



CIRUGÍA y CIRUJANOS

Órgano de difusión científica de la Academia Mexicana de Cirugía
Fundada en 1933

www.amc.org.mx www.elsevier.es/circir



CLINICAL CASE

Bilateral brachial plexus block. Case reporting and systematic review of literature[☆]



Gabriel Enrique Mejia-Terrazas^{a,*}, María de Ángeles Garduño-Juárez^a,
Marisol Limón-Muñoz^a, Areli Seir Torres-Maldonado^a, Raúl Carrillo-Esper^b

^a División de Anestesiología, Instituto Nacional Rehabilitación, México, D.F., México

^b Unidad de Cuidados Intensivos, Fundación Clínica Médica Sur, México, D.F., México

Received 3 July 2014; accepted 6 November 2014

KEYWORDS

Bilateral interscalene block;
Bilateral supraclavicular block;
Ultrasound bilateral brachial plexus block;
Bilateral infraclavicular block;
Ultrasound scanner

Abstract

Background: The bilateral brachial plexus block is considered a contraindication, due to the possible development of complications, such as toxicity from local anaesthetics or bilateral diaphragmatic paralysis. However, with the real time visualisation provided by the ultrasound scan, these complications have decreased and it is a safer procedure.

Clinical cases: Four cases are presented where the bilateral block was performed using guided ultrasound, as the patients were unable to receive general anaesthesia due to a history of adverse effects or the use of opioids in the post-operative or by the prediction of a difficult airway associated with obesity. A systematic review of the literature from January 1993 to June 2013, was also performed by using a search in the MEDLINE, EMBASE, ARTEMISA, LILACS, Google data bases, in Spanish and English language with the following words: bilateral brachial plexus block, bilateral interscalene block, bilateral infraclavicular block, bilateral supraclavicular block, bilateral lateral supraclavicular block, bilateral axillary block, ultrasound-guided bilateral brachial plexus block.

Conclusion: Based on the evidence found, ultrasound-guided bilateral brachial plexus block in selected patients and expert hands, is no longer a contraindication.

© 2015 Academia Mexicana de Cirugía A.C. Published by Masson Doyma México S.A. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

[☆] Please cite this article as: Mejia-Terrazas GE, Garduño-Juárez MA, Limón-Muñoz M, Torres-Maldonado AS, Carrillo-Esper R. Bloqueo bilateral del plexo braquial. Reporte de casos y revisión sistemática de la literatura. Cirugía y Cirujanos. 2015;83:312–318.

* Corresponding author at: División de Anestesiología, Instituto Nacional de Rehabilitación, Av. México-Xochimilco 289, Col. Arenal de Guadalupe, C.P. 011400, Delegación Tlalpan, México, D.F., México. Tel.: +52 5999 1000 Ext 11226, 11220 and 11219.

E-mail address: gisibyg@yahoo.com.mx (G.E. Mejia-Terrazas).

PALABRAS CLAVE

Bloqueo
interescalénico
bilateral;
Bloqueo
supraclavicular
bilateral;
Bloqueo del plexo
braquial bilateral;
Bloqueo
infraclavicular
bilateral;
Ecógrafo

Bloqueo bilateral del plexo braquial. Reporte de casos y revisión sistemática de la literatura**Resumen**

Antecedentes: El bloqueo de plexo braquial bilateral se ha considerado una contraindicación debido al posible desarrollo de complicaciones, como toxicidad por anestésicos locales o paresia diafragmática bilateral; pero con la visualización en tiempo real que proporciona la ecografía, estas se reducen, lo que nos proporciona un procedimiento más seguro.

Casos clínicos: Presentamos 4 casos en los que se realizó el bloqueo bilateral guiado por ecografía debido a la negativa de los pacientes a la administración de anestesia general, por antecedente de efectos adversos con su utilización o con los opioides en el postoperatorio, o bien por predicción de una vía aérea difícil asociada a obesidad. También exponemos una revisión sistemática de la literatura de enero de 1993 a junio de 2013, en las bases de datos MEDLINE, EMBASE, ARTEMISA, LILACS y Google, en idioma español e inglés con las siguientes palabras: bilateral brachial plexus block, bilateral interscalene block, bilateral infraclavicular block, bilateral supraclavicular block, bilateral lateral supraclavicular block, bilateral axillary block, ultrasound guided bilateral brachial plexus block.

Conclusión: Con base en la evidencia encontrada, el bloqueo del plexo braquial bilateral guiado por ecografía en pacientes seleccionados y con personal entrenado deja de ser una contraindicación.

© 2015 Academia Mexicana de Cirugía A.C. Publicado por Masson Doyma México S.A. Este es un artículo Open Access bajo la licencia CC BY-NC-ND (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Background

Historically, the brachial plexus block in its bilateral application is contraindicated mainly in its supraclavicular and interscalene approach,^{1,2} since the diffusion of local anaesthetic may block the phrenic nerve, causing diaphragm paresis with changes to the breathing mechanics, which bilaterally may cause respiratory failure.³ This was prompted by the plexus location techniques, since blind methods such as paraesthesia or neurostimulation were used, requiring large volumes of local anaesthetic to result in a successful block.^{4,5} But with the advent of ultrasound as a guide to conduct these procedures, it is possible to perform them safely, since the technique offers the following advantages: it allows location of the brachial plexus; usually the phrenic nerve may be observed,⁶ even in the presence of anatomical variations^{7,8} which negatively affect the patient's breathing mechanics; and it is also possible to directly visualise adjacent structures, particularly muscles, arteries and veins, thereby avoiding accidental injections, using a lower amount of anaesthetics, controlling diffusion to immediate areas, avoiding diffusion to structures that do not require blocking, and it is all conducted in real time.¹⁻³ Thus, the purpose of the case study was to show that with an ultrasound-guided bilateral brachial plexus block the phrenic nerve is not blocked and, therefore, the patient's ventilation is not affected. In addition, we conducted a systematic review of the procedure to support the suggested recommendations.

Clinical cases

All patients were asked for a written informed consent, wherein the nature of the procedure was explained as well as the potential complications, which they accepted. The

procedures were conducted by anaesthetists with experience equal to or greater than 5 years conducting this type of procedure. Transoperative analgesia was adequate in all cases. The CO₂ curve, respiratory rate, and oxygen saturation were not modified during the entire surgery; also, there was neither dyspnoea nor any evidence of respiratory failure during the transanaesthetic or the mediate postoperative periods.

Case 1: bilateral interscalene block

Female patient of 70 years, ASA II, with a diagnosis of subacromial impingement, scheduled for bilateral shoulder arthroscopy (biceps tenotomy, subacromial decompression, acromioplasty, and distal end resection of bilateral clavicle), history of systemic hypertension, who did not accept general anaesthetics, therefore local anaesthetics were chosen. The block was conducted with an ultrasound (MicroMaxx Ultrasound System, SonoSite Inc., United States) and a linear transducer of 13-6 MHz (HFL38, SonoSite Inc., United States) jointly with neurostimulation (B Braun Melsungen AG, Stimuplex Dig RC, Germany). The procedure was conducted first on the left side. The transducer was placed for a cross-section approach, and the procedure was conducted on the long axis with an insulated needle of 50 mm (B Braun Melsungen AG, Stimuplex A50, Germany); neurostimulation started once the nerve trunks were visualised and the needle tip was perineural, resulting in a muscular response, the contraction of the deltoid muscle, with a current intensity of 0.35 mA in grade II; the procedure was the same for both blocks. An adequate circumferential diffusion was visualised, with root displacement (Fig. 1). The local anaesthetic used was ropivacaine 7.5% with 15 cm³ for each side; a total dose of 225 mg was used (equivalent to 3 mg/kg). Dexmedetomidine at 1 mcg/kg/h was used for sedation. The surgical

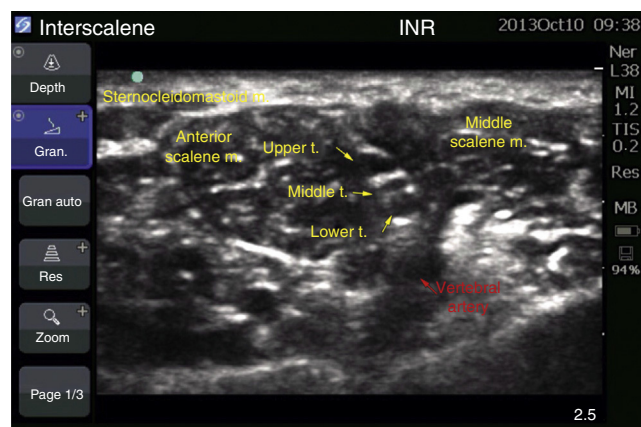


Figure 1 Ultrasound of the brachial plexus at the interscalene level.

position used was “beach chair”. A chest X-ray was taken upon completion to assess the hemidiaphragms, which were not compromised (Fig. 2).

Case 2: bilateral supraclavicular block

Female patient of 53 years, ASA III, with a diagnosis of bilateral radius fracture, scheduled for osteosynthesis of distal radius. History of obesity (BMI 42.96), hypertension, diabetes mellitus type 2 and sleep obstructive apnoea. Regional anaesthetics were chosen due to her co-morbidities. The block was guided with ultrasound (MicroMaxx Ultrasound System, SonoSite Inc., United States) and a linear transducer of 13-6 MHz (HFL38, SonoSite Inc., United States). The left block was conducted first, the transducer being placed in the supraclavicular cavity, parallel to the clavicle, with the edge touching the internal face of the clavicle and angled towards the chest; it was conducted on the long axis with an insulated needle of 100 mm (B Braun Melsungen AG, Stimuplex



Figure 2 Post-bilateral interscalene block chest X-ray (case 1) where the hemidiaphragms are not affected, indicating there was no phrenic nerve block on either side (the plate was taken at the end of surgery).

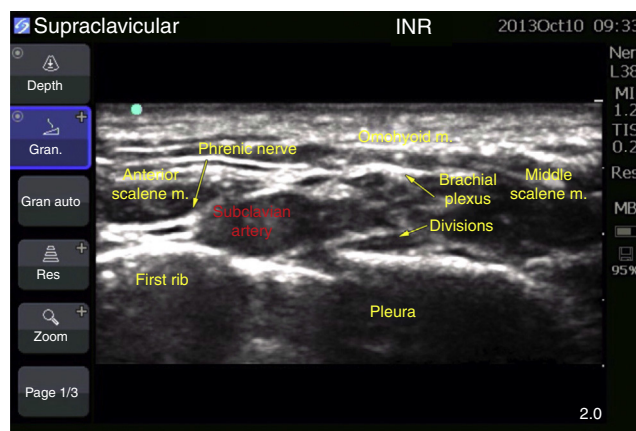


Figure 3 Brachial plexus ultrasound at supraclavicular level.

A100, Germany); once the subclavian artery was visualised (a round, pulsating, hypoechoic image), as well as the first rib (hyperechoic), the brachial plexus was identified, which appeared with 4–6 round, hypoechoic structures inside, with hyperechoic edge, grouped in the appearance of a “bundle of grapes”; the needle was placed along the angle formed by the carotid artery and the first rib, ropivacaine 0.75% and lidocaine 2% plain were administered, with a total dose of 180 and 300 mg (equivalent to 3 and 5 mg/kg of ideal weight, respectively, for a volume of 20 ml on each side) (Fig. 3).

Case 3: bilateral infraclavicular block

Female patient of 62 years, ASA II, with diagnosis of bilateral carpal tunnel syndrome, scheduled for bilateral endoscopic release. History of systemic hypertension, dyslipidemia and morbid obesity (BMI 44.5); due to these conditions, regional anaesthetics were chosen.

The block was guided with ultrasound (MicroMaxx Ultrasound System, SonoSite Inc., United States) and a linear transducer of 13-6 MHz (HFL38, SonoSite Inc., United States). The left block was conducted first, the transducer was placed longitudinally below the coracoid apophysis and inserted on the long axis in perpendicular direction towards the posterior cord, where the local anaesthetic was administered with an insulated needle of 150 mm (B Braun Melsungen AG, Stimuplex A150, Germany). A total dose of 150 mg of ropivacaine at 7.5% was used, and 200 mg of lidocaine 2% (equivalent to 3 and 4 mg/kg of ideal weight, respectively, for a volume of 20 ml on each side) (Fig. 4).

Case 4: supraclavicular block plus infraclavicular block

Female patient of 60 years, ASA I, with diagnosis of left Quervain tenosynovitis, as well as right trigger fingers, who was scheduled for open release and for correction. With no history of relevance, she did not accept general anaesthetics due to major adverse effects in prior surgeries, therefore regional anaesthetics were chosen. The block was guided with ultrasound (MicroMaxx Ultrasound System, SonoSite Inc., United States) and a linear transducer of 13-6 MHz (HFL38, SonoSite Inc., United States). The right

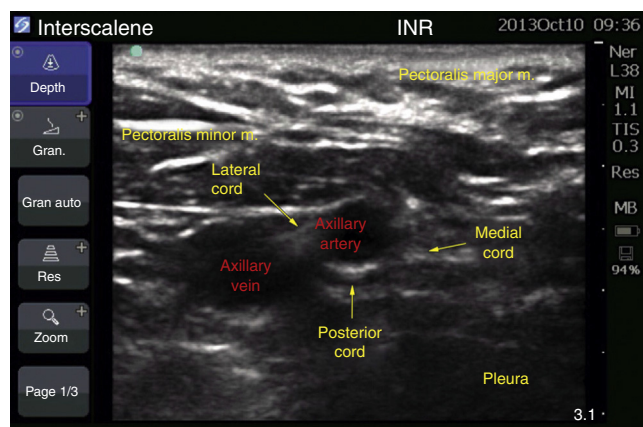


Figure 4 Brachial plexus ultrasound at infraclavicular level.

block (supraclavicular) was conducted first with the technique described in case 2, using an insulated needle of 100 mm (B Braun Melsungen AG, Stimuplex A150, Germany), ropivacaine 112.5 mg + lidocaine with epinephrine 2% were administered, 200 mg for a volume of 20 ml, at a depth of 25 mm. Twenty minutes afterwards, the left block (infraclavicular) was conducted, with an insulated needle of 150 mm (B Braun Melsungen AG, Stimuplex A150, Germany), with the technique described above for case 3; the following were administered: ropivacaine 75 mg + lidocaine epinephrine 2% 200 mg, volume of 25 ml, with a depth of 60 mm (equivalent to 3.3 and 7 mg/kg of ideal weight, respectively, for a volume of 20 ml on each side).

Systematic review

A systematic review was preferred for the review of medical and scientific literature, as we believed that the traditional review was not adequate since the studies published in the latter were limited to the assessment or justification of a position adopted by the authors, and there is no critical assessment of the literature.

Search strategy

The search was conducted from 1 January, 1993, until 30 June, 2013. The following electronic databases were included: MEDLINE, EMBASE, ARTEMISA, LILACS, Google. The following keywords in Spanish and English were used: bilateral brachial plexus block, bilateral interscalene block, bilateral infraclavicular block, bilateral supraclavicular block, bilateral lateral supraclavicular block, bilateral axillary block, ultrasound guided bilateral brachial plexus block.

The question that the systemic review attempted to answer was whether the bilateral block of the brachial plexus is a technique that may be routinely conducted, and a total of 104 articles were obtained, 16 of which were selected (Fig. 5).⁹⁻²⁴

The studies were selected based on the following grounds: (1) studies reporting the bilateral block technique for the brachial plexus; (2) location will be conducted with any technique (paraesthesia, neurostimulation, ultrasound); (3) any type of upper-limb surgery; (4) in English or Spanish

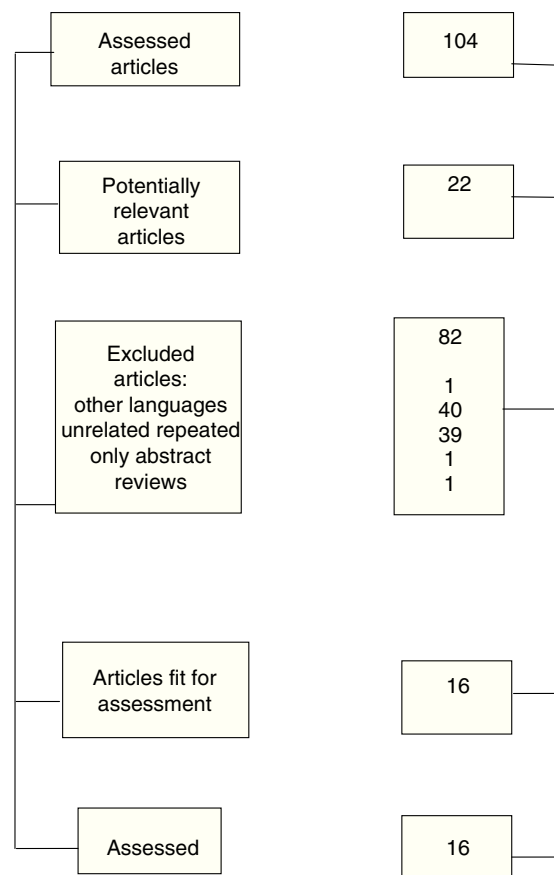


Figure 5 Flow diagram of information review.

language; (5) studies on humans; (6) patients of both sexes; (7) patients of any age; and (8) with any co-morbidity.

Once selected, they were evaluated to assess their methodological quality. Since all were case reports, the STROBE tool was used in order to issue a degree of recommendation on the application of these techniques.

Discussion

During the brachial plexus block, the phrenic nerve is also blocked, causing diaphragmatic hemiparesis in 20% of cases, and it may even occur in 100% of cases, mainly during the interscalene block. It is believed that the triggering mechanisms are generally caused by the rostral and ventral shape of the local anaesthetic diffusion due to the volume of local anaesthetic, which goes from 20 to 40 ml, and guided with the neurostimulation technique.³ During the supraclavicular block, the incidence is 50–67%, although without affecting the forced vital capacity.⁴ Renes et al.⁵ reported the absence of diaphragmatic hemiparesis in 95% of cases when using ultrasound, since it avoids the direct administration of local anaesthetic on the phrenic nerve or the distribution of the same around the roots of C3–C5. Kessler et al.⁶ posited that when applying the approach below the cricoid cartilage, the block of the phrenic nerve will depend on the administered volume. The phrenic nerve has its origin in C4, with a variable contribution from the roots of C3 and C5; it descends vertically leaning on the anterior scalene muscle.

Table 1 Assessed articles.

Author and year	Block	Drug	Total dose (mg)	Interval between each one (min)	Volume (ml)	Guide	Result	n	Complications	Characteristics
Pai et al. ²⁴ 2013	SC + AX	BUP + LID	280 + 165	120	24 + 38	PAR + NS	Adequate analgesia	1	No	Cardiomyopathy + difficult intubation
Llácer-Pérez ²³ 2012	IC	MEP	600	75	20	US	Adequate analgesia	1	No	Difficult intubation
Abd-Elseyed et al. ²⁰ 2011	AX + IC	ROP + MEP	150–400	120	20 + 20	US	Adequate analgesia	1	No	Cardiac complications + outpatient
Vermeulen et al. ²¹ 2011	SC + caudal	ROP	37 mg (25 mg plexus + 12 mg caudal)	UR	7 + 2.5 + 2.5	US	Adequate analgesia	1	No	Paediatric, sickle cell disease
Toju et al. ²² 2011	AX + SC	ROP	200	UR	20 + 20	US	Adequate analgesia	1	No	Morbid obesity
Tekin et al. ¹⁹ 2010	IC	LID + AD + LB	200 + 75	UR	10	US	Adequate analgesia	1	No	Patient did not accept general anaesthetic
Smith et al. ¹⁸ 2009	IS	BUP + AD	25 + 25	0	5	US	Adequate analgesia	3	No	Greater morbidity with general anaesthetic, opioid dependence and difficult intubation
Dhir et al. ¹⁷ 2008	IC	ROP + AD	50 + 50	30	17 + 17	US	Adequate analgesia	1	No	Postoperative analgesia
Cabellos et al. ¹⁶ 2008	AX	MEP	270 + 150	80	UR	NS	Adequate analgesia	1	No	Cardiac complications
Neuburger et al. ¹⁵ 2007	AX	MEP + ROP	500 + 150	15	UR	NS	Adequate analgesia	1	No	Alternative to general anaesthetic
Sandhu et al. ¹³ 2006	IC	LID + AD + B	800	0	20	US	Adequate analgesia	8	No	Alternative to general anaesthetic
Errando et al. ¹⁴ 2006	AX	MEP	525	20	35 + 15	NS + US	Adequate analgesia	1	No	Contraindication to general anaesthetic
Franco et al. ¹² 2004	SC + AX	MEP + AD	200 + 300	10	20 + 30	NS	Adequate analgesia	1	No	Greater morbidity with general anaesthetic
Maurer et al. ¹¹ 2002	IS	ROP	150 + 150	15	30 + 30	NS	Adequate analgesia	1	No	Intolerance to intravenous opioids
Maurer et al. ⁹ 2002	IS + IC	ROP	175 + 175	20	35 + 35	NS	Adequate analgesia	1	No	Difficult intubation and full stomach
Lierz et al. ¹⁰ 1998	AX + IS	ROP	40	UR	20 + 20	NS	Adequate analgesia	1	No	39% BBS

AD: adrenaline; BGA: balanced general anaesthetic; AX: axillary; B: bicarbonate; BUP: bupivacaine; IC: infraclavicular; IS: interscalene; LBUP: levobupivacaine; LID: lidocaine; MEP: mepivacaine; NS: neurostimulation; UR: unreported; PAR: paraesthesia; ROP: ropivacaine; SC: supraclavicular; BBS: burned body surface; CRPS: complex regional pain syndrome; US: ultrasound.

Additionally, the accessory phrenic nerve, which is present in 61.8% of cases, has its origin in the subclavian nerve, the ansa cervicalis or the sternohyoid nerve, and runs laterally with the phrenic nerve in 90% of cases, and medially in 10%; thus, the phrenic nerve block contributes to the diaphragmatic hemiparesis.^{7,8}

With the use of ultrasound, it is possible to visualise the phrenic nerve directly; it appears as a round hypoechoic structure, medial to the brachial plexus, and superficial to the anterior scalene muscle.⁶ If it can be visualised, directing the anaesthetic towards it or towards the root of C4 should be avoided, so as to avoid diffusion to the location of the phrenic nerve,³ and the required anaesthetic may be reduced from 20 to 5 ml, achieving adequate effectiveness. In cases where the phrenic nerve cannot be visualised, it is sufficient that the local anaesthetic does not go beyond the fascia of the anterior scalene.⁶ In case 1, we could not visualise the phrenic nerve, therefore the approach was made on the long axis, and the tip of the needle was placed in caudal position to the trunks, to ensure greater distance from the phrenic nerve; also, on starting the injection of local anaesthetic it was controlled with ultrasound visualisation to avoid dispersion of anaesthetic beyond the fascia of the scalenes, mainly the anterior scalene, to avoid blocking it; the fascia works as a wall and prevents contact between the local anaesthetic and the phrenic nerve.^{2,4}

The effect of bilateral diaphragmatic palsy due to anaesthetic block has not been adequately studied in humans.⁹ It is important because once the procedure is completed, the pulmonary forced vital capacity may be reduced by up to 60%, although it may be tolerated by the patient when the respiratory accessory muscles, such as the intercostal, scalene, and the sternocleidomastoid, are activated. These provide sufficient ventilation and avoid the patient presenting evidence of respiratory failure.

Toxicity by local anaesthetics is not present if the dose of total anaesthetic is calculated according to the body weight, and it is necessary to divide it between both procedures, waiting for some minutes between one procedure and the next to avoid a peak in the plasmatic concentration of anaesthetics and to avoid toxic levels of anaesthetic. Regional anaesthetic was applied in the 4 cases presented in this study, since general anaesthetic was not possible due to patient refusal or because it was deemed difficult for intubation.

A total of 16 reports was assessed in the systemic review of bilateral brachial plexus block techniques, with a total of 26 studied patients (Table 1).^{19–24} Sadly, they are all case report articles, since it is difficult to conduct controlled studies through experimentation, or rather, to conduct case control studies which might confirm the sensitivity and specificity of the procedure.

A qualitative analysis of data was made from the analysed information, which enabled us to answer our research question. The analysis reveals the following premise: there was no complication or major respiratory effect requiring endotracheal intubation in any of the cases. The bilateral use would be indicated in cases where it is important to avoid the morbidity derived from general anaesthetics due to patient co-morbidities, mainly at the cardiorespiratory level, or rather when there are foreseeable technical difficulties with the airways due to difficult intubation, or when

the patient does not accept the administration of general anaesthetic.

It would also be indicated so as to achieve adequate postoperative analgesia, particularly in patients with a history of major adverse effects from the use of intravenous opioids or in cases of addiction to them. All the authors reviewed believe that the use of bilateral brachial plexus block increases the benefits, by achieving adequate analgesia in selected patients without increasing procedural risks. This is obvious in our cases, since there were no complications of any kind.

The qualitative analysis of data obtained allows us to issue the following recommendations: (1) under specific circumstances, it may be the anaesthetic technique of choice, i.e., in patients who due to their co-morbidities present a greater risk for the administration of general anaesthetics; (2) in patients with foreseeably difficult intubation; (3) the presence of complications is not greater than when a unilateral technique is applied; (4) the calculation of the total dose of local anaesthetic without reaching the maximum dose does not reach toxic levels and it maintains adequate analgesia (the total dose is calculated per kilogram of weight and divided between each block), since no toxic plasmatic concentrations are reached in this procedure; (5) wait for a reasonable time between each block to avoid the plasmatic peak of the anaesthetic from reaching toxic levels in the case of immediate administration, and (6) the procedure must always be conducted with ultrasound guidance to reduce the volume of local anaesthetic and, therefore, the total dose administered; furthermore, the diffusion of the dose may be visualised and modified to avoid a phrenic nerve block.

Conclusion

In spite of the scant current evidence, this study shows that we can stop considering bilateral brachial plexus block techniques as contraindicated. When they are applied by experienced hands and with ultrasound guidance, they constitute a safe alternative, with an adequate risk-benefit balance.

Conflict of interest

The authors declare that there are no conflicts of interest.

References

1. Spence BC, Beach ML, Gallagher JD, Sites BD. Ultrasound-guided interscalene blocks: understanding where to inject the local anesthetic. *Anaesthesia*. 2011;66:509–14.
2. Holborow J, Hocking G. Regional anaesthesia for bilateral upper limb surgery: a review of challenges and solutions. *Anaesth Intensive Care*. 2010;38:250–8.
3. Riaz S, Carmichael N, Awad I, Holtby RM, McCartney CJ. Effect of local anaesthetic volume (20 vs 5 ml) on the efficacy and respiratory consequences of ultrasound-guided interscalene brachial plexus block. *Br J Anaesth*. 2008;101:549–56.
4. Mak PH, Irwin MG, Ooi CG, Chow BF. Incidence of diaphragmatic paralysis following supraclavicular brachial plexus block and its effect on pulmonary function. *Anaesthesia*. 2001;56:352–6.

5. Renes SH, Spoormans HH, Gielen MJ, Rettig HC, van Geffen GJ. Hemidiaphragmatic paresis can be avoided in ultrasound-guided supraclavicular brachial plexus block. *Reg Anesth Pain Med.* 2009;34:595-9.
6. Kessler J, Schafhalter-Zoppoth I, Gray AT. An ultrasound study of the phrenic nerve in the posterior cervical triangle: implications for the interscalene brachial plexus block. *Reg Anesth Pain Med.* 2008;33:545-50.
7. Bigeleisen PE. Anatomical variations of the phrenic nerve and its clinical implication for supraclavicular block. *Br J Anaesth.* 2003;91:916-7.
8. Loukas M, Kinsella CR, Louis RG, Gandhi S, Curry B. Surgical anatomy of the accessory phrenic nerve. *Ann Thorac Surg.* 2006;82:1870-5.
9. Maurer K, Ekatodramis G, Rentsch K, Borgeat A. Interscalene and infraclavicular block for bilateral distal radius fracture. *Anesth Analg.* 2002;94:450-2.
10. Lierz P, Schroegendorfer K, Choi S, Felleiter P, Kress HG. Continuous blockade of both brachial plexus with ropivacaine in phantom pain: a case report. *Pain.* 1998;78:135-7.
11. Maurer K, Ekatodramis G, Hodler J, Rentsch K, Perschak K, Borgeat A. Bilateral continuous interscalene block of brachial plexus for analgesia after bilateral shoulder arthroplasty. *Anesthesiology.* 2002;96:762-4.
12. Franco CD, Salahuddin Z, Rafizad A. Bilateral brachial plexus block. *Anesth Analg.* 2004;98:518-20.
13. Sandhu NS, Maharlouei B, Patel B, Erkulwater E, Medabalmi P. Simultaneous bilateral infraclavicular brachial plexus blocks with low-dose lidocaine using ultrasound guidance. *Anesthesiology.* 2006;104:199-201.
14. Errando CL, Pallardó MA, Herranz A, Peiró CM, de Andrés JA. Bloqueo axilar bilateral del plexo braquial guiado por neuroestimulación múltiple y ultrasonidos en una paciente con politraumatismo. *Rev Esp Anestesiología Reanim.* 2006;53:383-6.
15. Neuburger M, Büttner J, Lang D. Case report: Bilateral block of the brachial plexus – approaches, dosage and effectiveness. *Anesthesiol Intensivmed Notfallmed Schmerzther.* 2007;42:770-3 [in German].
16. Cabellos O, Claros L, Puente C, Ingelmo II. Bloqueo bilateral del plexo braquial por vía axilar para ligamentotaxis de fractura bilateral conminuta de extremidad distal del radio en paciente cardiopata con politraumatismo. *Act Anest Reanim.* 2008;18:46-54.
17. Dhir S, Singh S, Parkin J, Hannouche F, Richards RS. Multiple finger joint replacement and continuous physiotherapy using ultrasound guided, bilateral infraclavicular catheters for continuous bilateral upper extremity analgesia. *Can J Anaesth.* 2008;55:880-1.
18. Smith HM, Duncan CM, Hebl JR. Clinical utility of low-volume ultrasound-guided interscalene blockade: contraindications reconsidered. *J Ultrasound Med.* 2009;28:1251-60.
19. Tekin M, Gürkan Y, Ceylan DB, Solak M, Toker K. Ultrasound-guided bilateral infraclavicular block: case report. *Agri.* 2010;22:41-3 [in Turkish].
20. Abd-Elseyed AA, Seif J, Guirguis M, Zaky S, Mounir-Soliman L. Bilateral brachial plexus home going catheters after digital amputation for patient with upper extremity digital gangrene. *J Clin Med Res.* 2011;3:325-7.
21. Vermeylen K, Berghmans J, van de Velde M, de Leeuw T, Himpe D. Ultrasound as guidance for a combined bilateral supraclavicular and caudal block, in order to reduce the total anaesthetic dose in a two year old child after a pneumococcal sepsis. *Acta Anaesthesiol Belg.* 2011;62:151-5.
22. Toju K, Hakozaiki T, Akatsub M, Isosu T, Murakawa M. Ultrasound-guided bilateral brachial plexus blockade with propofol-ketamine sedation. *J Anesth.* 2011;25:927-9.
23. Llácer-Pérez M. Bloqueo infraclavicular bilateral guiado por ultrasonidos. *Rev Esp Anestesiología Reanim.* 2012;59:399-400.
24. Pai RV, Hedge HV, Santhosh M, Roopa S, Deshpande SS, Rao PR. Bilateral brachial plexus blocks in a patient of hypertrophic obstructive cardiomyopathy with hypertensive crisis. *Indian J Anaesth.* 2013;57:72-5.