



REVIEW ARTICLE

Changing Trends in the Management of Accidental Dural Puncture during Labor Epidural Analgesia: A Narrative Review and Recent Updates

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Abstract

Inadvertent or accidental dural puncture while attempting epidural for labor analgesia is a known anaesthetist complication with potential for post dural puncture headache, increased morbidity, prolonged hospitalisation and overall medical cost. Historically, following accidental dural puncture- resitation of the epidural catheter at another level was the norm. Over the last 2-3 decades, there is a paradigm shift in the management of dural puncture while attempting epidural. Recent publications and literature suggest placing the epidural catheter in to the subarachnoid space to make it an intrathecal catheter. Converting epidural to intrathecal not only ensure the need for another epidural attempt as it can provide rapidly good quality of analgesia that can be swiftly converted into surgical anaesthesia, but it also have a role in prevention of post dural puncture headache. Although intrathecal catheter after accidental dural puncture is rapidly gaining popularity, there are no recommendations from international consensus for managing the intrathecal catheters and, therefore, wide variation in clinical practice exists. Improper or mismanagement of intrathecal catheter can leads to serious complications like total spinal, high block, hypotension, medication errors, fetal distress. Intrathecal catheter must be carefully use with strict adherence to sterility and aseptic technique, meticulous labeling and documentation, cautious administration of medications and good communication to the patients and other staffs. The article highlights on the recognition of dural puncture and available options for accidental dural puncture, clinical management of intrathecal catheter for labor analgesia and cesarean section anaesthesia, prevention of post dural puncture headache after intrathecal catheters. The article also stressed on the prevention of other potential complications that may be associated with improper and unprotocolised management of intrathecal catheter.

Keywords

Epidural analgesia, Dural puncture, Intrathecal catheter, Post dural puncture headache, Labor analgesia

Introduction

Neuraxial analgesia in the form of an epidural or combined spinal epidural is the most common and popular technique used to control pain associated with labor and vaginal delivery. Neuraxial analgesia has many advantages but also carry some inherent risk associated with it. Among these complications, inadvertent or unintended dural puncture (UDP) while attempting epidural analgesia for labor pain is not uncommon with the potential for a high incidence of post-dural puncture headache (PDPH). The exact incidence of dural puncture is difficult to ascertain as many cases are not reported or even not detected, as per the published report incidence varies from 0.4-6% of epidurals [1,2]. Dural puncture with an epidural needle result in a very high incidence (64-88%) of PDPH, especially in the obstetric population [2-4]. The incidence varies depending on the size of the epidural needle a 16G touhy needle incidence may be as high as 88% as compared to 64% with 18 G touhy needle [5]. While in the majority of cases, it is easily recognized by either the obvious free flow of Cerebral Spinal Fluid (CSF) through the epidural needle or free aspiration of CSF after catheter placement, the dural puncture may be unrecognised in 11-33% at the time of insertion [6-10]. Given the high incidence of

PDPH after UDP, especially in the obstetric population contributes to significant maternal morbidity, and prolonged hospital stay and can also affect the mother's ability to care for her newborn.

This article is intended to address the preventable part of UDP and strategies and management options after UDP to reduce the PDPH and management of PDPH emphasizing on the recent guideline and recommendations. This includes-

- Prevention of unintended dural tap (UDP)
- Recognizing UDP
- Management of labour analgesia after UDP
- Prevention of PDPH
- Patient information and follow up
- Management of PDPH

Prevention of Inadvertent or Unintended Dural Puncture

The risk factors for UDP are unclear. Apart from the experience of the anaesthesiologist performing the epidural, other risk factors are not consistently proven to be independent factors for UDP. The relationship between UDP and maternal obesity, advanced age, lateral versus sitting position, and use of saline versus air is not shown to be consistent. A recent retrospective study from a single center involving 46668 epidurals identified women with a greater degree of cervical dilatation at the time of epidural placement are at greater risk of UDP since these women will be in the advanced stage of labor with frequent painful contractions making patient co-operation without undue movement with the procedure more difficult [11]. Moreover, the demand from the mother and spouse for immediate relief from the labor pain put additional stress on the anaesthetist performing the epidural. Another study has found patient movement and repeated epidural trials as risk factors for UDP [12], repeated trial of epidural is more frequent in difficult epidural placements [12]. Factors associated with difficult epidural placement are difficult palpation of interspinous space, spine deformity, and inability to flex the back [13]. Obesity is a major contributing factor to difficult epidural due to either failure to identify landmarks or deeper epidural space [14-17].

Except for the experience of the anaesthetist and patient cooperation, there is no other identifiable or preventable risk factor other than the anatomical issue that is consistently associated with increased UDP. For an inexperienced anaesthetist early call for help for a difficult epidural or involvement of an experienced anaesthetist for patients with greater cervical dilatation or uncooperative or patients with a low threshold for pain who may not be able to lie or sit still for the epidural placement may reduce the risk of UDP.

Recognizing UDP

In most cases, the recognition of UDP is straightforward as evidenced by the free flow of warm Cerebrospinal fluid (CSF) in the epidural needle hub, but it may not be so obvious in up to 11%-33% of UDP [10] making it difficult to identify at the time of placement of the catheter. It may be recognised by either aspiration of CSF, in doubtful cases, the aspirate fluid can be analysed by a urine dipstick analyser or glucometer for the presence of sugar and protein. Another way of recognising the intrathecal catheter is the absence of a meniscus sign or failure of the siphon test as epidural space is considered negative pressure to give a positive siphoned test. These tests may not be accurate all the time, and an intrathecal catheter may not be recognized until the first bolus of local anaesthetist manifesting as rapid onset of analgesia with a profound sensory motor blockade, hypotension, breathlessness or loss of consciousness, the diagnosis of UDP may not have obvious manifestation and its detection may be delayed until the patient presentation of typical PDPH [9]. Rapid onset of dense motor block is extremely rare after normal labour epidural bolus; a rapid dense motor block must be promptly reviewed by an experienced anaesthetist to exclude an intrathecal catheter.

Management of unintended dural puncture

The management options after UDP are limited but there is substantial variation in the management among anaesthesia providers. Every institution should have a written policy and guideline on the management of UDP. In the United Kingdom (UK), 85% of its obstetric unit has written guidelines or protocol on the management of UDP, whereas in the United States (US) it is only 13.6% [18]. The management options depend on the timing of recognition of UDP, if it is recognised before insertion of the catheter there are either of the two options- the catheter can be inserted intrathecally, or the epidural needle can be removed and the epidural catheter re-sited at a different level [18-22]. If another dural puncture occurs while attempting 2nd epidural- the catheter can be used as an intrathecal catheter, if the intrathecal catheter is unable to thread the catheter intrathecally, abandoned the procedure and alternative options of labour analgesia should be offered.

Intrathecal catheter

Since the first report by Cohen S, et al. in 1989 on the successful uses of intrathecal catheters for neuraxial analgesia after accidental dural puncture [23], this approach has become increasingly popular over the last two decades and is preferred by the majority of obstetric anaesthesiologist in the United Kingdom [19,24]. Intrathecal catheter provides two distinct advantages over the epidural first rapid and reliable analgesia that can easily and quickly deepen the block for caesarean delivery, 2nd is avoidance of another attempt of epidural

and risk of repeat dural puncture [25]. Several studies claim that intrathecal catheter after accidental dural puncture reduces both the incidence and severity of PDPH, however, the evidence is conflicting as most data come from retrospective studies and proper well design randomised clinical trials are lacking [8,19,25,26,27-32]. There are some drawbacks and potential risks of intrathecal catheters such as accidental medication error, risk of infection or injury to the spinal cord or nerve roots [33-37]. There is only one randomised prospective trial comparing the use of the intrathecal catheter versus repeat epidural after an accidental dural tap by Russell, et al. but the study was halted prematurely as the repeat epidural group had higher complications. A significant number of patients (14 out of 58) required multiple epidural attempts (more than 2) and 6 out of 58 women had a second dural tap while attempting an epidural, whereas the majority of the intrathecal women group had any complication [19].

Management of the intrathecal catheters

Consideration should be given to work culture and staff training and competency to manage the intrathecal catheter and its complications, this is particularly relevant at odd hours when anaesthetist and other supporting staffs may not be radially available for any unforeseen event. Unlike the epidural catheter, the intrathecal catheter should not be threaded more than 3 cm into the subarachnoid space. If catheter cannot pass beyond the touhy needle tip, the needle should be withdrawn slightly while continue flow of CSF to be confirmed before attempting reinsertion of the catheter, if still unable to reinsert the catheter of and patient experience pain or parasthesia, then it is better to remove the touhy needle and epidural re-attempted at another level.

Clear identification and labelling that the catheter is in intrathecal space and avoid inadvertent epidural dosing. Once the catheter is passed into subarachnoid space, it should be clearly label in the catheter tubing, connection and syringe pump with bold letter as intrathecal catheter and all the staffs caring the patients should be aware of the intrathecal catheter. Patient should be informed about the intrathecal placement of the catheter as well clear documentation in the medical record to be done, all medications to be administered by anaesthetist only [32].

Use of test dose to confirm the placement of intrathecal catheter is so far not recommended as standard test dose may cause significant sensory motor and haemodynamic changes, whereas, the use of lower test dose is controversial and often questionable [18,38].

Management of labor analgesia

Regarding the optimal intrathecal drug dosing, so far,

no prospective trial has been conducted on continuous spinal analgesia. Most of the studies are retrospective and focused mainly on the managements of accidental dural puncture with the intrathecal catheters compared to repeat epidural catheters [11,18,26-32,38-40]. In most of these analgesia was established with a lower dose local anaesthetist (bupivacaine 1.25-5 mg or ropivacaine 1.75-10 mg) combined with either fentanyl 12.5-25 mcg or sufentanil 2-7.5 mc; and maintained commonly with continuous infusion of low concentration local anaesthetist with opioid either bupivacaine 0.04-0.1% or ropivacaine 0.1-0.2% with either fentanyl 2-2.5 mcg/ml or sufentanil 0.75-1.0 mcg/ml at a rate of 1-3 ml per hour [11,18,26-32,39], whereas, only few studies has used intermittent bolus or patient controlled analgesia [29,34,41]. Some authors suggest to use 10% of the epidural dose for both intrathecal bolus and continuous infusion [41].

Practical tips: All drugs that are use through the intrathecal catheter should be given through the epidural filter using small syringes to ensure accurate dosing, the dead space of the epidural filter which is approximately 1 ml should be flush with 1-2 ml of normal saline after each dosing. If analgesia is inadequate after 10 minutes, further dose can be administer. Multi dose vial or ampules should not be used, each time, fresh vial or ampules to be taken, the remaining drug to be discarded after each use. Alternatively, all top up and bolus dosages can be given through a syringe pump instead of manual injection to avoid frequent disconnection - re-connection for drug dosing and also endure accurate dosing smaller size syringes are more reliable over the larger one. For inadequate analgesia or lower than T10 level, patchy or asymmetrical analgesia can be managed with either bolus top or change in patient position. Inability to aspirate clear CSF doesnot roll out the intrathecal catheter placement, intrathecal dose can be administer and asses for analgesia, if pain relief do not occur, probably the catheter may be no-longer in the intrathecal space, it is better to replace a catheter with unclear location.

Anaesthesia for caesarean delivery

Surgical anaesthesia can be quickly established through the intrathecal catheter in a titratable manner, an initial bolus of 1 ml of hyperbaric bupivacaine with either fentanyl 12.5-25 mcg or sufentanil 2.5-5 mcg, a subsequent dose of 0.5-1 ml can be administered to a total of 2.5 ml till desire block height is achieved [18,42]. Tachyphylaxis may develop after prolonged labor and a larger dose than normal may require especially in the later stage of labor [25,42]. Despite the relative ease of conversion into surgical anaesthesia, two studies have reported a significantly high failure rate to convert to caesarean section anaesthesia requiring either intravenous supplementation or conversion to general anaesthesia [43,44]. Once the surgical anaesthesia is

achieved long-acting opioid diamorphine 300 mcg or preservative-free morphine 10 mcg can be given to prolong the postoperative analgesia. When the catheter is not behaving as an intrathecal catheter and the desired response is not achieved, it is better to remove the catheter and attempt single-shot spinal anaesthesia. The intrathecal catheter if used for surgical anaesthesia, should not be used for postop analgesia but should be clearly labelled and covered with sterile drapes and should not remove for at least 24 hrs after its placement as this may prevent PDPH or its severity.

Summary of intrathecal dosing and medications for labour analgesia and cesarean section anaesthesia.

Initial bolus dosin	Bupivacaine	Bupivacaine 0.25% 0.5-1 ml (1.25-2.5 mg) + fentanyl 10-25 µg or sufentanil 2.5-5 mcg
	Ropivacaine	Ropivacaine 0.2%- 0.5-1.2 ml (1-2.4 mg) + fentanyl 10-25 µg or sufentanil 2.5-5 mcg
Maintenance of analgesia – continuous infusion	Bupivacaine (1-3 ml per hour)	Bupivacaine 0.05-0.125% + fentanyl 2-5 µg/ml or sufentanil 1-2 µg/ml
	Ropivacaine (1-3 ml per hour)	ropivacaine 0.1-0.2% + fentanyl 2-5 µg/ml or sufentanil 1-2 µg/ml
Patient controlled analgesia (PCA)	Basal rate 1-2 ml per hour, bolus dose 1 ml, lockout interval 15-30 min	Bupivacaine 0.05-0.125% or ropivacaine 0.1-0.2%+ fentanyl 2-5 µg/ ml or sufentanil 1-2 µg/ml
Manual intermittent top up	0.5-2 ml as bolus	Bupivacaine 0.125-0.25% or ropivacaine 0.2-0.375% + fentanyl 2-5 µg/ ml or sufentanil 1-2 µg/ml
Cesarean section anaesthesia	Initial	Bupivacaine plain or hyperbaric 0.5%, 1 ml (5 mg) initial dose, and then titrate to desired level with additional 0.5 ml (2.5 mg) boluses or Bupivacaine 0.75% hyperbaric 0.5 ml (3.75 mg) initial dose, and then titrate to desired level with additional 0.3 ml boluses
	Additive	fentanyl 12.5-25 mcg or sufentanil 2.5-5 mcg or morphine 0.05-0.3 mg
	Subsequent dose	Bolus bupivacaine (0.5-1 ml) to maintain desired anaesthetic level and patient comfort

Epidural re-site

Repeat attempt of epidural after a dural puncture was a common practice before 2-3 decades. More and more anaesthetists are comfortable in managing the intrathecal catheter, over a period, there is a paradigm shift in the management of accidental dural tap. Many anaesthetist still prefer to attempt another epidural after accidental dural tap. The main reason behind the epidural placement is unfamiliarity of the anaesthetist and nursing issue with the management of intrathecal catheter and to avoid the risk of medication error and other potential complications of the intrathecal catheters such as infection and neural trauma [33-37,45]. It is reasonable to put the epidural at another level if the unit has no given protocol or guideline for the management of the intrathecal catheters as it is easy to manage labour analgesia with more commonly used technique of epidural analgesia over intrathecal analgesia specially in patients expected to be in labour for many hours (eg epidural attempted at very early stage of labor and got UDP) [44,45].

If the decision to reattempt the epidural again after UDP, it should be done by an experienced anaesthetist and if another dural puncture occur, the catheter should be used as intrathecal or if unable to thread the catheter into the subarachoid space, the procedure to be abandon and alternative method of analgesia like patient-controlled analgesia (PCA) with remifentanil should be consider. Once the epidural is re sited, epidural drug dose should be used cautiously as the epidural dose requirement reduces after dural puncture.

Prophylaxis epidural blood patch (PEBP) through the epidural catheter for PDPH is an option. However, the works of literature do not uniformly support its routine use to reduce the incidence and severity of PDPH. PEBP has not been proven to reduce the incidence of PDPH. However, it may reduce the duration and severity of PDPH symptoms [46,47].

Regarding the quality of analgesia between intrathecal and epidural, most of the studies have similar analgesia

except for one retrospective study where they reported better analgesia with the intrathecal catheter than with women managed with epidural resiting [18], two studies have in-fact reported inadequate or failed analgesia following intrathecal placement of the epidural catheter [29,44].

Preventive strategy of post dural puncture headache (PDPH) after accidental dural tap

Placing the epidural catheter through the dural hole after the accidental dural puncture may reduce the risk of PDPH over that associated with a dural puncture with an epidural needle. The pathophysiology of PDPH is still partially understood. The most accepted concept of persistent leakage of CSF causes intracranial hypotension which leads to low-pressure postural headache. However, the severity of headache has not been correlated with the rate of CSF leak, theoretically, the CSF leakage can be reduced by leaving a catheter longer through the dural hole which intern induced inflammatory response and pericatheter oedema that leads to a reduction in the dural hole and CSF leakage [19,25-27,45,48].

Although many studies claimed the use of intrathecal catheter as prophylaxis against PDPH as it may reduce both the incidence and severity of PDPH and the need for an epidural blood patch, a recent meta-analysis of 13 studies totalling 1653 patients found the relative risk of PDPH 0.82 (0.71-0.95) and need for EBP 0.62 (0.49-0.79) with 95% CI after conversion to the intrathecal catheter as compared to epidural catheter re-siting. However, the trial sequential analysis revealed insufficient evidence to draw a definitively solid conclusion [18]. Another recent study however demonstrated a significantly lower incidence of PDPH (21.7 Vs. 67.3%) and need for EBP (12.4 Vs. 50.0%) when the catheter was threaded into subarachnoid space as compared with epidural catheters siting after accidental dural tap [19].

Cohen, et al. suggested leaving the intrathecal catheter for more than 24 hrs as a preventive measure to reduce PDPH [49], it has been supported by two more studies [31,40] in terms of reduction of incidence of PDPH but not for the requirement of epidural blood patch, but other studies failed to demonstrate a reduction in the incidence of PDPH [26,31]. Based on current evidence, keeping the intrathecal catheter for more than 24 hrs after an accidental dural puncture has the potential to reduce both the incidence and severity of PDPH and the need for EBP [19,20,26,27,40].

Intrathecal/epidural narcotic has also been tried as a prophylaxis for PDPH after UDP after a few case reports published the benefit of epidural morphine for both prophylaxis and treatment of PDPH [50-55]. One randomized trial has shown a significant reduction in PDPH after two dosages of epidural morphine 3 mg, the first dose given immediately after delivery of the baby

and the next dose 24 hrs after delivery [53]. However, other prospective studies and meta-analyses found no difference in the incidence or severity of PDPH with either epidural or intrathecal morphine.

Intrathecal saline and PDPH

The injection of saline through the intrathecal catheter to reduce the risk of PDPH is a matter of debate. Theoretically, injection of saline through an intrathecal catheter may restore the CSF volume and thereby mitigate the effect of intracranial hypotension and eventually the reduction in PDPH [18,38,56,57]. Charsley and Abram observed that immediate injection of 10 mL intrathecal normal saline after a wet tap significantly reduced the incidence of PDPH and the need for EBP. When an intrathecal catheter had been placed following a wet tap, an injection of 10 mL of normal saline before its removal effectively prevented PDPH [56]. Another study on intrathecal saline before single-shot spinal anaesthesia by Nasrin Faridi, et al. demonstrated that administration of normal saline (5 ml) before intrathecal administration of hyperbaric bupivacaine significantly prevented PDPH in patients undergoing elective caesarean delivery under spinal anaesthesia [58]. Kuczkowski, et al. in a small case series involving 7 patients with an accidental dural puncture and all threaded with the intrathecal catheter and received intrathecal saline, none of the patients reported PDPH [57]. Based on the available pieces of literature, administration of intrathecal saline both at the time of dural puncture and especially at the time of removal may have an important role as a preventive option PDPH, however, the evidence for this effect is not strong and dosage, timing and mode (single vs. continuous dose) of administration have not been established [25].

Medication errors

Human error is a potential risk for medication errors as there is the possibility of confusion and the intrathecal catheter may be mistaken as an epidural and a large volume of the drug may be injected intrathecally, this is a serious concern and the main reason behind avoiding the intrathecal placement of catheters [59]. There are reports of high spinal blocks due to accidental injection of epidural dose into the intrathecal catheter [43]. Among all the medications error, accidental administration of tranexamic acid is of particular concern as it is a drug of look-alike medication and is commonly used in an obstetric unit. There are many fatal and near-fatal case reports of accidental injection of tranexamic acid into intrathecal space either through a spinal needle or intrathecal catheters [60-63]. As a preventive measure for a medication error in addition to proper labelling of the intrathecal catheter and writing a note in the patient record; it is very essential and important to inform the midwife/nurses as well as the laboring mother; in proper

detail handover at each shift change, and allowing only anaesthetists to administer medications through the intrathecal catheter [32].

Infection prevention

The presence of intrathecal catheter inherently carry a risk of iatrogenic infection, there are reports of meningitis after the use of intrathecal catheters full aseptic and sterility be maintained till the intrathecal catheter remains *in situ*, the particular concern should be given to prevent any contamination of medications, syringes and tubing [64]. Multi-dose vial or use of the same syringe multiple times is to be strictly avoided, and all medication is to be drawn preferably through a filter needle and to be injected through the filter that comes with the catheter. All medications that need to be given should be freshly prepared if an intermittent top-up regime is used or alternately intermittent bolus dosing to be given through the syringe pump itself to avoid frequent disconnection of the catheter unit. If the catheter remains in place in the post-partum period in an attempt to lower the risk of PDPH or the need for saline injection- the catheter may be knotted, this will prevent both accidental injections of medication as well as the risk of infection [65]. For patients receiving additional medication like intrathecal morphine the catheter should be properly capped and carefully secured to prevent inadvertent CSF leak and risk of bacterial contamination.

Other concern and complications

Serious neurological complications like meningitis, neurological injury, tinnitus, and persistent CSF leak-causing CSF- cutaneous fistula [38,64-67], have been reported following intrathecal catheters. None of the case reports or studies has reported an increased incidence of meningitis, epidural or spinal abscess, hematoma, arachnoiditis or neurological injury like cauda equina syndrome [25].

Protocol and guideline

Although intrathecal catheter after an inadvertent dural puncture is widely accepted and is rapidly gaining popularity, however, it carries a potential for serious complications, especially in units where there is no clear guideline and protocol regarding the management of intrathecal catheters. Every institution should make its protocol and policy based on the labour room staffing and anaesthesia coverage (in-house or on-call coverage). All staff involved in the labor analgesia and delivery should be trained and educated and be able to understand the difference between intrathecal and epidural catheters [24]. Guidelines should clarify and specify the labelling of intrathecal catheters, medications for intrathecal use, management of complications like high or total spinal and duration of catheter insertion. Routine use of intrathecal catheters without proper education and

training of the anaesthetist, midwife and labour nurses and a clear institutional protocol is not encouraged.

Summary and Suggestion/Recommendation

We have provided the factors linked with accidental dural puncture and techniques for detection of dural puncture and options after the accidental dural puncture of which intrathecal placement of the epidural catheter is favoured as it has some clear advantages over the repeat attempt of another epidural.

An intrathecal catheter can provide fast and reliable analgesia which can be swiftly converted into cesarean section anaesthesia if the need arises for urgent or emergent delivery of the baby.

To get the maximum benefit with the minimal risk we suggest the following protocol after an accidental dural puncture

1. When a clear dural tap occurs while attempting epidural- the first thing to do is to put the stylet into the needle and think for a while, consider threading the epidural catheter to make it an intrathecal catheter, skin to intrathecal space should be noted in the needle and catheter should not be placed beyond 3 cm into the intrathecal space to avoid high block and possible neural trauma.
2. Following epidural catheterisation- aspirate should be done preferably with a smaller syringe and any clear fluid that is aspirated should be tested for the presence of glucose to confirm the fluid as CSF and treat the catheter as intrathecal.
3. When the catheter is intrathecal (wet tap, easy aspirate of clear CSF)- no test dose is recommended, for a catheter of uncertain location - a test dose with low dose local anaesthetist with or without adrenaline should be used to rule out intrathecal placement.
4. An unusual and rapid block after epidural bolus should be suspected as intrathecal placement/migration of epidural catheter. Rapid onset dense motor block is extremely rare after normal labor epidural bolus, and it should be promptly reviewed by an anaesthetist to exclude an intrathecal catheter.
5. Intrathecal analgesia- should be initiated with a lower concentration of local anaesthetist with lipophilic opioid either as a bolus followed by continuous infusion with or without patient-controlled boluses or manual on-demand top-up. Bolus doses and manual 'top-ups' should always be given by a person trained to manage both spinal and epidural analgesia.
6. All patients with the intrathecal catheter are to be monitored as patients with epidural

analgesia, apart from the normal haemodynamic monitoring no other extra monitoring is required for intrathecal catheters. However, all the staff caring for the patients should be aware of intrathecal analgesia and be able to detect high spinal.

7. Patients requiring cesarean delivery after intrathecal catheter- small local anaesthetic (0.5-1 ml) with or without opioids with gradual titration to the level of Thoracic 4-6 with proper monitoring and resuscitation equipment to deal with total or high spinal should be done.
8. Since an intrathecal catheter carries the potential of serious complications such as high spinal block or toxic drug administration, risk of infection- complete sterility to be maintained, clear labelling and proper documentation is mandatory; precautions should be taken to avoid cerebrospinal fluid leakage. During structured handover, the presence of an intrathecal catheter should be notified to all staff members. When the catheter is not in use it should be properly capped or knotted to prevent accidental injection.
9. As part of the prevention of PDPH after an accidental dural tap- if the epidural catheter is threaded and used as an intrathecal catheter, it should be left in place for at least 24 hrs, and sterile saline may be injected through the intrathecal catheter either as a continuous infusion or bolus injection before removal of the catheter. However, the evidence is not strong enough and no clear dose, timing and mode (bolus Vs. continuous infusion) of administration have been established.
10. Every institution should make its clear institutional guidelines and protocol based on the resources and manpower coverage. All staff involved in the labor analgesia and delivery should be trained and educated and be able to understand the difference between intrathecal and epidural catheters.

Conclusion

Intrathecal catheter placement after an accidental dural puncture is a safe and reliable technique manages labor pain which can be easily converted into surgical anaesthesia if the need arises. However, strict adherence to institutional protocol and good communication is essential to avoid any potential complications.

References

1. Jadon A, Chakraborty S, Sinha N, Agrawal R (2009) Intrathecal catheterization by epidural catheter: Management of accidental dural puncture and prophylaxis of PDPH. *Indian J Anaesth* 53: 30-34.
2. Kang XH, Bao FP, Xiong XX, Li M, Jin TT, et al. (2014) Major complications of epidural anesthesia: A prospective study of 5083 cases at a single hospital. *Acta Anaesthesiol Scand* 58: 858-866.
3. Banks S, Paech M, Gurrin L (2001) An audit of epidural blood patch after accidental dural puncture with a Tuohy needle in obstetric patients. *Int J Obstet Anesth* 10: 172-176.
4. Sprigge JS, Harper SJ (2008) Accidental dural puncture and post dural puncture headache in obstetric anaesthesia: presentation and management: A 23-year survey in a district general hospital. *Anaesthesia* 63: 36-43.
5. Sadashivaiah J, McLure H (2009) 18-G Tuohy needle can reduce the incidence of severe post dural puncture headache. *Anaesthesia* 64: 1379-1380.
6. Gleeson CM, Reynolds F (1998) Accidental dural puncture rates in UK obstetric practice. *Int J Obstet Anesth* 7: 242-246.
7. Van de Velde M, Schepers R, Berends N, Vandermeersch E, De Buck F (2008) Ten years of experience with accidental dural puncture and post-dural puncture headache in a tertiary obstetric anaesthesia department. *Int J Obstet Anesth* 17: 329-335.
8. Costa AC, Satalich JR, Al-Bizri E, Shodhan S, Romeiser JL, et al. (2019) A ten-year retrospective study of post-dural puncture headache in 32,655 obstetric patients. *Can J Anaesth* 66: 1464-1471.
9. Paech M, Banks S, Gurrin L (2001) An audit of accidental dural puncture during epidural insertion of a Tuohy needle in obstetric patients. *Int J Obstet Anesth* 10: 162-167.
10. Eley V A, Abeyapala W, Kelley A, Kumta N, Chin A (2022) Recognized and unrecognized dural punctures in 12,981 labor epidurals: an audit of management. *J Anesth* 36: 399-404.
11. Orbach-Zinger S, Ashwal E, Hazan L, Bracco D, Ioscovich A, et al. (2016) Risk factors for unintended dural puncture in obstetric patients: A retrospective cohort study. *Anesth Analg* 123: 972-976.
12. Michaan N, Lotan M, Galiner M, Amzalag A, Many A (2016) Risk factors for accidental dural puncture during epidural anesthesia for laboring women. *J Maternal-Fetal & Neonatal Medicine* 29: 2845-2847.
13. Guglielminotti J, Mentré F, Bedairia E, Montravers P, Longrois D (2013) Development and evaluation of a score to predict difficult epidural placement during labor. *Reg Anesth Pain Med* 38: 233-238.
14. Eley VA, van Zundert A, Callaway L (2015) What is the failure rate in extending labor analgesia in patients with a body mass index ≥ 40 kg/m² compared with patients with a body mass index < 30 kg/m²? A retrospective pilot study. *BMC Anesthesiology* 15: 115.
15. Hollister N, Todd C, Ball S, Thorp Jones D, Coghill J (2012) Minimizing the risk of accidental dural puncture with epidural analgesia for labor: A retrospective review of risk factors. *Int J Obstet Anesth* 21: 236-241.
16. Kula AO, Riess ML, Ellinas EH (2017) Increasing body mass index predicts increasing difficulty, failure rate, and time to discovery of failure of epidural anesthesia in laboring patients. *J Clin Anesth* 37: 154-158.
17. Uyl N, de Jonge E, Uyl-de Groot C, van der Marel C, Duvekot J (2019) Difficult epidural placement in obese and non-obese pregnant women: A systematic review and meta-analysis. *Int J Obstet Anesth* 40: 52-61.

18. Izquierdo M, Xiao-Feng Wang, Wagner K III, Prada C, Torres A, et al. (2019) Preliminary findings and outcomes associated with the use of a continuous spinal protocol for labor pain relief following accidental dural puncture. *Reg Anesth Pain Med* 44: 1098-1103.
19. Heesen M, Hilber N, Rijs K, Van der Marel C, Rossaint R, et al. (2020) Intrathecal catheterization after observed accidental dural puncture in laboring women: Update of a meta-analysis and a trial-sequential analysis. *Int J Obstet Anesth* 41: 71-82.
20. Apfel C, Saxena A, Cakmakkaya O, Gaiser R, George E, et al. (2010) Prevention of postdural puncture headache after accidental dural puncture: A quantitative systematic review. *Br J Anaesth* 105: 255-263.
21. Newman MJ, Cyna AM, Middleton P (2018) Epidural catheter replacement and intrathecal catheter techniques for preventing post-dural puncture headache following an inadvertent dural puncture in labor. *Cochrane Database of Syst Rev* 2018: CD008266.
22. Sng BL, Sia ATH (2017) Maintenance of epidural labor analgesia: The old, the new and the future. *Best Practice and Research: Clin Anesth* 31: 15-22.
23. Cohen S, Daitch JS, Goldiner PL (1989) An alternative method for management of accidental dural puncture for labor and delivery. *Anesthesiology* 70: 164-165.
24. Ramaswamy KK, Burumdayal A, Bhardwaj M, Russell R (2013) A UK survey of the management of intrathecal catheters. *Int J Obstet Anesth* 22: 257-259.
25. Orbach Zinger S, Jadon A, Lucas DN, Sia AT, Tsen LC, et al. (2021) Intrathecal catheter use after accidental dural puncture in obstetric patients: literature review and clinical management recommendations. *Anaesthesia* 76: 1111-1121.
26. Russel I F (2012) A prospective controlled study of continuous spinal analgesia versus repeat epidural analgesia after accidental dural puncture. *Int J Obstet Anesth* 21: 7-16.
27. Norris MC, Leighton BL (1990) Continuous spinal anesthesia after unintentional dural puncture in parturients. *Regional Anesthesia* 15: 285-287.
28. Bolden N, Gebre E (2016) Accidental dural puncture management: 10-year experience at an academic tertiary care center. *Reg Anesth Pain Med* 41: 169-174.
29. Rutter SV, Shields F, Broadbent CR, Popat M, Russell R (2001) Management of accidental dural puncture in labor with intrathecal catheters: An analysis of 10 years' experience. *Int J Obstet Anesth* 10: 177-181.
30. Ayad S, Demian Y, Narouze SN, Tetzlaff JE (2003) Subarachnoid catheter placement after wet tap for analgesia in labor: Influence on the risk of headache in obstetric patients. *Reg Anesth Pain Med* 28: 512-515.
31. Kaddoum R, Motlani F, Kaddoum RN, Srirajakalidindi A, Gupta D, et al. (2014) Accidental dural puncture, postdural puncture headache, intrathecal catheters, and epidural blood patch: Revisiting the old nemesis. *J Anesth* 28: 628-630.
32. Jagannathan DK, Arriaga AF, Elterman KG, Kodali BS, Robinson JN, et al. (2016) Effect of neuraxial technique after inadvertent dural puncture on obstetric outcomes and anesthetic complications. *Int J Obstet Anesth* 25: 23-29.
33. Tien M, Peacher DF, Franz AM, Jia SY, Habib AS (2016) Failure rate and complications associated with the use of spinal catheters for the management of inadvertent dural puncture in the parturient: A retrospective comparison with re-sited epidural catheters. *Curr Med Res Opin* 32: 841-846.
34. Deng J, Wang L, Zhang Y, Chang X, Ma X (2017) Insertion of an intrathecal catheter in parturients reduces the risk of post-dural puncture headache: A retrospective study and meta-analysis. *PLoS One* 12: e0180504.
35. Moaveni D (2020) Management of intrathecal catheters in the obstetric patient. *BJA Education* 20: 216-219.
36. Reynolds F (2005) Infection as a complication of neuraxial blockade. *Int J Obstet Anesth* 14: 183-188.
37. Shields N, Innes E, Goodman J (2019) A rare complication of accidental dural puncture during epidural insertion for labor analgesia. *Anaesth Reports* 7: 18-21.
38. Hoesni S, Bhinder R, Tan T, Hughes N, Carey M (2010) Herpes simplex meningitis after accidental dural puncture during epidural analgesia for labor. *Int J Obstet Anesth* 19: 466-467.
39. Lenart MJ, Carness JM (2016) Cerebrospinal fluid-cutaneous fistula after continuous spinal catheter in an obstetric patient. *A A Case Reports* 7: 103-107.
40. Cohen S, Stricker P, Sakr A (2005) Cerebrospinal fluid leak after disconnection of an intrathecal catheter adapter placed after accidental dural puncture. *Reg Anesth Pain Med* 30: 591.
41. Rana K, Jenkins S, Rana M (2018) Insertion of an intrathecal catheter following a recognised accidental dural puncture reduces the need for an epidural blood patch in parturients: An Australian retrospective study. *Int J Obstet Anesth* 36: 11-16.
42. Verstraete S, Walters MA, Devroe S, Roofthoof E, Van de Velde M (2014) Lower incidence of post-dural puncture headache with spinal catheterization after accidental dural puncture in obstetric patients. *Acta Anaesthesiol Scand* 58: 1233-1239.
43. Gurlit S, Reinhardt S, Mollmann M (2004) Continuous spinal analgesia or opioid- added continuous epidural analgesia for postoperative pain control after hip replacement. *Eur J Anaesthesiol* 21: 708-714.
44. Viscomi CM, Rathmell JP, Pace NL (1998) Duration of intrathecal analgesia: Early versus advanced labor. *Anesth Analg* 86: 219-220.
45. Cohn J, Moaveni D, Sznol J, Ranasinghe J (2016) Complications of 761 short-term intrathecal macrocatheters in obstetric patients: A retrospective review of cases over a 12-year period. *Int J Obstet Anesth* 25: 30-36.
46. Agerson A N, Scavone BM (2012) Prophylactic epidural blood patch after unintentional dural puncture for the prevention of postdural puncture headache in parturients. *Anesth Analg* 115: 133-136.
47. Stein MH, Cohen S, Mohiuddin MA, Dombrovskiy V, Lowenwirt I (2014) Prophylactic vs therapeutic blood patch for obstetric patients with accidental dural puncture-a randomised controlled trial. *Anaesthesia* 69: 320-326.
48. Harrington BE (2004) Postdural puncture headache and the development of the epidural blood patch. *Reg Anesth Pain Med* 29: 136-163.
49. Cohen S, Amar D, Pantuck EJ, Singer N, Divon M (1994) Decreased incidence of headache after accidental dural puncture in cesarean delivery patients receiving continuous postoperative intrathecal analgesia. *Acta Anaesthesiol Scand* 38: 716-718.

50. Thangathurai D, Bowles HF, Allen HW, Mikhail MS (1998) Epidural morphine and headache secondary to dural puncture. *Anaesthesia* 43: 519.
51. Boskovski N, Lewinski A (1982) Epidural morphine for the prevention of headache following dural puncture. *Anaesthesia* 37: 217-218.
52. Eldor J, Guedj P, Cotev S (1990) Epidural morphine injections for the treatment of postspinal headache. *Can J Anaesth* 37: 710-711.
53. Al-metwalli R (2008) Epidural morphine injections for prevention of post dural puncture headache. *Anaesthesia* 63: 847-850.
54. Brinser ME, Seng DL, Mandell GL, Waters J, Dalby PL, et al. (2019) Neuraxial morphine after unintentional dural puncture is not associated with reduced post-dural puncture headache in obstetric patients. *J Clin Anesth* 52: 58-62.
55. Peralta FM, Wong CA, Higgins N, Toledo P, Jones MJ, et al. (2020) Prophylactic intrathecal morphine and prevention of post-dural puncture headache: A randomized double-blind trial. *Anesthesiology* 132: 1045-1052.
56. Charsley MM, Abram SE (2001) The injection of intrathecal normal saline reduces the severity of postdural puncture headache. *Reg Anesth Pain Med* 26: 301-305.
57. Kuczkowski KM, Benumof JL (2003) Decrease in the incidence of post-dural puncture headache: Maintaining CSF volume. *Acta Anaesthesiol Scand* 47: 98-100.
58. Faridi Tazeh Kand N, Eslami B, Ghorbany Marzony S, Abolhassani R, et al. (2014) Injection of intrathecal normal saline in decreasing postdural puncture headache. *J Anesth* 28: 206-209.
59. Newman MJ, Cyna AM (2008) Immediate management of inadvertent dural puncture during insertion of a labor epidural: a survey of Australian obstetric anaesthetists. *Anaesthesia and Intensive Care* 36: 96-101.
60. Patel S, Robertson B, McConachie I (2019) Catastrophic drug errors involving tranexamic acid administered during spinal anaesthesia. *Anaesthesia* 74: 904-914.
61. Sing E, Singh S, Singh S (2022) Inadvertent Therapeutic Error Involving Spinal Anesthesia during Cesarean Section: A Case Report. A Case Report. *J South Asian Feder Obst Gynae* 14: 323-324.
62. Veisi F, Salami B, Mohseni G (2010) Accidental intrathecal injection of tranexamic acid in cesarean section: A fatal medication error. *APSF Newsletter Spring* 25.
63. Patel S, Loveridge R (2015) Obstetrical neuraxial drug administration errors: A quantitative and qualitative analytical review. *Anesth Analg* 121: 1570-1577.
64. Cohen S, Hunter CW, Sakr A, Hijazi RH (2006) Meningitis following intrathecal catheter placement after accidental dural puncture. *Int J Obstet Anesth* 15: 172.
65. Tao W, Nguyen AP, Ogunnaike BO, Craig MG (2011) Use of a 23-gauge continuous spinal catheter for labor analgesia: A case series. *Int J Obstet Anesth* 20: 351-354.
66. Ravi R (2006) Isolated tinnitus following placement of an intrathecal catheter for accidental dural puncture. *Int J Obstet Anesth* 15: 180.
67. Chan BO, Paech MJ (2004) Persistent cerebrospinal fluid leak: A complication of the combined spinal-epidural technique. *Anesth Analg* 98: 828-830.