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A PROSPECTIVE RANDOMISED CONTROLLED TRIAL COMPARING TRACHEAL INTUBATION PLUS MANUAL IN-LINE STABILISATION OF THE CERVICAL SPINE USING THE MACINTOSH LARYNGOSCOPE VS THE MACGRATH® SERIES 5 VIDEOLARYNGOSCOPE

Anaesthesia 2014;69:1345-50
Ilyas S, Symons J, Bradley WP, Segal R, Taylor H, Lee K, Balkin M, Bain C, Ng I

Abstract

Purpose The purpose of this study was to compare intubation success with either a Macintosh blade or a McGrath Series 5 Videolaryngoscope in patients with in-line stabilization of the neck.

Background Patients who present with possible neck injuries require in-line stabilization during intubation. This may contribute to difficulty with intubation because of the inability to extend the neck to obtain an optimal glottic view. Some studies have found indirect videolaryngoscopy devices improve both the glottic view and intubation success during in-line stabilization. Other studies have found that these devices may not reduce cervical neck motion and may increase the time to intubation. The McGrath laryngoscope has a marked anterior bend in the blade and this design may reduce the amount of neck extension required during intubation, which may be advantageous in patients with suspected cervical neck injuries. These investigators hypothesized that the McGrath videolaryngoscope would decrease the time to successful intubation by improving the grade view of the larynx compared to a Macintosh laryngoscope.

Methodology This was a prospective, randomized controlled trial comparing time to successful intubation (defined as confirmation of end tidal CO₂) with a McGrath videolaryngoscope or a Macintosh blade in patients undergoing elective surgery with in-line stabilization. Secondary outcomes included the proportion of successful intubations and complications. Patients were excluded if they required an awake fiberoptic intubation, had upper airway pathology, or were at risk for aspiration. All intubations were performed by anesthesia providers with at least 10 years experience who had experience with both devices. (The amount of experience was not quantified). In-line stabilization was performed on all patients by an experienced provider.

Anesthesia was induced with propofol and rocuronium. After confirmation of zero twitches on the train-of-4, intubation proceeded. In the Macintosh group, the McGrath blade was first used to determine the grade of glottic view; then the Macintosh blade was placed and a pre-shaped styletted tracheal tube size 7.0–7.5 for women and 8.0–8.5 for men was placed. In the McGrath group the opposite sequence occurred. The time to successful intubation was defined as the time from placement of the study blade in the mouth until confirmation of end tidal CO₂. During intubation with the study blade, the grade view was recorded.
The incidence of failed intubation, dental or oral trauma, and serious complications were recorded. A one-sided $P < 0.05$ using was considered significant.

Result  
A total of 128 patients completed the study; 64 in each group. Demographic and airway exam results were similar between the two groups. In the Macintosh group 9% of patients were a Mallampati 3 to 4 compared to 13% in the McGrath group ($P = \text{NS}$). All subjects in the McGrath group had either a grade 1 or grade 2 view (92% and 8% respectively). In the Macintosh group 29% of patients had a grade 1 view, 48% a grade 2 view, and 23% a grade 3 view. In 67% of patients in the Macintosh group the McGrath blade showed a better glottic view, and in 20% of these the glottic view improved from a grade 3 view to a grade 1 view.

Despite the better view obtained with the McGrath blade, the time to intubation was approximately 33 seconds longer in the McGrath group ($P = 0.0003$; Figure 1). There were five failed intubations in the McGrath group and none in the Macintosh group (92% vs. 100%, $P = 0.02$). Three failed intubations were due to difficulty passing the endotracheal tube (which required conversion to a Macintosh blade) and two were due to technical failures. In these two cases, the screen on the McGrath blade stopped working which required intubation with the Macintosh blade. The frequency of sore throat (39% vs. 36%), hoarseness (36% vs. 34%), and dental trauma ($n = 1$ in Macintosh group) were similar in the Macintosh and McGrath groups.

Conclusion  
The McGrath laryngoscope improved the glottic view but increased the time to intubation compared to the Macintosh blade in patients who had in-line stabilization during intubation. There was a higher failure rate in the McGrath group due to technical difficulties and difficulty passing the endotracheal tube.

Comment  
I was intrigued when I first read this article because the authors found it took a significantly longer time to intubate with the McGrath blade compared to a Macintosh blade in patients undergoing intubation with in-line stabilization. In a similar study by Taylor\(^1\)
the time to intubation (defined as the time from placement of the blade in the mouth until its removal) was significantly shorter with a Macintosh blade compared to the McGrath blade during in-line stabilization (22 sec vs. 36 sec). However, in this study it took on average almost 33 seconds longer to intubate compared to only 14 seconds in the Taylor study.

This caused me to scratch my head. The authors attributed this to different definitions of intubation success between the two studies (confirmation of end tidal CO$_2$ vs. removal of the blade from the mouth in the Taylor study). I can agree with that to a certain extent; however, when I looked closer at the data in this study what I found was they included the two McGrath intubations with the screen failure in their analysis. Had they excluded these two intubations from their analysis then they would not have found a significant difference in the failed intubation rate between the two groups (95% vs. 100%, P = 0.12). I suspect had these two technical failures been excluded, the difference in the time to intubation would not have been so large (and the standard deviation smaller).

Indirect devices have revolutionized how we approach the difficult airway; however, their main drawback is that the time to intubation can take longer because of difficulty with navigating the tube into the glottis.

On a statistical note, I believe the decision to use a one-sided P as opposed to a two-sided P value for their results was incorrect. Use of a one-sided P value is appropriate when you hypothesize which group will have the larger mean (or proportion) before you collect any data AND if the other group ends up with a larger mean or proportion, that you would attribute the difference to chance and call that difference “not statistically significant.” When I went back and ran the analysis using a two-sided P value with their reported results for intubation success the P = 0.057, which is not significant. Therefore, I think there is a chance the authors may have committed a Type I error, meaning they found a difference when there really was no difference. I agree the McGrath probably took longer to successfully intubate the patients, but not to the degree they found, and the successful intubation rate would have been similar in both groups.

Dennis Spence, PhD, CRNA


The views expressed in this article are those of the author and do not reflect official policy or position of the Department of the Navy, the Department of Defense, the Uniformed Services University of the Health Sciences, or the United States Government.
Intubation biomechanics: laryngoscope force and cervical spine motion during intubation with Macintosh and Airtraq laryngoscopes

Anesthesiology 2014;121:260-71
Hindman BJ, Santoni BG, Puttlitz CM, From RP, Todd MM

Abstract

Purpose The purpose of this study was to compare the amount of force required for intubation and the degree of cervical neck extension between the Macintosh and Airtraq laryngoscopes.

Background Excessive force or motion during intubation of patients with cervical spine instability may increase their risk of spinal cord injury. Unfortunately, the biomechanics of intubation, that is cervical spine motion as a function of applied force, has not been described. Previous investigations of intubation with a Miller blade demonstrated it results in 30% less cervical neck motion and 30% less force compared to a Macintosh blade. This suggests that cervical spine motion may be directly proportional to the amount of force applied.

New indirect video-laryngoscopy devices are purported to provide a better glottic view with less cervical neck motion. Previous investigations have demonstrated the Airtraq laryngoscope resulted in 30% to 50% less cervical neck motion between the occiput and 4th/5th cervical vertebrae. In this study the authors examined the maximal laryngoscope force and cervical spine motion between occiput-C5, comparing the Macintosh and Airtraq laryngoscope blades.

Methodology This was a randomized cross-over study of 14 healthy adults undergoing elective surgery requiring intubation. Inclusion criteria included: Mallampati Class I or II, thyromental distance of ≥6 cm, sternomental distance of ≥12.5 cm, aged 18 years to 90 years, and body mass index (BMI) of ≤30 kg/m². Patients with suspected difficult airway, cervical spine abnormalities, previous cervical spine surgery, coronary artery disease, cerebral vascular disease, reactive airway disease, symptomatic gastroesophageal reflux, blood pressure >180/80, or ASA III or greater were excluded.

Each patient was intubated twice, either with an Airtraq or Macintosh 3 laryngoscope blade. The intubation sequence was randomized. Patients were positioned with a pad under their head to obtain neutral sniffing position. A standardized induction sequence with propofol, lidocaine, fentanyl, rocuronium, and sevoflurane was used for all patients. After confirmation of loss of train-of-four (ratio ≤0.1 mA), the patients were intubated by one of two experienced anesthesia providers based on the predetermined randomization sequence. During each
intubation, laryngoscope force (using a pressure sensor array), cervical spine motion (measured with continuous C-arm fluoroscopy), and glottic view (percent of glottic opening viewed with an Airway Cam) were recorded.

Force and movement were examined in stages. In stage 1 the head was in neutral position, in stage 2 the laryngoscope was introduced into the oropharynx and positioned inferior to the tongue (inferior border of C2 on fluoroscopy), stage 3 was the “best view” of the glottis, and stage 4 was intubation (endotracheal tube advanced 1 cm below vocal cords). Comparisons of total force and the degree of cervical neck extension between the occiput-C5 were made at each stage. Statistical analysis was appropriate.

**Result**

There were N = 14 patients enrolled. There were nine women and five men; 57% were Mallampati I and 43% Mallampati II. The glottic view was significantly better with the Airtraq (percentage of glottic view: 90% ± 10) compared to the Macintosh blade (percentage of glottic view: 74% ± 16%). The relationship between cervical neck extension and total force was nonlinear and was significantly different between the Macintosh and Airtraq laryngoscope blades. During laryngoscope introduction (stage 2) the Airtraq resulted in 25% less occiput-C5 extension but 14% greater force compared to the Macintosh blade (P = NS). However, at stage 3 and 4 the Airtraq resulted in significantly less occiput-C5 extension and total force than the Macintosh blade. At scope placement (stage 3 - best glottic view) the Airtraq resulted in 35% less occiput-C5 motion and 78% less total force compared to the Macintosh blade (P = .0001). At the time of intubation the Airtraq resulted in 35% less occiput-C5 motion and 85% less total force (P = .0001).

Gender differences were found in the total force required to obtain the best glottic view. Men required significantly more force compared to women (52 ± 7.5 vs. 31 ± 12.5 N, P = .0070). There was a positive correlation between body weight and the Macintosh vs. Airtraq force difference at the time of the best glottic view. Patients who weighed more requiring significantly more force to achieve the best glottic view (r = 0.52, P = 0.01).

![Figure 1. Total Force during Laryngoscopy](image)
**Conclusion**  The relationship between Macintosh and Airtraq laryngoscope cervical spine motion and total force was nonlinear and differed between the two devices. The “low-force” video laryngoscope, Airtrac, did not necessarily result in proportionally less cervical spine motion. Overall, however, the Airtraq resulted in less cervical spine motion during laryngoscopy and intubation than the Macintosh blade.

**Comment**

Anytime you intubate a patient with cervical spine instability there is always the potential risk of causing injury. The likelihood of injury is probably related to the degree of instability combined with the force and degree of cervical neck extension. The incidence of worsening neurological deficits after intubation in a patient with an unstable c-spine is not known; however, minimizing cervical neck motion with in-line stabilization and using devices such as the Airtraq that minimize the amount of extension and force needed to intubate the patient probably minimizes the risk. In this study, the authors demonstrated that the Airtraq resulted in 35% less neck extension (a difference of 10 degrees) and 79% less force to intubate healthy volunteers with no cervical neck instability compared to a Macintosh 3 blade. The device also provided a 15% better total view of the glottis compared to the Macintosh blade.

The authors’ main finding was that the relationship between extension and force was nonlinear and differed between the two devices. What the findings demonstrated was that with the Macintosh blade this relationship is fairly linear. If you examine figure 1 you see there appears to be a fairly linear relationship between degree of neck extension and total force between the time of scope placement and the best glottic view. However, with the Airtraq there was still a fair bit of extension, only 10 degrees less than the Macintosh, but significantly much less total force to achieve the best glottic view. How these results apply to a patient with an unstable neck is unclear. I suspect, given the Airtraq requires less extension and force to achieve a good view of the vocal cords, that it would still reduce the risk when compared to a Macintosh blade.

**Dennis Spence, PhD, CRNA**

The views expressed in this article are those of the author and do not reflect official policy or position of the Department of the Navy, the Department of Defense, the Uniformed Services University of the Health Sciences, or the United States Government.
**Supplemental postoperative oxygen does not reduce surgical site infection and major healing-related complications from bariatric surgery in morbidly obese patients: A randomized, blinded trial**

Anesth Analg 2014;119:357-65
Wadhwa A, Kabon B, Fleischmann E, Kurz A, Sessler D

**Abstract**

**Purpose** The purpose of this clinical trial was to test the hypothesis that the risk of major complications related to infection and resulting in delayed healing would be minimized in the morbidly obese undergoing bariatric surgery when 80% supplemental oxygen was administered for 12 to 16 hours postoperatively.

**Background** Postoperative surgical site infections are the most common and serious complications following anesthesia and surgery. Hospital length of stay is typically prolonged, seriously affecting quality of life and massively escalating cost of care. Evidence is conclusive that oxidative killing is the most important human immune defense against typical surgical pathogens. It requires molecular oxygen to be enzymatically altered into what is known as bactericidal superoxide. Subcutaneous tissue oxygen partial pressures <40 mm Hg are associated with increased infection risk. Additionally, adequate tissue oxygenation is necessary for scar formation, an essential step in wound healing. Increasing the fraction of inspired oxygen can increase tissue oxygen tension. Morbidly obese people typically have critically low subcutaneous tissue oxygenation partial pressures and, therefore, are at high risk for postoperative surgical site infections.

The theory tested in this clinical trial was that the morbidly obese would heal better if the duration of supplemental oxygen administration was lengthened to between 12 and 16 hours. It was thought that doing so might increase tissue oxygen tension at the surgical wound.

**Methodology** This study was conducted as a randomized blinded trial at 3 unrelated hospitals: The Cleveland Clinic, The University of Vienna Hospital, and The Norton Hospital in Louisville, Kentucky.

Those having open or laparoscopic Roux-en-Y gastric bypass procedures were consented and randomized into one of two groups:

- **Group 1** - Routine postoperative Oxygen
- **Group 2** - Supplemental postoperative Oxygen

All patients had a standardized general anesthetic that included 80% FIO2 intraoperatively and dosing of anesthetic drugs and intravenous fluids to maintain hemodynamic stability. Subjects in the Routine Oxygen group were extubated and given 2 L/min nasal cannula oxygen until the first postoperative morning. Nasal cannula oxygen produced an FIO2 of 24% to 30% oxygen. If subjects were on CPAP at home prior to surgery and could not maintain their oxygen saturation >90% on nasal cannula oxygen, they were placed on CPAP with 30% oxygen. If
prolonged intubation occurred (any who remained intubated after leaving the operating suite), oxygen was also administered at 30% via the endotracheal tube. Additional oxygen was administered to any subject who could not maintain a saturation >90%.

Supplemental Oxygen subjects were extubated and given 10 L/min of oxygen via a non-rebreathing mask. This produced an approximate F\textsubscript{1}O\textsubscript{2} of 80%. If patients in this group could not maintain an oxygen saturation >90% on the 10 L/min flow of oxygen and they used CPAP at home, they were placed on CPAP at an inspired oxygen concentration of 80%. The F\textsubscript{1}O\textsubscript{2} was administered at 80% to anyone in this group that did not meet safe extubation criteria. Nursing staff was blinded to the oxygen flowmeters and instructed not to change the oxygen settings until the morning of the first postoperative day unless clinically necessary.

Demographic characteristics of both groups, preoperative laboratory values, fluid therapy, blood loss, urine output and opioid use, pain measurements using an analogue scale, and postoperative blood glucose values were recorded. A baseline infection risk was determined and quantified using the National Nosocomial Infection Surveillance System process. Evaluation for signs of surgical site infection or impaired wound healing began on postoperative day 2 by a blinded investigator with no previous patient contact. Surgical wounds were considered infected if they met 1992 CDC criteria, and wound healing and infections were additionally numerically scored using the ASEPSIS system. Patients were discharged from the hospital according to usual protocol. Surveillance for wound infection continued up to 60 days after surgery. The plan was to recruit 638 subjects in each group in order to identify a 25% reduction in the incidence of infection and healing complications between groups.

**Results**

A total of 400 subjects from three sites were enrolled and included in the final analysis, 198 in the Routine Oxygen group and 202 in the Supplemental Oxygen group. Following the first planned interim analysis, the study was closed to further recruitment due to concerns of futility of the intervention and difficulty in recruitment. Following is a summary of relevant demographics:

- **Surgical technique** - 91% of the surgeries were performed laparoscopically
- **Demographic characteristics**
  - No difference between groups in perioperative glucose concentrations, intraoperative crystalloids and opioids, and median duration of surgery
- **Antibiotic administration**
  - Group 1 (30% oxygen post-op) - 8% received antibiotics >1 hr before incision, 78% within 1 hr of incision, 14% after incision
  - Group 2 (80% oxygen post-op) - 23% received antibiotics >1 hr before incision, 72% within 1 hr, 5% after incision

Surgical wound infection was the most commonly observed complication, present in 8.5% of the total sample (Figure 1). Additionally, there was no difference in wound healing or wound infections between groups or hospitals. BMI did not appear to influence complications between groups, nor did an open versus laparoscopic technique.
Conclusion  The hypothesis was not supported. Neither statistically nor clinically significant differences were found in the risk of surgical site infections or associated complications in 400 patients undergoing bariatric surgery followed by an extended period of time receiving 80% FiO$_2$.

Comment
There is a profound physiologic response of oxidative killing. Numerous factors are known to influence tissue oxygen tension including body temperature, tobacco use, anemia, fluid management, and poorly managed pain. Understanding this, and understanding the higher risk of wound infections and healing-related complications in the morbidly obese due in part to low tissue oxygenation, I was still surprised that the hypothesis was not supported in this study. Part of my surprise was due to the components of care that were well controlled in this study: temperature, fluid administration, and postoperative pain. My own theory was that an increased FiO$_2$ might overcome the low tissue oxygen tension known to impede wound healing. That theory also was not supported.

Bariatric surgery and resultant weight loss may have more benefits in improving overall health status than we originally thought. I give a great deal of credit to the investigators in attempting to discover methods to minimize postoperative infections in this surgical population at high risk for wound infections.

Mary Golinski, PhD, CRNA

National Nosocomial Infection Surveillance System – is an ongoing collaborative surveillance system sponsored by the Centers For Disease Control (CDC) to obtain national information specific to nosocomial infections. For further information on the surveillance system see: Am J Infect Control. 1991;19:19-35 - National nosocomial infections surveillance system (NNIS): description of surveillance methods
Sleep disordered breathing in a high-risk cohort: prevalence and severity across pregnancy

Am J Perinatal 2014;31:899-904
Facco F, Ouyang DW, Zee PC, Grobman WA

Abstract

Purpose The purpose of this study was to determine the prevalence of sleep disordered breathing (SDB) among a group of parturients at high risk for adverse pregnancy outcomes associated with SDB. The authors also wanted to determine the incidence of new-onset sleep disordered breathing in this high-risk cohort in late pregnancy.

Background The physiologic changes of pregnancy have been reported to worsen sleep disordered breathing symptoms. It has been speculated that the prevalence of sleep disordered breathing increases during the course of pregnancy, with the increase being partially explained by weight gain and upper airway edema. Sleep disordered breathing during pregnancy has also been associated with an increased risk of preeclampsia, gestational hypertension, gestational diabetes, and preterm birth. Unfortunately, most studies examining sleep disordered breathing during pregnancy have been retrospective or cross-sectional. This study sought to examine the prevalence and trends in sleep disordered breathing in parturients at high risk for hypertensive disorders of pregnancy, preterm birth, and gestational hypertension.

Methodology This was a prospective, observational cohort study that followed a group of parturients at high risk for development of adverse outcomes associated with sleep disordered breathing (i.e., hypertensive disorders of pregnancy, iatrogenic preterm birth, and gestational hypertension).

Inclusion criteria were any of the following:

- self-reported BMI ≥30 kg/m²
- chronic hypertension
- pregestational diabetes (type 1 or 2)
- history of prior preeclampsia
- twin gestation

Parturients were asked to complete an in-home sleep study between 6 and 20 weeks gestation (early pregnancy) and again at sometime between 28 and 37 weeks (late pregnancy). Sleep disordered breathing was defined as an Apnea Hypopnea index ≥5 (AHI; apnea/hypopnea events/hour). Groups were categorized based on the severity of their apnea/hypopnea:

- mild (AHI ≥5-14.9)
- moderate (AHI ≥15-29.9)
- severe (AHI ≥30)

New-onset sleep disordered breathing was defined as an increase in the AHI ≥5 in late pregnancy.

Investigators examined the frequency of “new-onset,” “no-change,” “improved,” or “worsened” Obstructive Sleep Apnea based upon changes in the AHI. In
addition to the AHI, the investigators also examined changes in the respiratory disturbance index and oxygen desaturation index (average number of oxygen desaturations of ≥4% per hour). Sample size calculations and statistical analysis were appropriate.

**Result**  A total of 188 parturients completed a sleep study in early pregnancy, and 128 completed the follow-up sleep study in late pregnancy. The average age of participants was 33 ± 6 years and the prepregnancy BMI was 33 ± 9 kg/m². Overall, 62% were obese (BMI ≥30 kg/m²), 30% had a history of chronic hypertension, 58% gestational diabetes, 6% twins, 29% were nulliparous, and 17% had a prior history of preeclampsia.

In this high-risk cohort the prevalence of Obstructive Sleep Apnea (AHI ≥5) was 30% in early pregnancy. This increased to 47% in late pregnancy (P <0.001; Figure 1). A majority of the cases were mild sleep disordered breathing. Most parturients (70%) had no change in sleep disordered breathing severity across pregnancy, while 3% improved, and 27% (n = 34) worsened. Twenty-six (n = 26) of 34 parturients developed new-onset sleep disordered breathing in late pregnancy. The overall incidence of new-onset sleep disordered breathing in pregnancy was 20%, with most cases being mild (n = 24). One parturient developed moderate sleep disordered breathing and another severe sleep disordered breathing. Significant increases in the respiratory disturbance index, AHI, and oxygen desaturation index were seen in late pregnancy (P <0.002; Figure 2).

**Conclusion**  Sleep disordered breathing was common during pregnancy and appeared to worsen over the course of pregnancy. Approximately 20% of high-risk parturients developed sleep disordered

![Figure 1. Sleep Disordered Breathing Severity Across Pregnancy](image)

**Note:** SDB = Sleep Disordered Breathing. AHI = Apnea Hypopnea Index. Early Pregnancy = 6 to 20 weeks gestation; Late Pregnancy = 28 to 37 weeks gestation.
breathing by the third trimester, with the majority being mild cases.

**Comment**

The prevalence rate of diagnosed Obstructive Sleep Apnea in pregnant women is very low, 7 per 10,000 pregnancy-related discharges.\(^1\) However, few studies have examined trends in sleep disordered breathing during pregnancy. In this study the investigators found, not surprisingly, that the prevalence rate and severity of sleep disordered breathing increased in late pregnancy. The real question is, what do we do with these results? Do these sleep disordered breathing symptoms persist after pregnancy? Does having sleep disordered breathing during pregnancy increase the women's risk of developing sleep disordered breathing later in life?

Currently, there are no well-done, randomized controlled trials examining the effects of interventions such as CPAP treatment on maternal or infant outcomes and health care costs in parturients who develop sleep disordered breathing during pregnancy. It would be challenging to conduct such a study given the small number of parturients with moderate to severe sleep disordered breathing, which would be the population that may benefit the most from treatment.

However, a study of this same sample\(^2\) found significantly higher rates of gestational diabetes in parturients in early pregnancy with mild (43%) and moderate/severe (63%) sleep disordered breathing compared to those without sleep disordered breathing (27%). This makes me wonder if treatment of even mild sleep disordered breathing cases would decrease gestational diabetes rates.

So how do these results apply to anesthesia providers? Well, I would have a high index of suspicion for sleep disordered breathing in parturients that are at high risk for pregnancy-related complications such as BMI $\geq 30$ kg/m\(^2\), chronic hypertension, pregestational diabetes (type 1 or 2), history of prior preeclampsia, and/or twin gestation. If I suspect the patient has moderate or severe sleep disordered breathing and they require general anesthesia I might consider closer observation postoperatively (i.e, continuous pulse oximetry or end tidal carbon dioxide) and minimize or reduce the opioid dosing, both parental and neuraxial.

**Dennis Spence, PhD, CRNA**
Sleep Disordered Breathing is a group of disorders of abnormal respiratory patterns (apneas and hypopneas) or abnormal gas exchange (hypoxemia) during sleep. Sleep disordered breathing ranges from mild snoring, with or without daytime sleepiness, to mild or severe Obstructive Sleep Apnea (OSA) with or without associated symptoms such as daytime somnolence. Obstructive Sleep Apnea is characterized by chronic, frequent obstruction of the airway during sleep that is associated with frequent oxygen desaturations and nocturnal arousals.

American Academy of Sleep Medicine criteria for a clinical diagnosis of Obstructive Sleep Apnea requires a sleep study (polysomnography) confirmation of an AHI \(\geq 15\) with or without symptoms or an AHI \(\geq 5\) with symptoms of daytime somnolence.

Another common measure reported on sleep studies is the RDI, or respiratory disturbance index, which is the average number of apneas, hypopneas, and respiratory-effort related arousals. These arousals are characterized by increasing respiratory effort for 10 seconds or more leading to a arousal from sleep that do not technically meet the definition of an apnea or hypopnea. The RDI uses the same cutoffs for severity as the AHI.

The Centers for Medicare and Medicaid pays for Obstructive Sleep Apnea treatment with continuous positive airway pressure therapy with an AHI or RDI \(\geq 15\) with or without symptoms or an AHI or RDI \(\geq 5-14\) with symptoms (daytime somnolence, fatigue, insomnia, mood disorders, and cognitive impairment, or cardiovascular comorbid conditions such as hypertension, coronary artery disease, or prior stroke).

The views expressed in this article are those of the author and do not reflect official policy or position of the Department of the Navy, the Department of Defense, the Uniformed Services University of the Health Sciences, or the United States Government.
LOWER INCIDENCE OF POST-DURAL PUNCTURE HEADACHE WITH SPINAL CATHETERIZATION AFTER ACCIDENTAL DURAL PUNCTURE IN OBSTETRIC PATIENTS

Acta Anaesthesiol Scand 2014;58:1233-1239
Verstraete S, Walters MA, Devroe S, Rooftooff E, Van De Velde M

Abstract

Purpose  The purpose of this study was to determine if insertion of an intrathecal catheter after Accidental Dural Puncture reduced the incidence of post-dural puncture headache (PDPH) and epidural blood patch in obstetric patients compared to replacing the epidural catheter.

Background  The incidence of Accidental Dural Puncture in obstetric patients during epidural placement ranges from 0.19% to 6.6%. When Accidental Dural Puncture occurs, between 50% and 70% of patients will develop a PDPH. When an Accidental Dural Puncture occurs, the anesthesia provider has two options: re-site the epidural at a different interspace or advance the epidural catheter into the subarachnoid space and use it as a spinal catheter. A recent meta-analysis found a trend towards a lower risk of PDPH with placement of an intrathecal catheter, but this finding was not statistically significant. However, this same meta-analysis did find that placement of an intrathecal catheter reduced the likelihood of needing an epidural blood patch (RR = 0.64, P = .001).

Methodology  This was a retrospective review of 29,749 regional blocks at a single institution in Belgium between January 1, 1997 and July 31, 2013. All patients underwent combined spinal epidural (CSE), epidural, or spinal anesthesia for labor pain relief, cesarean delivery, or in-utero surgery. All neuraxial procedures were performed by a 4th or 5th year anesthesia resident or staff anesthesia provider using an 18-gauge Tuohy and a 20-gauge soft tip epidural catheter (B. Braun, Melsungen, Germany). For CSE anesthesia either a 27-gauge or 29-gauge spinal needle was used up to the year 2000, after which only 27-gauge needles were used.

At the study hospital, when an Accidental Dural Puncture occurred prior to 2002 (CSF flow from the needle or CSF aspirated from the catheter) the epidural was re-sited at another interspace. After 2002 institutional guidelines recommended placement of an intrathecal catheter. The intrathecal catheter was inserted 4 cm into the spinal canal and labor analgesia was provided with ropivacaine 0.175% with sufentanil 0.75 µg/mL at a rate of 1 mL/hr with a patient-controlled bolus of 0.5-1.0 mL every 30 minutes as needed. After delivery, the intrathecal catheter was left in for a minimum of 24 hours and 0.9% saline was infused at 2 mL/hr.

Patients who developed a PDPH received conservative management for 24 hours; bed rest, oral hydration, intravenous acetaminophen with or without
ibuprofen, and intravenous hydration. (A PDPH was defined as a headache that developed within five days after a neuraxial procedure, which worsened with sitting or standing and improved within 15 minutes after lying down.) If symptoms did not improve within 24 hours, patients were offered an epidural blood patch. All patients remained in the hospital for four or five days after delivery. The authors used multivariable logistic regression to determine the odds of experiencing a PDPH or need for an epidural blood patch, while controlling for neuraxial technique, age, body mass index, indication, diagnosis of the leak via Tuohy or catheter, and mode of delivery.

**Result** Over a 16 year period there were 128 recognized Accidental Dural Punctures out of 29,669 neuraxial procedures performed. The Accidental Dural Puncture rate was 0.43%. Of those who experienced an Accidental Dural Puncture, 69.5% had a spinal catheter placed and 30.5% had an epidural re-sited at a different interspace. A majority of the Accidental Dural Punctures were identified during epidural needle placement (82%). Of the 128 Accidental Dural Punctures, 98 occurred during labor, 25 during cesarean delivery, 4 for fetal surgery, and 1 during regional anesthesia for uterine artery embolization. Out of the 128 Accidental Dural Punctures, 61 (48%) developed a PDPH (Figure 1).

The rate of Post-Dural Puncture Headache was reduced in patients who had an intrathecal catheter compared to those who simply had their epidural catheter reinserted at a different interspace (42% vs. 62%, OR = 2.3, P = 0.04). There was a trend toward decreased need for an epidural blood patch in the intrathecal catheter group; however, this difference

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**Figure 1. Outcomes After Accidental Dural Puncture**

<table>
<thead>
<tr>
<th>Attempted Epidural with Accidental Dural Puncture (n = 128)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Epidural Replaced (n = 39)</strong></td>
</tr>
<tr>
<td>Post Dural Puncture Headache 62% (n=24)</td>
</tr>
<tr>
<td>No Post Dural Puncture Headache 38% (n=15)</td>
</tr>
<tr>
<td><strong>Used as Spinal Catheter (n = 89)</strong></td>
</tr>
<tr>
<td>Post Dural Puncture Headache 42% (n=37)</td>
</tr>
<tr>
<td>No Post Dural Puncture Headache 58% (n=52)</td>
</tr>
<tr>
<td><strong>Epidural Blood Patch</strong></td>
</tr>
<tr>
<td>Epidural Blood Patch 87.5% (n=21)</td>
</tr>
<tr>
<td>No Epidural Blood Patch 12.5% (n=3)</td>
</tr>
<tr>
<td><strong>Epidural Blood Patch</strong></td>
</tr>
<tr>
<td>Epidural Blood Patch 86% (n=32)</td>
</tr>
<tr>
<td>No Epidural Blood Patch 14% (n=5)</td>
</tr>
</tbody>
</table>

**Note:** Over a 16 year period there were 128 recognized Accidental Dural Punctures out of 29,669 neuraxial procedures performed (Accidental Dural Puncture rate = 0.43%).
was not statistically significant (36% vs. 54%, OR = 2.1). Most interestingly, 71% (15/21) of the patients in the epidural group who developed a PDPH required a second blood patch compared to only 16% (5/32) in the intrathecal catheter group (P = 0.01). None of the potential confounding variables were found to be predictive of PDPH development.

**Conclusion**

Insertion of an intrathecal catheter with a continuous infusion of normal saline at 2 mL/hr for 24 hours after a recognized Accidental Dural Puncture reduced the incidence of PDPH. It also reduced the need for a second blood patch to relieve a persistent headache.

**Comment**

One of the most challenging dilemmas in obstetric anesthesia is what to do when you get a wet tap (Accidental Dural Puncture) during epidural placement. Some providers will always re-site the epidural at a different interspace, while others will place an intrathecal catheter. I must admit, I am not a fan of placing an intrathecal catheter, especially on a busy labor deck with multiple anesthesia providers. However, if the epidural was very difficult, say in a morbidly obese parturient, I might consider placing an intrathecal catheter. My concern during a crash cesarean delivery is a dosing error resulting in an excessively high sensory level. At my institution we always label the catheter as being intrathecal and make sure all providers and nurses are aware.

The authors of this study reported that placing an intrathecal catheter reduced the chance of developing a PDPH. In fact, they found a decrease in the rate of PDPH of almost one third in patients who had an intrathecal catheter placed (down from 62% to 42%). There were several limitations of this study. A major limitation is the study was retrospective and prone to selection bias. Since the majority of patients received an intrathecal catheter, I wonder if that biased the anesthesia provider as to their management when the patient reported a PDPH. We also do not know anything about the severity or associated symptoms with the PDPH. Even though they attempted to statistically control for the delivery mode (vaginal or cesarean), I believe the study would have been strengthened if they had only examined the outcomes of patients who had a vaginal delivery because pushing during the second stage of labor may increase the risk of the patient developing a PDPH. Finally, the authors’ conclusions are not entirely accurate. In fact, when they included several confounding variables, no difference in the odds of PDPH was seen. At best these results are hypothesis generating.

So how can you take these results and apply them to your practice? The most important first step would be to develop a departmental guideline for the anesthesia and nursing staff. I think this is critical to ensuring all staff are on the same page as to how to manage an Accidental Dural Puncture when a provider decides to place an intrathecal catheter. I would make sure the catheter is labeled clearly, and if you decide to leave the catheter in after delivery, I would recommend tying a knot in the catheter and taping the end so no one would inadvertently inject a
medication into the catheter. Finally, if you have to bolus the intrathecal catheter, I would dose it slowly. If the patient is in labor I would only bolus with 1-2 mL at a time of the epidural solution (e.g., 0.125% bupivacaine with fentanyl 2 µg/mL). If the patient requires a cesarean delivery, I would use 0.75% hyperbaric bupivacaine and probably bolus with only a quarter of the usual dose for a surgical block at a time until I achieved an adequate level and follow it with 1-2 mL of saline.

**Dennis Spence, PhD, CRNA**

The views expressed in this article are those of the author and do not reflect official policy or position of the Department of the Navy, the Department of Defense, the Uniformed Services University of the Health Sciences, or the United States Government.
ADDUCTOR CANAL BLOCK VERSUS FEMORAL NERVE BLOCK FOR TOTAL KNEE ARTHROPLASTY: A PROSPECTIVE, RANDOMIZED, CONTROLLED TRIAL

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Abstract

Purpose The purpose of the study was to determine if an adductor canal block would cause less quadriceps weakness while providing pain relief that was at least as good as a femoral nerve block at 6 to 8 hours post total knee arthroplasty.

Background Adequate pain relief is an important aspect of recovery from total knee arthroplasty. Regional anesthesia plays an important role in any postoperative analgesic regimen for this procedure. Specifically, the femoral nerve block is a proven method of decreasing postoperative pain and reducing hospital length of stay after total knee arthroplasty. While effective, the femoral nerve block is associated with motor block resulting in an increased risk of falls and decreased ability to participate actively in post-procedure physical therapy.

The adductor canal block has been proposed as an alternative to the femoral nerve block because anatomic studies have revealed that the adductor canal contains many nerves which innervate the knee joint including the saphenous nerve, vastus medialis nerve, medial femoral cutaneous nerve, as well as the medial retinacular nerve. Blocking these sensory nerves could provide adequate pain control without the motor involvement associated with femoral nerve block.

Methodology This was a prospective, randomized controlled trial of 93 ASA I-III patients undergoing total knee arthroplasty. Patients were randomized to receive either an adductor canal block or a femoral nerve block as one component of a multimodal analgesic regimen.

Preoperatively, demographic data and medical history were collected on all participants. Quadriceps strength of both legs was assessed using a dynamometer. Sensory function along the saphenous distribution was assessed and recorded. The anesthesia provider performing the block was aware of the treatment; however, the data collector was unaware of a patient’s group assignment.

In the adductor canal block group, 15 mL of 0.5% bupivacaaine with 5 μg/mL epinephrine was injected mid-thigh under ultrasound guidance. In the femoral nerve block group 30 mL of 0.25% bupivacaine with 5 μg/mL epinephrine was injected with ultrasound guidance.

Intraoperatively patients received a combined spinal epidural with propofol sedation. The spinal was
initiated with 2.5 mL of 0.5% bupivacaine and the epidural was bolused with 2% lidocaine as needed. The epidural was continued postoperatively. All patients received PCEA with 10 μg/mL hydromorphone and 0.06% bupivacaine for postoperative days (POD) 0 to 2. Initial settings were 4 mL/h with a 4 mL demand bolus every 10 minutes, maximum 20 mL/h. At 7 a.m. the following day (POD 1), the continuous infusion was lowered to 2 mL/h, and at 5 p.m. on POD 1 the continuous infusion was set to 0. At noon on POD 2, the epidural was discontinued. Oral postoperative pain medications were standardized as well.

Quadriceps strength was assessed in both legs, along with pain scores and opioid consumption at 6 to 8, 24, and 48 hours after anesthesia. Motor strength, pain scores, and opioid consumption were compared. If motor strength in the adductor canal block group was 3 kg less than the femoral block group, if mean adductor canal block pain scores were 1.6 points higher, or if opioid consumption was 50% greater in the adductor canal group, then the adductor canal block was considered to be inferior to the femoral nerve block. Sample size calculation was based on detecting a 50% difference in quadriceps motor strength at 6-8 hours between the two groups.

**Results**

There were 94 patients enrolled in the study; 46 patients received an adductor canal block and 47 patients received a femoral nerve block. Four patients had failed blocks. The success rate for the adductor canal block was 94%, and femoral nerve block success was 98%. Baseline demographics were similar.

When comparing Numeric Rating Scale pain scores, opioid use, and dynamometer readings, the adductor canal block was at least as good as the femoral nerve block. This meant the adductor canal block group did not increase muscle weakness and did not have higher pain scores or opioid consumption than the femoral block group.

At 6 to 8 hours postop the mean strength during extension of the knee was significantly higher in the adductor canal block group than in the femoral nerve block group.

**Figure 1. Median Quadriceps Strength Over Time**

![Figure 1. Median Quadriceps Strength Over Time](image)

**Note:** Femoral Nerve Block group had significantly less quadriceps strength at 6-8 h (P < 0.05).
block group (P < 0.05; Figure 1). However, by the 24
to 48 hour assessment, muscle strength was similar in
both the adductor canal block group and the femoral
nerve block group. Pain scores and opioid
consumption at all time points were similar in both
groups. No patients fell; however, three patients in the
femoral nerve block group had their knee buckle due
to quadriceps weakness on POD 1.

Conclusion  The adductor canal block was a
useful alternative to the femoral nerve block for
patients undergoing total knee arthroplasty. The
adductor canal block produced less motor block of
the quadriceps muscles resulting in increased motor
strength. The adductor canal block was at least as
effective as the femoral nerve block when comparing
pain scores and opioid consumption.

Comment  This study is unique in that the
authors evaluated quadriceps muscle strength using a
dynamometer, providing clear evidence that patients
in this study experienced improved motor strength
after an adductor canal block compared to patients
who received a femoral nerve block in the early
postoperative period. In my opinion, this data coupled
with the evidence supporting that the adductor canal
block is at least as good as the femoral nerve block
establishes a compelling argument for the use of the
adductor canal block for postoperative pain control
after a total knee arthroplasty. This is important in
today’s climate of early participation in postoperative
physical therapy after total knee arthroplasty. It is
quite common for patients to ambulate after this
procedure on the day of surgery. In my practice
patients who undergo total knee arthroplasty in the
morning are expected to participate in afternoon
physical therapy. Physical therapists often struggle
with patients who do not have quadriceps strength
within the first eight hours after surgery. Although
none of the patients in this study experienced a fall,
the investigators noted that patients who had a
femoral nerve block were more likely to experience
buckling of the knee, which is a precursor to a fall in
the unassisted patient. While both of these peripheral
nerve blocks are relatively easy to administer, the
femoral nerve block can be administered without
ultrasound guidance, while the adductor canal block
requires ultrasound to visualize relative anatomic
structures. This may be a limiting factor for
practitioners who are not familiar with or do not have
access to ultrasound equipment.

I have used the adductor canal block in my practice
and conclude it provides adequate pain relief in this
population. I have observed that most patients
experience mild to moderate pain when receiving
either block alone in the early postoperative period. In
patients receiving a femoral nerve block in
conjunction with a sciatic nerve block I have observed
better pain scores; however, patients receiving a sciatic
nerve block are unable to ambulate early after surgery.
The adductor canal block is a simple peripheral nerve
block to administer and should be considered as an
alternative to the femoral nerve block in patients
undergoing total knee arthroplasty with the
expectation of ambulation on the day of surgery.

Riley Williams, DNP, CRNA

For further information on placement of the adductor
canal block, the website http://www.neuraxiom.com/
html/addcan.html is an excellent resource.