Cutting needles versus cutting edge technology

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Editorial

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Lumbar puncture (LP) is a procedure frequently performed by neurologists, emergency medicine physicians and anesthesiologists. A variety of LP needles are available and there are interesting differences in the practise among the different specialty groups, in particular in the choices for type and size of the needle. A recent article in Clinical Neurology and Neurosurgery highlights intervertebral disc injury as a complication of LP [1]. The authors report the results of a study in which lumbar punctures were performed at 50 cadavers. In brief, a needle was inserted in the midline at each level and advanced until a bony resistance was felt. A lateral Xray was then performed to determine the position. If the needle had not entered the spinal canal, it was withdrawn and repositioned. This procedure was repeated until the needle was shown to have entered passed through the spinal canal. In 150 lumbar punctures in 50 cadavers, the needle had penetrated an intervertebral disk 37 times. As mentioned by the authors, in a "real life scenario" the probability of entering the intervertebral disc space is probably lower. Yet, these results are noteworthy because a pre-clinical study has shown that intervertebral disc injury might initiate degenerative processes [2] which could eventually lead to chronic back pain. When the intervertebral joint is punctured during a LP, then the degree of injury will likely be influenced by the force applied, and the nature and diameter of the needle. It is time, surely, to once again re-consider the use of cutting, traumatic LP needles.

LPs have been performed since the first formal descriptions of Quincke and Wynter in 1891 [3]. Although many of their patients died, research continued on animals and humans, and within a few years, in 1898, Bier administered cocaine intrathecally to 6 patients. Although the injections produced successful anesthesia of the legs, the patients suffered severe headaches, and soon after Bier himself underwent an attempted spinal anesthetic. The procedure failed because of incompatibility of the syringe and needle, and was further complicated by leakage of a large amount of cerebrospinal fluid (CSF) resulting in a severe post-dural puncture headache (PDPH) [4]. Within a short time period these and the other main risks of LP such as meningitis, epidural hematoma and neurological injury became apparent. The history of the development of spinal needles since then has been described in detail [5]. The result is that today's clinicians have at their disposal a wide choice of needles, which have been developed to improve the safety of LP. Fig. 1 consists of close-up photographs of the tips of a selection of needles.

Hypodermic needles (Fig. 1) have their orifice in a very sharp tip, making them unsuitable for performing a LP. The bevel is at an acute angle, causing the orifice to have a large circumference with sharp edges. These needles are designed to cut through tissues. Even narrow gauge hypodermic needles can cause neurological injury should they come into contact with nerves or the spinal cord [6]. If such a needle is used for a LP, it will likely cut a hole the diameter of the needle in the dura. Similarly, on entering an intervertebral disc, such a needle would be likely to cause maximum trauma.

A range of LP needles have been developed with a similar design to those used by Quincke in the late 1890's (Fig. 1). They have an orifice in the tip, but the bevel has a less acute angle, and the tip and the edges of the bevel are less sharp than those of a hypodermic needle. They are considered to be "cutting" or "traumatic" needles, although they have been shown to cause irregular dural lacerations [7]. Names used for these needles include Quincke, Green and Hingson [8]. Atraucan needles have an end-orifice and a double-bevelled tip, with a distal sharp angle for dural puncture, and a more obtuse angle proximally for dural dilation. They are sometimes referred to as atraumatic [8], but are essentially also cutting needles [9]. Needles with the Quincke design, or similar, are commonly used in neurology practice for diagnostic LPs and are still referred to as "conventional" spinal needles [10,11].

Spinal needles with a so-called 'pencil-point' blunt tip have been available since the 1950s. They have a side orifice (approximately 1 mm proximal to the tip) with rounded edges (Fig. 1). The conical tip is thought to separate the fibres of the dura, so that when the needle is withdrawn there is less chance of a residual hole, and less chance of CSF leakage. Names of atraumatic needles include Sprotte, Whitacre, and Marx [8].

A large number of studies have investigated the influence of needle choice on the incidence of complications after LP. Atraumatic needle use in anesthesia was already widespread at the start of the third millennium and has become almost universal following the publication of the numerous studies, including those mentioned below. Vallejo and colleagues randomized >1000 patients to spinal anesthesia using one of 5 needles [9]. They showed that PDPHs were significantly more frequent for traumatic (Atraucan, Quincke) versus atraumatic (Gertie Marx, Sprotte, Whitacre) needles, being 5 and 8.7%, versus 4, 2.8 and 3.1% respectively. Moreover, of the patients with PDPH, the proportions requiring epidural blood patch were much higher for the traumatic than for the atraumatic needles (55 and 66%; versus 12.5, 0, and 0% respectively). Similar findings were reported soon afterwards by Choi [12] who found that needle type, but not diameter influence the incidence of PDPH among obstetric patients. They reported the following PDPH incidences: Sprotte 24G 3.5%, Quincke 24G 11.2%; Whitacre 25G 2.2%, Quincke 25G 6.3%; Whitacre 27G 1.7%, Quincke 27G 2.9%.

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Recently, Zorrilla-Vaca et al. published the results of a systematic review and meta-analysis of the results of 57 randomized controlled trials involving 16,416 patients undergoing LP for spinal anesthesia [13]. They found that pencil-point needle use was associated with a significant reduction of PDPH incidence (risk ratio (RR), 0.41; 95% confidence interval (CI) 0.31–0.54; $P < 0.001$), and did so similarly in obstetric and non-obstetric procedures. Furthermore, in a metaregression they found that among cutting needles there was a significant correlation between needle gauge and rate of PDPH. In neurological practice, and in emergency departments, practice has lagged somewhat behind the evidence. In 2000, a special report from the American Academy of Neurology noted that incidence of PDPH was much higher among patients undergoing diagnostic LP than in patients undergoing obstetric and non-obstetric spinal anesthesia [14]. It found that the incidence of PDPH was reduced by smaller needle sizes, orientation of the bevel of cutting needles parallel to the dural fibers, and use of non-cutting needles for spinal anesthesia (they found the evidence of diagnostic LPs inconclusive and recommended further research). The year afterwards, in a survey of 7798 American Academy of Neurology members, Birnbach and colleagues found that only half of the respondents reported having knowledge of pencil point needles, and only 2% frequently used them [15]. The situation among emergency physicians appears to be similar. In a study of the incidence of PDPH among patients undergoing diagnostic LPs in two emergency departments in the USA, only 20 or 22G Quincke needles were used, and the PDPH rates were 30% and 6.1% for the 20G and 22G needles respectively [16].

Despite growing evidence supporting the use of atraumatic needles, Quincke-type cutting needles are still commonly used in neurology practice for diagnostic LPs and are still referred to as "conventional" spinal needles [10]. A Cochrane review found that the use of traumatic needles (for all indications) is associated with a higher risk of PDPH compared to atraumatic needles (36 studies, 9378 participants, RR 2.14, 95% CI 1.72–2.67) [8]. Interestingly, and relevant to the paper by Ertas et al., they found that needle type did not influence the incidence of backache.

The following year (2018) Nath et al., who noted that atraumatic needles had not been widely adopted by neurologists, reported the results of a large systematic review and meta-analysis [10]. Overall they found that whereas the incidence of PDPH was 11.0% (95% CI 9.1–13.3) with conventional needles, it was only 4.2% (3.3–5.2) with atraumatic needles (relative risk 0.40, 95% CI 0.34–0.47, $p < 0.0001$). Similarly, atraumatic needles also reduced the incidence of any headaches, mild headaches, and severe headaches. Moreover atraumatic needle use was found to be associated with a reduced need for intravenous fluid, strong analgesics, and epidural blood patch, while they did not increase the LP failure rate, incidence of traumatic tap, paresthesia, or backache. On the basis of these findings, a BMJ clinical guideline strongly recommended the use of atraumatic needles for all patients undergoing LP [11]. Interestingly too, they noted that although atraumatic needles are more expensive than conventional spinal needles, the evidence suggests that the lower incidence of complications with their use reduces the overall costs of care. Importantly, the "rapid recommendations panel" that produced the guideline included patients, and considered patient-important outcomes. In their infographic, they included the following text about patient preferences and values:

> *"The panel believes patients will put a high value attributed to the large reduction in symptoms that they may suffer following the procedure. Given the lack of harms from atraumatic needles, most patients are likely to choose this option."* [11]

There is currently no evidence that the use of traumatic needles increases the incidence of back pain, but it should be borne in mind that most data come from studies in which back pain was a secondary outcome. On the other hand, there is very strong evidence that traumatic needles increase the incidence of PDPH, and that the wider the gauge of traumatic needle in use, the greater is the chance of PDPH. So, why then, do the majority of anesthesiologists use narrow gauge atraumatic needles, whereas the majority of neurologists continue to use 20 or 22G traumatic needles?

Reasons why neurologists do not change to atraumatic needles include increased costs and increased rates of neurological injury. Other reasons include concerns of usability and familiarity [17]. The blunt tip of a pencil point requires more pressure for it to be advanced through tissues, and this requires adaptations to technique, such as use of an introducer, especially with narrower gauge needles. Interestingly, Engedal et al. found that when their department changed from using 22G cutting needles to 25G atraumatic needles, the incidence of complications declined and so too did the incidence of first attempt failures and the requirement for multiple attempts.

There are fears among neurologists that the use of pencil point needles may increase the time needed for pressure equilibration (when testing lumbar CSF pressure) and for CSF collection. The BMJ practice guideline found that there was insufficient evidence to make a confident recommendation [11]. A recent randomized trial in which a range of

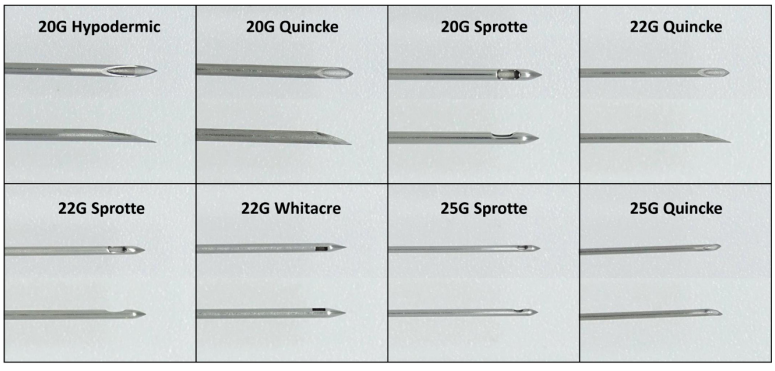

Fig. 1. Tips of different types of lumbar puncture needles. Traumatic needles: Hypodermic and Quincke; atraumatic needles: Sprotte and Whitacre. G: gauge. *Image courtesy of M. Venema-Wierda.*

clinicians (from medical students to experienced physicians) were randomly assigned to use one of three different needles for diagnostic LPs concluded that a 25G atraumatic needle is superior to a 22G atraumatic and a 22G cutting needle in preventing PDPH (incidences were 22.0%, 30.2% and 32.8% respectively) [18]. In each group the mean CSF draw was 17 mL, but draw times with the 25G atraumatic needle were double those of the 22G cutting needle (954 versus 451 seconds - presumably by passive gravity drip). Interestingly the authors make no comment on the latter fact, suggesting that they considered the reduction in PDPH incidence to outweigh the increased draw time.

Consensus guidelines for LP procedures in patients with neurological diseases suggest 25G atraumatic needles are used, but that CSF is not actively aspirated, and if larger volumes of CSF are required, that clinicians use a larger gauge atraumatic needle [19]. We have favorable personal experience of using 25G pencil point needles for aspiration of 10 mL of CSF from almost 500 surgical patients undergoing spinal anesthesia, with mean aspiration times for 10 mL of CSF of 2 minutes, [unpublished data] but further detailed analysis and research is required to verify the safety of aspiration.

In summary, Ertas and colleagues have shown that intervertebral disc puncture is possible during LP, which may be one cause of back pain. While current evidence suggests that the choice of LP needle does not influence the incidence of back pain, logic suggests that if a disc is punctured, traumatic needles will cause more injury that atraumatic needles. The evidence that atraumatic needles significantly reduce the incidence of PDPH is clear, having been shown repeatedly. PDPH is a serious complication with severe implications for patients, and so we challenge our neurological colleagues to invest energy in implementation of a more patient-friendly choice, by using atraumatic needles. If further research is performed it should focus on determination of the optimal gauge of atraumatic needle, to achieve a balance between pressure transduction equilibration rate and CSF flow, and the incidence of PDPH.

Declaration of Competing Interest

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