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Changing the needle for lumbar punctures Results from a prospective study

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ABSTRACT

Objective: Post-dural puncture headache (PDPH) is a common complication of diagnostic lumbar punctures. Both a non-cutting needle design and the use of smaller size needles have been shown to greatly reduce the risk of PDPH. Nevertheless, larger cutting needles are still widely used. This study describes the process of changing the needle in an outpatient clinic of a Danish neurology department.
Methods: Prospective interventional trial. Phase 1: 22 G cutting needle. Phase 2: 25 G non-cutting needle. Practical usability of each needle was recorded during the procedure, while the rate of PDPH and the occurrence of socioeconomic complications were acquired from a standardized questionnaire.
Results: 651 patients scheduled for diagnostic lumbar punctures were screened for participation and 501 patients were included. The response rate was 80% in both phases.

In phase 2, significant reductions were observed in occurrence of PDPH (21 vs 50, $p = 0.001$), number of days spent away from work (55 vs 175, $p < 0.001$), hospitalizations (2 vs 17, $p < 0.001$), and number of bloodpatch treatments (2 vs 10, $p = 0.019$). Furthermore, during the procedure, both the need for multiple attempts (30% vs 44%, $p = 0.001$), and the failure-rate of the first operator (17% vs 29%, $p = 0.005$) were reduced.
Conclusions: Our study showed that smaller, non-cutting needles reduce the incidence of PDPH and are easily implemented in an outpatient clinic. Changing the needle resulted in fewer socioeconomic complications and fewer overall costs, while also reducing procedural difficulty.

1. Introduction

Diagnostic lumbar punctures are frequently implemented in the routine evaluation of patients with neurological symptoms. Indications for the procedure are extensive ranging from suspicion of an inflammatory or infectious disease to evaluation of chronic neurodegenerative disorders. Post-dural puncture headache (PDPH) is a common complication of the test, with younger patients being particularly at risk [1]. Although proven to reduce the occurrence of PDPH, the usage of small, non-cutting needles is still not widespread in neurology departments [2]. In a UK survey, a cutting needle was used in over 70% of neurology units, and only two of 48 units reported using a gauge smaller than 22 G [3]. In a US survey, the use of non-cutting needles was even lower, as only 2% of the responding neurologists reported that they routinely used this type of needle [4]. The reasons given for the continued use of larger cutting needles vary from economical and practical concerns to a lack of up-to-date knowledge [2,4].

According to The International Classification of Headaches (ICHD-II), set out by the International Headache Society, PDPH is a postural headache that arises within 5 days of a dural puncture. The headache is aggravated within 15 min of assuming an erect posture, and improves within 15 min of lying down. Furthermore, at least one of five additional symptoms must be present. These include neck stiffness, tinnitus, hypacusia, photophobia, and nausea [5]. There may also be severe complications following dural puncture and PDPH. In a literature review, Zeidan et al. [6] discovered 46 cases of unilateral or bilateral intracranial subdural hematomas following spinal and epidural anesthesia, of which at least six were mortal. Furthermore, spinal hematomas [7], postpartum seizures [2], coma [8], and cranial nerve palsies [9] have been attributed to dural puncture and PDPH. The incidence of PDPH varies between <1% and 70%, and is dependent on both patient and procedural characteristics [10]. Factors associated with increased risk of PDPH include young age [11–13], low body-mass-index

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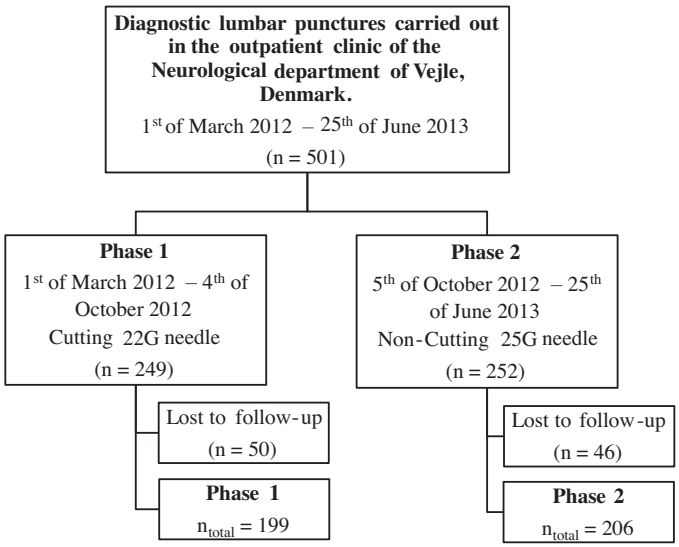

Fig. 1. Study design.

(BMI) [12,14], chronic headache or prior PDPH [11,12], female gender [12], large needle diameter [15,16], and a cutting needle design [10,14–18], PDPH is most likely caused by persistent leakage from a dural defect, which subsequently leads to intracranial hypotension [1]. As a consequence, reduced support of intracranial structures, particularly during an erect position, leads to a downward pull on pain-sensitive structures. This is substantiated by downward displacement of the posterior fossa content, observed in orthostatic headache patients [19,20], and by the rare occurrence of both cranial nerve palsies and subdural hematomas following dural puncture and PDPH [6,9]. Furthermore, intracranial cerebrospinal fluid (CSF) depletion possibly leads to compensatory vasodilation, as predicted by the Monro-Kellie doctrine. Not unlike migraine, this could cause a substantial headache.

Owing to the apparent paradox between the evidence supporting the use of smaller, non-cutting needles, and the widespread use of larger, cutting needles, we performed a prospective, interventional trial to provide greater insight into the feasibility and potential benefits of using a 25 G non-cutting needle, as opposed to the "classical" Quincke cutting 22 G needle, for diagnostic lumbar punctures. We recorded the practical usability of the specific needle, the rate of PDPH, and the occurrence of socioeconomic complications.

2. Methods

The study was approved by the Regional Ethics Committee. We obtained informed consent from all patients. The study took place at the outpatient clinic of the Department of Neurology, Vejle Hospital, Denmark (Fig. 1), and the study population consisted of consecutive patients older than 15 years undergoing scheduled or sub-acute diagnostic lumbar puncture.

Patients evaluated for a novel onset and persisting headache syndrome and/or refusing participation were not included ($n = 150$). We designed the study as a two phase interventional trial, in which we used the traumatic Spinocan 22 G needle in phase 1 and the non-cutting Pencan 25 G needle in phase 2. Phase 1 ran from 1 March 2012 to 4 October 2012, with a sharp cross-over to phase 2, which ended on 25 June 2013. Patients were blinded to both phase and needle type.

The first year residents of the department performed the lumbar punctures, with the opportunity to call on an associate for assistance if necessary. If the department failed to perform the procedure, assistance from the anesthesiology department was acquired. In both phases, the procedure was performed using local anesthesia and the stylet was reinserted before the needle was withdrawn. When using the traumatic needle the bevel was arranged parallel to the spine. An introducer cannula was used in phase 2. Data collected included patient demographics, BMI, headache history, total number of puncture attempts, removed spinal fluid volume, and need for assistance. Following the procedure, the patients were provided with a questionnaire that included information on headache duration and severity, orthostatic components, additional symptoms, influence on activities of daily living and work, and, finally, if any treatment modalities had been used. The questionnaire scored headache as either non-existent, mild or severe. A nurse provided instructions and a stamped and addressed envelope for returns. We defined PDPH as any orthostatic headache accompanied by at least one additional symptom, according to the ICHD-II classification. If the patient experienced severe headache, we likewise classified the PDPH as severe.

We predefined the primary outcome as the relative risk of PDPH and severe PDPH depending on needle type, and calculated this in a multivariate regression model reporting risk-ratios. We categorized exposure variables according to clinical experience and previously published studies, and included these in the model, if univariate analysis showed an effect. We compared baseline demographics and procedural characteristics between phases using a Student's t test for continuous variables, and Fisher's exact test for ratios. We evaluated the practical usability of each needle in a multivariate model reporting risk-ratios of the need for associate and anesthetic assistance. We assessed the number of extra attempts required per patient in a Poisson regression, adjusted for needle type, age, gender, and BMI. We compared number of days spent either away from work or bedridden during each phase using the Wilcoxon rank-sum test, and compared the need for various treatment modalities using Fisher's exact test. We performed data analysis using STATA version 11.0 statistical software.

3. Results

A total of 651 patients underwent lumbar puncture during the study period. Of these, 501 met the inclusion criteria and were included in the study. A total of 96 patients were lost to follow-up (19%); however, these were evenly distributed between phase 1 ($N = 50$) and phase 2 ($N = 46$). A total of 199 and 206 patients completed the study in phases 1 and 2, respectively (Fig. 1). There were no significant differences between groups of patients in the two phases regarding age, gender, BMI, history of headache, prior PDPH, and CSF volume drawn (Table 1). Furthermore, adherence to local anesthetics and stylet reinsertion was even between phases. In phase 1, a parallel cutting axis was used in 97% of lumbar punctures.

A total of 21 patients developed PDPH after lumbar puncture with the non-cutting 25 G needle, vs 50 with the traumatic 22 G needle (10% vs 25%) (Table 2). In a multivariate regression analysis adjusting for age, gender, and BMI, this corresponded to a 50% risk reduction when using the smaller, non-cutting needle (RR 0.50, 95% CI 0.32–0.76, $p = 0.001$). When only including severe PDPH in the model, the risk-ratio decreased and remained statistically significant (RR 0.43, 95% CI 0.26–0.73, $p = 0.002$). The models further showed that age under 50 years, female gender, and BMI under 20 all significantly increased the risk of both PDPH and severe PDPH (Table 3). In univariate analyses, the risk of PDPH was not influenced by a history of chronic headache (RR 1.01, $p = 0.856$), previous PDPH (RR 1.04, $p = 0.477$), or the need for multiple attempts during the procedure (RR 1.06, $p = 0.801$).

After the procedure, a total of 175 days away from work was reported for patients during phase 1, vs only 55 during phase 2