Ultrasound-guided axillary brachial plexus block. 
Part 2 — technical issues

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Abstract

Axillary brachial plexus block is one of the most frequently employed peripheral blocks. The popularity of axillary block stems from its success as a safe and relatively easy technique with numerous applications. The technique of axillary block has evolved. It was modified after the development of precise nerve localization modalities. Currently, ultrasound is the most important localization technique for regional anaesthesia. Ultrasound-guided axillary block encompasses a spectrum of techniques. The selection of a specific technique can be adjusted to an operator’s individual level of skill and proficiency. Axillary block under US-guidance can be performed using a traditional perivascular method and by placing a selective blockade of individual nerves that supply the surgical area. Regardless of the selected method, it enables the incorporation of individual patient anatomical variation in an anaesthesia plan. This paper discusses the technical details and efficacy issues of US-guided axillary brachial plexus block techniques.

Keywords: regional anaesthesia, peripheral nerve block, brachial plexus; regional anaesthesia, peripheral nerve block, axillary block; regional anaesthesia, techniques


The use of ultrasonography enables all steps of a regional block to be controlled, such as determination of the anatomical structure of the anaesthetized region via real-time control, operational correction of the needle position and verification of the injection site and pathway of local anaesthetic agent dispersion [2]. Ultrasonography enables the assignment of an optimal site of needle puncture and the planning of the insertion vector based on the topographic relationships among particular patients.

The utilization of this technique has introduced new possibilities of axillary block performance and has significantly changed its operation compared with traditional methods. Assuming that a crucial factor of effective/failed block is the appropriate deposition of local anaesthetic agent in the immediate vicinity of nerves, the main goal of ultrasound imaging is the confirmation of proper anaesthetic dispersion around anaesthetized structures. The possibility of visualizing the anatomical structure of an anaesthetized region facilitates the selection of the needle insertion site, which enables a needle to be optimally placed near targeted nerves, and the vector of needle insertion, which minimizes the risk of complications (puncture of vessels and nerves, reduction in the number of needle repositions, and limited patient discomfort). The use of ultrasonography to guide the
nation, the majority of authors recommend the
on a screen. Despite the need for better manual coordi-
ation. Axillary block is a superficial procedure. In the region
of axilla, ample space is provided for needle manipulation.
The angle of needle insertion is flat; thus, it is highly visible
on a screen. Despite the need for better manual coordi-
nation, the majority of authors recommend the in-plane
 technique during axillary block. Although the out-of-plane
technique seems to be technically easier, it demands more
experience for assessing the needle end and interpreta-
tion is more challenging. The in-plane technique, which is
the most convenient method of needle insertion, can be
performed from the top, over a transducer, and from the
side of a tag. It facilitates the manipulation of a needle and
the correction of its bending angle. In patients for which
the site of needle insertion conflicts with the location of
vessels, insertion of the needle from the bottom side of a
transducer is an alternative.

Numerous studies provide different descriptions of the
axillary brachial plexus block technique with the use of
ultrasonography. However, these studies lack a universal
and extensively accepted technique that is defined by an un-
ambiguously determined location for placing a transducer,
site of needle puncture and method of insertion. The recom-
manded volume and number of local anaesthetic injections
differ among authors. In general, two approaches for per-
forming axillary brachial plexus block can be distinguished.
The first approach comprises a modified traditional method
that assumes the injection of a prespecified volume of an-
aesthetic agent around the axillary artery with the use of one
or more injections. Ultrasonography enables confirmation
of the location of the needle end in the selected site and
is a perivascular (or volumetric) technique. An alternative
to the perivascular method is the technique of perineural
block (technique of selective block of nerves). This concept
assumes the precise localization and identification of nerves,
which is essential for achieving a proper area of anaesthesia,
and their injection with the minimum effective volume of
local anaesthetic agent. The volume of anaesthetic and the
number of injections as well as the number of required re-
opositions of the needle are necessary for the proper disper-
sion of anaesthetic around anaesthetized structures.

**PERIVASCULAR TECHNIQUE**

This technique is similar to the traditional volumetric
method of axillary brachial plexus block, which dates to
the work of de Jong, Burnham and Winnie [3–5]. It assumes
perivascular administration of a relatively high volume of
anaesthetic agent (30–40 mL). The proper and extensive
dispersion of a drug within a perivascular space is a deter-
minant of its efficacy. Advantages of this method include the
technical ease of application without the need to identify
particular nerves of the brachial plexus. The prime point of
reference is the axillary artery, around which anaesthetic
agent should be deposited. Contrary to traditional methods,
which are based on the administration of anaesthetic agent
in the region surrounding an artery, the current concept of
volumetric block assumes a separate injection of muscu-
locutaneous nerve due to its location apart from the neu-
rovascular bundle in the majority of patients. The volume
of anaesthetic agent that is utilized for musculocutaneous
nerve block ranges from 5 to 10 mL.

The number of sites around an artery, in which a local
anaesthetic agent should be injected for the optimal block
effectiveness, remains a subject for discussion. Different
authors suggest the administration of the drug in one, two
or three sites around the axillary artery [6–8]. In the case of
single perivascular injection, some authors recommended
that the total volume should be administered to the artery
in the location that correspond to the 6:00 position on a clock.
When two sites are injected, the scheduled volume should
be split and administered in locations that correspond to
the 12:00 and 6:00 positions on a clock. In the case of three
injections, the volume should be administered in locations
that correspond to the 10:00, 2:00 and 6:00 positions on a
clock (Fig. 2).

 Few studies have compared the efficacy of axillary bra-
chial plexus block performed using a perivascular method
with the administration of a large volume of anaesthetic
agent (32–40 mL), which is deposited in two, three or four
injections, and injection into the musculocutaneous nerve
(Table 1). These comparisons indicate no statistically sig-
significant differences in the efficacy of axillary brachial plexus block regarding the number of injections. A smaller number of needle repositions produced a shorter duration of anaesthesia and better acceptance by patients. Some differences were noted regarding the time when the block of particular nerves of brachial plexus appeared in relation to the site of anaesthetic agent administration (the nerves that were located near the injection sites were quickly blocked); however, these differences did not change the general efficacy of the anaesthesia. Due to the increased popularity of ultrasonography in regional anaesthesia in the last few years, the use of the perivascular technique of axillary block has decreased and become a relic. The results of the previously mentioned studies indicate that in addition to the methods of anaesthesia that are based on ultrasonography, this technique may remain an attractive option that provides an effective block with a simpler method. This method can be particularly useful for physicians who are less experienced in interpreting ultrasound images and have low-quality equipment and in situations in which the dose of administered anaesthetic agent or quick blocking have no critical importance.

PERINEURAL TECHNIQUE

When introducing ultrasonography to regional anaesthesia facilitates direct visualization, tiny neural structures and other anatomical elements are frequently present in the immediate vicinity. This technique enables peripheral block to be performed using an approach that is distinct from traditional methods and guides the precise localization of particular neural elements, which is important for ensuring analgesia in certain clinical situations and the use of injections with the smallest volume of anaesthetic agent. A similar technique was previously employed with electrostimulation of peripheral nerves; however, only the possibility of visualization facilitated the complete potency of this method.

The perineural technique assumes selective injections with anaesthetic agent and that all nerves are essential for receiving anaesthesia. In addition to real-time observations of needle position, the essence of this concept is the assessment of the injection site and the manner of anaesthetic agent distribution around targeted neural structures. The observation of the dispersion of the anaesthetic agent during injection enables the interruption of its administration in the case of an inappropriate site of injection or anaesthetic dispersion. The volume of the administered drug can be optimized and decreased. The distribution of an anaesthetic agent is assumed to be optimal when it surrounds a targeted nerve. Note that the objective of this action is the administration of an anaesthetic agent to a perineural space, which can be confirmed with ultrasonography by a visible boundary nerve/anaesthetic (Fig. 3). This distribution pattern indicates that the drug was administered to the space with a running nerve.

If the previously mentioned distribution pattern is not feasible, an increase in the administered volume rarely causes an improvement in block efficacy and an unnecessary increase in the dose of local anaesthetic. A better solution may be the correction of the needle end position to optimize the drug distribution. Note that local anaesthetic disperses after administration along the fascial spaces/connective tissue septum, which are not always visible on ultrasound images. The position of the needle end cannot always be precisely assessed in relation to these structures. Thus, confirmation

Figure 2. Perivascular technique of axillary brachial plexus block with the use of (A) two injections, (B) three injections and (C) four injections. The expected field of anaesthetic agent dispersion is shown in grey, and the vectors of needle insertion are shown in dotted lines.
of the correct position and proper pattern of drug distribution on an ultrasound image prior to the administration of the primary dose of local anaesthetic is important. To verify these parameters, a small test volume (0.5–1 mL) prior to use may be justified.

The advantage of the perineural technique of axillary brachial plexus block is the possibility of significant reduction of local anaesthetic dose. Multiple repositions of the needle end may be needed, which may escalate a patient’s discomfort and prolong the duration of the block. In this technique, visualization of the targeted neural structures the appropriate experience in the interpretation ultrasound images and the identification of nerves, as well as the sufficiently precise operation of a needle is critical. The use of needles with ultrasound tags, which facilitate the assessment of the position of the needle end, may be helpful.

During axillary brachial plexus block with this method, a minimum of four main branches of plexus should be localized and injected: the median, ulnar, musculocutaneous and radial nerves. The recognition of particular variants of a brachial plexus structure is very important for assessing the minimum number of injections. If musculocutaneous nerve cannot be visualized in the fascial space within the flexors of the arm, it should be assumed that it runs together with the median nerve in the immediate vicinity of the axillary artery. In this case, administration of local anaesthetic within the bellies of the arm flexors is not justified. When the ulnar nerve is superficially localized (upper to vein), a single injection of local anaesthetic at the site that corresponds to the position 12:00 on a clock may be sufficient for anaesthetizing the median nerve and the ulnar nerve (as well as the median cutaneous nerve of the arm and the median cutaneous

### Table 1. Efficacy of perivascular axillary brachial plexus block depending on number of injections of local anesthetic agent

<table>
<thead>
<tr>
<th>Author</th>
<th>Injection technique</th>
<th>Volume of LA in particular injections</th>
<th>Total volume of LA</th>
<th>Aim of trial, results</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tran 2012 [6]</td>
<td>2 injections</td>
<td>n. msc. 7 mL, 6:00 — 28 mL</td>
<td>35 mL</td>
<td>Efficacy of block — NS</td>
<td>Onset of median nerve block quicker in group with 4 injections vs 2</td>
</tr>
<tr>
<td></td>
<td>3 injections</td>
<td>n. msc. 7 mL, 6:00 — 14 mL</td>
<td></td>
<td></td>
<td>injections; Onset of radial nerve block quicker in group with 2 injections vs 3</td>
</tr>
<tr>
<td></td>
<td>4 injections</td>
<td>n. msc. 7 mL, 2:00 — 7 mL, 10:00 — 7 mL, 6:00 — 14 mL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bernucci 2012 [7]</td>
<td>Perivascular vs perineural</td>
<td>n. msc. 8 mL, 6:00 — 24 mL</td>
<td>32 mL</td>
<td>Efficacy of block — NS</td>
<td>Perivascular technique — fewer needle repositions, shorter time of performing, perineural technique — quicker onset of block</td>
</tr>
<tr>
<td>Imasogie 2010 [7]</td>
<td>2 injections</td>
<td>n. msc. 10 mL, posterior to axillary artery — 30 mL</td>
<td>40 mL</td>
<td>Efficacy of block — NS</td>
<td>Shorter time of block performing in group with 2 injections</td>
</tr>
<tr>
<td></td>
<td>4 injections</td>
<td>n. msc. 10 mL, n. med. 10 mL, n. uln. 10 mL, n. rad. 10 mL</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

n. msc. — nervus musculocutaneus; n. med. — nervus medianus; n. uln. — nervus ulnaris; n. rad. — nervus radialis, LA — local anaesthetic; NS — non-significant

![Figure 3. Anaesthetic agent administered by perineural injection with a visible boundary between the nerve and the drug. (A) Anaesthetic agent administered in ulnar nerve region; (B) anaesthetic agent in the area surrounding the musculocutaneous nerve within the fascial space that divides the muscle bellies. Both pictures present how the local administration of an anaesthetic agent contrasts the blocked nerve among the surrounding tissues](image-url)
nerve of the forearm). However, if the ulnar nerve is deeply located (below a vein) and is close to a radial nerve, single injection may be an efficient method of anaesthesia for both nerves. With the use of a small volume of local anaesthetic that is precisely deposited around particular nerves, the anaesthesia can also capture the median cutaneous nerve of the arm, which is a tiny nerve that runs under the skin fascia. A block of this nerve has significant importance in the case of a procedure that is performed with a clumping cuff placed on the arm and in cases in which the cutting line of tissue extends to the area above the elbow. In these patients, an additional two or three injections that contain 1 mL of local anaesthetic can be administered to sites that correspond to the localization of the median cutaneous nerve of the arm (superficially to the axillary artery and along subcutaneous fascia), which facilitates anaesthesia of the medial part of the arm. The median cutaneous nerve of the forearm, which runs in the immediate vicinity of the median nerve, is usually blocked with it. In patients with a visible median cutaneous nerve of the forearm, separate injection may be possible [9, 10].

The final decision regarding the number of injections and the administered volume of local anaesthetic agent is dependent on achieving dispersion of the drug. Optimal drug distribution is rarely achieved without corrections to the needle end position. The majority of authors recommend injection of the most deeply located median nerve, followed by the nerves that are more superficial. This finding is associated with the concerns regarding changes in anatomical relationships by the administered volume of local anaesthetic and the occlusion of deeper structures in the case of accidental injection of microscopic air-bubbles during the injection of superficial structures. However, some authors recommend that a small volume of anaesthetic agent and careful draining of air bubbles using a needle-drain-syringe system to prevent excessive and vigorous aspirations prior to drug administration can minimize the risk of these events and that the sequence in which particular nerves are injected is not important.

Some studies suggest a recommended that a volume of local anaesthetic that ranges from 5 to 10 mL be injected in the vicinity of each of the four main nerves of the brachial plexus. In the majority of patients, the use of the technique of the selective block of particular nerves in the axillary region enables efficient blocking using 20 mL or less of anaesthetic. The described method can achieve an efficient block with significantly lower volumes, even with an approximately of 1 mL per each injected nerve [11]. Table 2 summarizes the studies that aimed to establish a minimum local anaesthetic volume, which is prerequisite for an effective axillary block of brachial plexus.

**BLOCK EFFECTIVENESS**

The evaluation of the effectiveness of a regional block is complex. It is somewhat dependent on the definition and the employed criteria, as well as the position of the assessing person. From the point of view of an anesthesiologist, the most important factor is the topographic area of the achieved anaesthesia and the need for additional anaesthetic procedures to ensure a patient’s comfort. From the point of view of a patient, the following issues are important: the degree of discomfort during a block, the duration of the analgesic effect in the postoperative period and the degree of discomfort during a block, the duration of the analgesic effect in the postoperative period and the concomitant complications. From the point of view of an operator, the important factor that impacts the assessment of a regional block is the time needed to perform the technique and its efficacy. Thus, the evaluation of block effectiveness should combine the elements of all components.

Previous studies present evidence regarding ultrasound-guided axillary brachial plexus block that indicates the high analgesic efficacy of this procedure. Table 3 summarizes the percentage evaluation of the efficacy of ultrasound-guided axillary brachial plexus block in randomized clinical trials.

The results show reveal high efficacy of ultrasound-guided axillary brachial plexus block—more than 80%; some studies achieved an efficacy of 100% regardless of the high volume of the employed local anaesthetic or the technique of anaesthesia (perivascular or perineural). However, note that the authors of the cited studies were experts in the use of ultrasonography in regional anaesthesia. As the effect of the use of ultrasonography is highly dependent on the skills and experience of the operator, the efficacy of procedures

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**Table 2. Minimal doses of local anesthetic agent needed to effective axillary brachial plexus block**

<table>
<thead>
<tr>
<th>Author</th>
<th>Injection technique</th>
<th>Goal, results</th>
<th>Minimal dose</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>O’Donnell</td>
<td>Selective block of n. med., n. rad., n. uln. and n. msc.</td>
<td>Minimum effective anesthetic volume (MEAV50)</td>
<td>4 mL (1 mL per each nerve)</td>
<td>Positive correlation between injected volume and time of block duration</td>
</tr>
<tr>
<td>Ponrouch</td>
<td>Mid-humeral, n. med., n. uln.</td>
<td>Minimum effective anesthetic volume (MEAV)</td>
<td>n. med.: 2 ± 0.1 mL n. uln.: 2 ± 0.1 mL</td>
<td></td>
</tr>
<tr>
<td>Gonzalez</td>
<td>n. msc. + perivascular block</td>
<td>Minimum effective volume (MEV90)</td>
<td>5.5 mL n. msc. 23.5 mL perivascular</td>
<td></td>
</tr>
</tbody>
</table>

n. msc. — nervus musculocutaneus; n. med. — nervus medianus; n. uln. — nervus ulnaris; n. rad. — nervus radialis
performed by less experienced staff may be worse. Note that the significant advantage of axillary block is its high controllability. Incomplete analgesia of all regions innervated by brachial plexus does not indicate block failure and the need to change the anaesthesia concept. Insufficient conditions for performing a supplementary block of a single nerve are common. This supplementary block may be performed in the more distal part of a given nerve or on the level of a primary procedure. The use of ultrasonography and the insertion of a needle under visual control eliminate concerns regarding the damage of previously anaesthetized nerves, which was a source of controversy during techniques with only random localization. Waiting too long for confirmation of block failure is not justified. Ineffective block is commonly assessed as a lack of anaesthesia after 30 minutes from the administration of local anaesthetic agent. The dynamics of a block should also be considered. According to the experience of some authors, the lack of block development in an innervated region after 10-15 minutes from local anaesthetic administration indicates a high risk of achieving a block with an insufficient depth and justifies “preventing” supplementary block. In this case, the maximum dose of local anaesthetic agent should not be exceeded. This criteria is extremely important if a high dose of anaesthetic was administered during the first injection.

### TIME OF BLOCK AND ONSET AND DURATION OF ANALGESIA

The first potential advantage of ultrasound-guided blocks is a reduction in the time needed to achieve surgical anaesthesia. This reduction is possible due to the rapid performance of a block procedure and the rapid onset of analgesia. Reducing the block procedure time is possible by avoiding time-consuming manipulations of a needle and random repositions while searching for targeted nerves. The mean time required for these manipulations and the deposition of an anaesthetic agent during ultrasound-guided axillary block ranges from app. eight minutes to more than 15 minutes (Table 3) [6, 8, 20, 21]. In this case, the time required for preparation, setup of the ultrasound machine and protection of a transducer. Optimization of a projection, interpretation of an image and selection of the needle position in relation to the ultrasound transducer frequently requires more time than initially expected. However, the time required to overcome these obstacles can be reduced with greater experience.

The second advantage of ultrasound-guided blocks is the time from deposition of the local anaesthetic agent to the time at which effective anaesthesia was achieved. The factor that facilitates the reduction in time is the precise deposition of local anaesthetic in the immediate vicinity.

<table>
<thead>
<tr>
<th>Author, year</th>
<th>Technique</th>
<th>Number of patients</th>
<th>Type and volume of local anaesthetic agent. number of injections</th>
<th>Efficacy</th>
<th>Time of block performing (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tran 2012 [6]</td>
<td>Perivascular</td>
<td>40</td>
<td>1.5% lidocaine with adrenalin 35 mL, 2–4 injections</td>
<td>90–97.5 %</td>
<td>11–12.2</td>
</tr>
<tr>
<td>Bernucci 2012 [7]</td>
<td>Perivascular, perineural</td>
<td>25</td>
<td>1.5% lidocaine with adrenalin 32 mL, 2–4 injections</td>
<td>92–96%</td>
<td>8.2–15.7</td>
</tr>
<tr>
<td>Marhofer 2010 [14]</td>
<td>Perineural</td>
<td>10</td>
<td>1% mepivacaine 4 or 15 mL</td>
<td>80–100%</td>
<td>LD</td>
</tr>
<tr>
<td>Tran 2009 [15]</td>
<td>Perivascular</td>
<td>40</td>
<td>1.5% lidocaine with adrenalin 35 mL, 4 injections</td>
<td>97.5%</td>
<td>7.4</td>
</tr>
<tr>
<td>Casati 2007 [16]</td>
<td>Perineural</td>
<td>30</td>
<td>0.75% ropivacaine 20 mL</td>
<td>97%</td>
<td>LD</td>
</tr>
<tr>
<td>Chan 2007 [17]</td>
<td>Perineural</td>
<td>62</td>
<td>0.5% bupivacaine + 2% lidocaine</td>
<td>82.8%</td>
<td>LD</td>
</tr>
<tr>
<td>Sites 2006 [18]</td>
<td>Perivascular</td>
<td>28</td>
<td>42 mL, 1.5% lidocaine + adrenalin 30 mL</td>
<td>82%</td>
<td>7.9</td>
</tr>
<tr>
<td>Liu 2005 [19]</td>
<td>Perivascular</td>
<td>30</td>
<td>1.5% lidocaine 0.5 mL kg⁻¹ + adrenalin 1–2 injections</td>
<td>83–90%</td>
<td>6.7–8.2</td>
</tr>
</tbody>
</table>

LD — lack of data
of the nerves, which may be an argument in favour of the perineural technique of the axillary brachial plexus block. This observation is supported by daily clinical practice and published data. In his study of a group of patients, on which the perineural technique was performed, Bernucci [7] demonstrated that the time to achieve effective anaesthesia was shorter for these patients than for patients who were anaesthetized using the perivascular method. These results were supported by Trana [6], who noted a rapid onset for the median and radial nerves when local anaesthetic agent was injected in the immediate vicinity of these nerves during ultrasound-guided axillary block.

From the patient’s perspective, a very important factor is the time of duration of the analgesic effect in the postoperative period. This time is influenced by many other variables, such as the type and concentration of the local anaesthetic agent and the employed adjuvants. Interpatient differences regarding the pharmacodynamics of local anaesthetic agents are also very important. The essential role of the adopted definition and the mode of evaluation of analgesia was investigated in particular studies. The absolute values of the duration of axillary block vary among existing studies. However, the determination of the factors that may impact the time of duration is more important. The previously mentioned elements that increase the volume of administered local anaesthetic agent seems to be important. According to a study by Schoenmakers [21], the use of 40 mL of 1% mepivacaine solution during ultrasound-guided axillary block resulted in a significantly longer time of analgesia compared with a volume of 15 mL of the same agent. Ponrouch [12] also indicated a positive correlation between the administered volume of the anaesthetic and the time of duration for the median nerve and the ulnar nerve block. Marhofer [14] noticed the trend towards prolongation of analgesia time after administration with a higher volume of local anaesthetic agent. This finding is not unambiguous, regardless of whether this effect may be caused by an increase in volume or the dose of local anaesthetic agent. These observations demand confirmation in future clinical trials.

BLOCK SAFETY

An important element that influences the selection of a regional anaesthesia technique is the safety of the technique. The block of plexus and peripheral nerves is a very safe method with a low risk of complications [22]. The use of ultrasonography contributes to an increase in their safety [23]. The risk of complications during axillary block is low due to anatomical relationships: the neural structures in the region of axilla are superficially located far from the pleura, the spinal canal or other anatomical structures, which damage or accidental anaesthesia may have an adverse impact on a patient’s state. During axillary brachial plexus block, the risk of accidental injection of local anaesthetic agent into vessels and the risk of systemic toxic reaction after administration of these drugs should be considered. The use of ultrasonography does not eliminate the possibility of these complication appearances and does not exclude the risk of neurological damage after block. However, the risk of these complications is low, the estimated incidence of toxic reaction after axillary block accounts for app. 1.5 per 10,000 cases, and the frequency of neurological complications is 0.37 per 10,000 [24]. The best way to avoid complications is compliance with the fundamental principles of regional anaesthesia: respect for a technique, maintenance of the needles in the field of vision during an entire procedure and the administering local anaesthetic agent only after confirmation of the injection site.

SUMMARY

Ultrasound-guided axillary brachial plexus block is a useful and universal technique of local anaesthesia. It is suitable for use during the majority of procedures within the upper limb, including the shoulder. The use of ultrasonography increases the safety of this method and renders it more controllable compared with traditional localizing modes. One of its advantages is the safety that is enhanced by the remoteness of the pleura and structures of central nervous system. Axillary block is suitable for use by physicians with different degrees of experience in ultrasound-guided local anaesthesia techniques. Perivascular techniques, which do not require the precise identification of all vascular structures, can be reserved for inexperienced physicians to enhance their experience and enable them to gain practice in performing ultrasound-guided block. For expert physicians, the identification and performance of precise and selective injections of particular nerves of the brachial plexus with a minimal volume of local anaesthetic agent may remain challenging tasks.

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   b) AB conducted the trainings and practical workshops regarding the use of ultrasonography and electrostimulation in regional anaesthesia, for which he received remuneration form BBraun, GE, and Philips.
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