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Ultrasound in regional anaesthesia - new developments

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Introduction

“Considerations of someone who has sometimes strange ideas” or “The truth is sometimes unpleasant”. Regional anaesthesia plays an important role in the peri-operative management of paediatric and adult patients. The importance of this sub-specialty has changed over the last few years. Even in 1884, when Carl Koller performed the first regional block in Vienna, surgery was associated with severe pain, and the importance of invasive peri-operative pain therapy was neglected for a long time. With an increase in scientific efforts in the field of regional anaesthesia and a parallel change in the mind of healthcare professionals and patients it became clear that effective pain elimination is possible even after large surgical procedures. An increase in knowledge and manual skills was and remains necessary in several areas to achieve significant advances in this specific medical field:

Anatomy

‘Regional anaesthesia is applied anatomy’. This statement is the most important prerequisite for successful performance of regional anaesthesia. Almost perfect topographic anatomical knowledge helps us to identify neural structures quickly and effectively. Unfortunately a lot of anatomical descriptions in the scientific literature are inexact, and specific anatomical literature does not fit with our demands. Therefore, regional anaesthetic anatomical descriptions are required.

Pharmacology

It was a long way from cocaine, the first local anaesthetic drug, to the pure enantiomere drugs we use today. Drugs such as levobupivacaine and ropivacaine are relatively safe with an adequate pharmacokinetic and pharmacodynamic profile. Unfortunately the last significant developments in this field were launched almost a decade ago, and it is time for more specific drugs such as long-acting pure sensory local anaesthetics.

Safety

It is interesting to note that regional anaesthesia is under particular observation with regard to complications. It does not seem to be a problem that a patient undergoing hand surgery in a trauma setting aspirates during induction of general anaesthesia. But with a patient in a similar situation complaining about paraesthesia in the fifth finger three weeks after performance of a brachial plexus blockade there is an excellent chance of medico-legal proceedings. Despite regional anaesthesia being relatively safe compared with other medical specialities, it is in our particular interest to increase this further. Our knowledge about the mechanism of nerve injury is still incomplete, and intravascular administration or fast resorption of local anaesthetic drugs is still followed by severe cardiovascular and central nervous complications. ‘Lipid rescue’ is a promising approach for treatment of those events, but we should investigate methods to avoid such complications.

However, the discussion about safety in regional anaesthesia should be more profound. Block failures or incomplete blocks can be also seen as complications. In these cases a second anaesthetic technique is required, and ‘plan B’ is never as good as ‘plan A’. Referring to the available literature, a failure rate for peripheral regional anaesthetic techniques of up to 20% can be a reasonable assumption. What would be the opinion of our patients if general anaesthesia would fail in 20%? Or if travelling by airplane would fail in up to 20%? Or if ...? I could continue this list, but the statement would be always the same: 20% failure rate is inappropriate – in all domains!

Equipment

Excellent anatomical knowledge and hand skills are important prerequisites to use ultrasound for regional anaesthesia in daily practice. Appropriate equipment is equally important. Significant advancements in ultrasound technology have led to miniaturised and affordable high-end equipment. Moreover, some ultrasound companies develop and produce equipment which is designed for the specific demands of anaesthesiologists. The absence of appropriate ultrasound equipment is a poor excuse to avoid the use of modern techniques in daily practice. Anaesthesiologists need to learn how to claim obtain equipment; even if unpleasant organisational processes are necessary.

Hand skills

Finally, the ability to combine anatomical knowledge with the use of specific equipment is known under the term 'hand skills'. It is clear that hand skills are highly individual, but weak skills in specific areas can be trained. A comparison with golf may clarify that statement: every physically averaged person is able to achieve scores below 80 (statement from Ben Hogan) – but of course only the absolute minority of persons are able to achieve scores under par, and Tiger Woods plays in his own category. So, every anaesthesiologist is able to achieve success rates for regional blocks above 95% - a few are able to increase that percentage to 98% - unfortunately Dr Woods (= an anaesthesiologist with 100% success rate) is unidentified in this field.

What is the context to ultrasound?

"We see what we believe – we believe what we see"

It is challenging to write a summary and update about a specific topic, and the main keyword does not appear until half-way through the text. But if the reader reviews carefully the previous text, he will find a huge number of connections between anatomy, pharmacology, safety, equipment and hand skills and the potency of ultrasonographic guidance during regional anaesthetic techniques.

Anatomy

The brachial plexus serves as one example of the complexity of the relevant anatomy. During the past 100 years it was clear that many kinds of surgeons have the particular anatomical knowledge to treat patients in their specialty safely and effectively. Regional anaesthesia is one opportunity to increase the competence and status of anaesthesiologists. Winnie's statement 'Regional anaesthesia is applied anatomy' has remained indispensable, and ultrasound has given us the opportunity to visualise the anatomy. Moreover, we are also able to visualise adjacent anatomical structures, the needle and the spread of local anaesthetic solution. Visualisation of adjacent structures is closely associated with an increase in safety. The visualisation of vessels and the cervical pleura for supraclavicular approaches to the brachial plexus is one example for the usefulness of this technique, and although the improvement in safety has not been proven in a scientific way, nobody can deny the importance of direct visualisation of these structures during performance of blocks.

Pharmacology

Weak techniques have been compensated for by large volumes of local anaesthetics. It is not worthwhile while reviewing the literature on this, but volumes up to 40 ml for interscalene brachial plexus blocks, similar volumes for axillary brachial plexus blocks or 30 ml for sciatic nerve blocks are frequently described in scientific papers and textbooks. Therefore, it is no wonder that local anaesthetic related side-effects are described in the literature, and a large number of unreported cases may be presumed. Recent publications describe the performance of low volume peripheral regional blocks, but it is clear that an appropriate technique and specific hand skills are necessary for successful implementation of these advanced techniques in daily clinical practice. We have performed interscalene blocks for shoulder surgery without general anaesthesia for many years with volumes of local anaesthetics between 10 and 15 ml.

Safety

Similar to other topics in this field, the ability of ultrasonographic guidance to increase the safety of regional anaesthetic has not been investigated in an evidence-based manner. Concerns regarding the calculation of power is one issue, but who really wants to report about complications? A comparative study 'ultrasound versus nerve stimulation' (or other 'conventional' guidance methods) would be very attractive ... and is completely useless. A 'race' between experts in ultrasound and nerve stimulation would result in greatest success and lowest complication rates – with no practical impact for the clinical user. We should refer more to our ability for logical thinking – the direct view of all involved structures during a regional block *must* be associated with an increase of the margin of safety.

Recent publications report complications of different regional techniques despite (or because of) the use of ultrasonographic guidance. Some experts in regional anaesthesia use these publications as arguments against the implementation of ultrasound in our daily clinical regional anaesthetic practice. Of course it is possible to inject the local anaesthetic inside a nerve under direct visualisation! But is this really due to the technique itself? Or are these publications more due to poor knowledge; and is the use of these publications as a counter-argument an abuse of dubious data? The reader should decide for himself.

Equipment

The best equipment is useless without background knowledge in ultrasound physics and the implementation of these skills in our daily practice. Equipment must be used correctly to achieve optimal results. Therefore, intensive training is an invaluable factor which can be obtained from specific textbooks and highly specialised lectures and workshops.

Hand skills

Similar to the section on equipment, specific hand skills can be obtained in basic and advanced workshops. As mentioned above, not everyone will become Tiger Woods in regional anaesthesia, but a single handicap is always achievable.

A short review of the current status and future expectations

We are not at the end of an evolution in the specific field of the use of ultrasound in regional anaesthesia. A lot has happened in the past 15 years. Most of the peripheral techniques are described in a sufficient manner and similar techniques are used worldwide to a great extent. There are deficiencies in the field of neuraxial ultrasound in adults, but recent developments in this are seem promising.

The most important progress in the near future will be in two specific fields: ultrasound technology and education. The future impact of 4-D ultrasound technology for regional anaesthesia should not be overlooked, but we presume that most of literature in that field must be re-written due to an increase in knowledge regarding distribution of local anaesthetics and the opportunity to perform blocks which are guided online by a 3-dimensional ultrasound view. In addition, the position of the needle relative to neuronal structures can be adjusted in the most exact way in order to avoid nerve damage. Finally, a virtual visualisation system could be the optimal system to perform sophisticated regional anaesthetic techniques.

We cannot influence technical developments and we should, therefore, focus on the second most important issue: education. Worldwide interest can be seen in the performance of ultrasound guided regional blocks, but at the beginning (about 12-15 years ago) it was more a technique practiced by a few 'freaks'. In the meantime, and thanks to sustained efforts in scientific publication and education, knowledge is spreading around the world. This does not necessarily mean that the techniques are used everywhere in daily clinical practice. Although it has been shown that ultrasound in regional anaesthesia is a cost-effective technique (when all cost factors are considered), implementation is associated with a lot of questions and concerns. Clarification of facts is the important in this context. The target should be that ultrasound is used for regional anaesthetic techniques all over the world. In particular, Third World countries should profit from these techniques because of their cost effectiveness and a nearly 100% predictability of success rates with the avoidance of general anaesthesia for a large number of surgical procedures. In the world of consumer electronics the price for electronic equipment becomes lower and lower, and Austrian telecommunication companies offer internet packages with free laptop computers. Similar trends may be possible for ultrasound equipment, when (maybe 'used') low-cost machines will be sold with needle equipment in a package with education tools.

There is still a lot to do. Regional anaesthesia has a good chance to become a central part in medical treatment. Although it has nothing to do with ultrasound, recent publications show the benefit of regional blocks on long-term outcome following cancer surgery. Hopefully we will have the opportunity to participate in further developments in the future – it is absolutely worthwhile!

Key Learning Points

- Anatomy - to highlight the importance of exact anatomical knowledge and the implementation in the daily clinical practice.
- Safety - to understand the importance of low volume blocks by using appropriate guidance methods and the impact of these techniques on safety.
- Ultrasound technology - to understand basic technical prerequisites of ultrasound equipment and how to adjust this equipment to achieve optimal results.
- Education - to highlight the superior importance of appropriate education as a prerequisite to perform ultrasound guided regional anaesthetic techniques.

Suggested further reading

Ultrasound Guidance for Nerve Blocks: Principles and Practical Implementation, P. Marhofer.
Oxford: Oxford University Press. 160 pages, 120 colour figures (ISBN-10: 0199547564, ISBN-13: 978-0199547562).