axillary brachial plexus block.
Methods: Patients undergoing hand surgery were recruited. To estimate the MEC90, a sequential up-down biased coin method of allocation was used. The bupivacaine dose was 5 mL for each nerve (radial, ulnar, median, and musculocutaneous). The initial concentration was 0.35%. This concentration was changed by 0.05% depending on the previous block; a blockade failure resulted in increased concentration for the next patient; in case of success, the next patient could receive or reduction (0.1 probability) or the same concentration (0.9 probability). Surgical anesthesia was defined as driving force $\leq$2 according to the modified Bromage scale, lack of thermal sensitivity and response to pinprick. Postoperative analgesia was assessed in the recovery room with numeric pain scale and the amount of drugs used within 4 h after the blockade.
Results: MEC90 was 0.241% [R^2: 0.978, confidence interval: 0.20–0.34%]. No patient, with successful block, reported pain after 4 h.
Conclusion: This study demonstrated that ultrasound guided axillary brachial plexus block can be performed with the use of low concentration of local anesthetics, increasing the safety of the procedure. Further studies should be conducted to assess blockade duration at low concentrations.

☆ Ethical Institution Comittee Register: 0482/11.
ClinicalTrials.gov Register: NCT01838928.

* Corresponding author.
E-mail: leohcferraro@yahoo.com.br (L.H.C. Ferraro).

http://dx.doi.org/10.1016/j.bjane.2013.11.007

PALAVRAS-CHAVE
Anestesia regional;
Bloqueio do plexo braquial;
Bupivacaina;
Ultrassom;
Bloqueio axilar;
Concentração mínima efetiva

Concentração mínima efetiva de bupivacaína para o bloqueio do plexo braquial via axilar guiado por ultrassom

Resumo
Introdução: O uso do ultrassom na anestesia regional permite a redução da dose de anestésico local utilizada para o bloqueio de nervos periféricos. O presente estudo foi conduzido com o objetivo de determinar a concentração mínima efetiva (CME90) de bupivacaína para o bloqueio do plexo braquial via axilar (BPVA).
Métodos: Pacientes submetidos a cirurgias da mão foram recrutados. Foi usado um método de alocação ''biased coin'' seqüencial ''up-down'' para estimar a CME90. A dose de bupivacaína foi de 5 mL para cada nervo (radial, ulnar, mediano e musculocutâneo). A concentração inicial de era 0,35%. Essa concentração era alterada em 0,05% dependendo do bloqueio anterior: a falha do bloqueio resultava em aumento da concentração para o próximo paciente; no caso de sucesso, o próximo paciente poderia receber ou redução (probabilidade de 0,1) ou mesma concentração (probabilidade 0,9). A anestesia cirúrgica foi definida como força motora ≤ 2 segundo a escala de Bromage modificada, ausência de sensibilidade térmica e de resposta ao pinprick. A analgesia pós-operatória foi verificada na sala de recuperação anestésica com escala numérica de dor e a quantidade de analgésicos utilizados até 4 horas após o bloqueio.
Resultados: A CME90 foi de 0,241% [R2: 0,978, Intervalo de Confiança: 0,20%–0,34%]. Além disso, nenhum paciente com sucesso do bloqueio apresentou dor após 4 horas.
Conclusão: Este estudo demonstrou que pode-se realizar o BPVA guiado por ultrassom utilizando-se baixas concentrações de anestésico local, aumentando a segurança do procedimento. Novos estudos devem ser realizados para avaliar a duração de bloqueios com baixas concentrações.

Introduction

A successful peripheral nerve block depends on the correct identification of nervous structures and the injection of a suitable dose of local anesthetic around it in order to obtain a complete impregnation of all the nerves involved in the surgery. For axillary brachial plexus blockade (ABPB), in which the failures are typically attributed to improper needle placement or septation of the brachial plexus sheath in axillary region,[1,2] volumes up to 80 mL have been used to increase the success rate.[3] However, the use of large amounts of local anesthetic increases the chance of systemic toxicity, which is the major complication of regional anesthesia. Although the incidence of systemic toxicity is less than 0.2%, this complication is difficult to treat and potentially fatal.[4,5]

The introduction of ultrasound into clinical practice of regional anesthesia made it possible to visualize the nerve structures, allowing greater accuracy in the administration of local anesthetics. The minimum effective volume of local anesthetic for blocking some peripheral nerves had been investigated, and studies have shown that effective blockades may be achieved with small volumes of anesthetic, which reduces the likelihood of systemic toxicity.[6–11] However, the clinical applicability of low volumes and the limitation of identifying intraneural injections by ultrasound have been questioned.[12]

Reducing the local anesthetic concentration may limit the total dose administered without changing the volume injected. However, the minimum concentration of local anesthetic to obtain a safe ABPB without compromising the blockade quality and effectiveness has not been established yet.

The aim of this study was to calculate the minimum effective concentration of 20 mL bupivacaine without epinephrine, which reached surgical anesthesia dose for axillary brachial plexus block guided by ultrasound for hand surgery in 90% of patients (MEC90).

Material and methods

The present study used a step-up/step-down model to determine the MEC90 of bupivacaine in ultrasound guided ABPB.

This protocol was approved by the Ethics Research Committee of our institution (Ref 0482/11) and registered in the Clinical-Trials.gov (protocol NCT01838928). Patients aged between 18 and 65 years, with indication for anesthesia and analgesia brachial plexus block, undergoing elective surgery of the hand with less than 2 h duration, physical status ASA I, II or III according to the American Society of Anesthesiologists, and body mass index (BMI) <35 kg m^{-2} were included in the study between the years 2011 and 2012, after signing the informed consent form. Patients with disorders that prevented the assessment of motor sensitive function, cognitive impairment or active psychiatric condition, infection at the blockade puncture site, bleeding disorders or history of allergy to bupivacaine were excluded from the study.