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A National Survey of Duramater Closure Techniques in Indonesia: Surgeon Preferences, Risk Factors and Cost Constraints in Neurosurgical Practice

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A B S T R A C T

This study surveyed duraplasty practices among Indonesian neurosurgeons, focusing on material selection, clinical considerations, complications, and healthcare financing. An online questionnaire was distributed to 170 alumni of the Bandung Neurosurgery Training Center between February and August 2025, with an overall 50% response rate. Eighty-five responses were analyzed descriptively and compared with international practices. The results show that major CSF leak risk factors include increased intracranial pressure, re-operations, and incidental durotomy, with prevention strategies emphasizing watertight closure, non-absorbable silk sutures, and dural sealants. Cost and patient indication were the main determinants in technique selection. Indonesian neurosurgeons generally prefer autologous grafts for cost-effectiveness. The study highlights the need for standardized, evidence-based guidelines and further comparative research to ensure efficient and sustainable neurosurgical care under national health insurance.

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INTRODUCTION

Postoperative dura mater closure was the most important step in every procedure of brain or spinal surgery. This procedure will prevent CSF leakage, brain tissue herniation, and structural adhesion. The incidence of CSF leak after cranial surgery reach 27% and up to 17% in lumbar spine surgery (Kizmazoglu et al., 2019; Dafford & Anderson, 2015). If CSF leakage occurred, other complications will increase such us infection, pseudomeningocelle, tension pneumocephalus and finally increase the health costs due to prolonged therapy and health care (Cappabianca et al., 2006). Among the anatomical structure of meningen that contain and protect the critical neural structure, just the dura mater is the only layer that can be surgically repaired. Watertight dural closure or another technique that used in dural closure practice has many variations (Kshettry et al., 2016).

Additional materials used in cranial, spinal or transsphenoidal surgery also still have many controversies related to the incidence of CSF leakage postoperatively. Numerous techniques have been developing in dural closure practice around the world, but the problem of CSF leak remains the 'scary" problem for the neurosurgeon. To date, there is no national consensus on effective, safe, and cost-efficient duraplasty practices, as covered by health insurance in Indonesia. The data generated from this national survey will be invaluable in comparing duraplasty practices with similar practices internationally (Schiariti et al., 2014; Caroli et al., 2004). Given Indonesia's unique healthcare financing system and the lack of national data, this study aims to describe current dural closure practices, compare them with international standards, and evaluate the role of cost constraints in technique selection. This study was also the first survey since the practice of neurosurgery operation starts its services by 1960-s in Indonesia.

THEORETICAL REVIEW

Previous studies on duramater closure have emphasized the importance of achieving a watertight seal to minimize postoperative cerebrospinal fluid (CSF) leakage, which remains one of the most common complications in cranial and spinal neurosurgery. Literature highlights a wide variety of closure techniques and graft materials, including autologous fascia lata, pericranium, synthetic grafts, and xenografts, each demonstrating different levels of effectiveness, complication rates, and long-term outcomes. Comparative analyses show that while autologous grafts are biocompatible and cost-effective, their harvesting increases operative time and morbidity, whereas synthetic substitutes offer convenience but may be associated with higher infection risks or rejection. Several international surveys have reported that surgeon preferences are strongly influenced by availability of materials, personal training background, and institutional policies. In low- and middle-income countries, cost considerations and limited access to advanced biomaterials are significant barriers, leading to variations in practice and a reliance on more affordable or locally available options. However, few studies have specifically explored the balance between clinical decision-making, economic constraints, and healthcare

financing systems in the context of neurosurgery in Indonesia, making this national survey an important contribution to the global discourse on duraplasty practices.

METHODOLOGY

We develop the questionnaire to refer to the item from the Italian questionnaire by d'Avella et al. We adjust some content of questions to bring it up to the local aspects and national health regulatory in Indonesia (d'Avella et al., 2019). The questionnaire reviewed and approved by 3 neurosurgeons expert panel. We used the Google Form to build the questionnaire content and instrument. We distributed the questionnaire online by email and link, then the answers collected automatically in the database. We have about 280 million of population in Indonesia and services by 490s members of Indonesia Neurosurgical Society in the period when the survey conducted. We did a consecutive sampling technique to obtained responses.

We sent the questionnaire to the neurosurgeons who practice in six regions of the main island of Indonesia. The questionnaire consists of 19 questions that divided into 3 parts to gain the Indonesian neurosurgeon experiences in dural closure. All the questions were a part of three major aspects of risk factors of CSF leakage, management CSF leakage after the operation and the technique of dural closure. Likert-type scale was used to classify the agreement and disagreement of the respondents. Scale 1 strongly disagreed, 2 disagreed, 3 was somewhat agreed, 4 agreed and 5 strongly agreed. To analyzed the percentage of agreement we count scale 3,4,5 as the agreement and scale 1,2 as disagreement. We summed the percentage of each answer and make some graphics to show the results.

RESEARCH RESULTS

Table 1. Demographic of the Respondents

Chracteristics	**Results**
Participants	N= 85
Sex	
-Male (%)	81 (95.3%)
-Female	4 (4.7%)
Age	
-Average	43.36±7.18 years old
-Range	(31-58 years old)
Hospital Center Area	
-Java	57 (67.1%)
-Bali & Nusa Tenggara	4 (4.7)
-Borneo	4 (4.7)
-Sumatra	19 (22.4)
-Papua	1 (1.2)

Duration of NS Practice since graduate -Average -Range	8.18±5.45 years 1-21 years
Total operation procedure per month - Over 30 - 10-30 - 1-10	7 (8.2%) 45 (52.9) 33 (38.8)
Dominant Operation Procedure -Brain - Spine	77 (90.6%) 8 (9.4)
The most duraplasty procedure -Brain -Spine	82 (96.5%) 3 (3.5%)

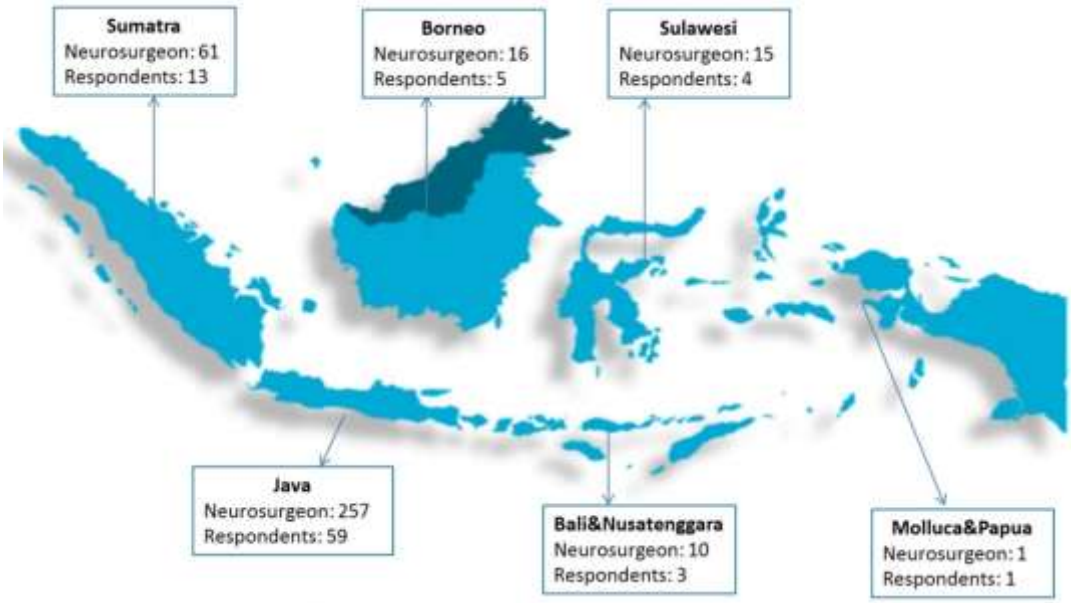

Figure 3. Respondents Characteristics

The survey distributed to a neurosurgeon in Indonesia especially from Bandung Neurosurgical training center alumni and we received 85 responses from the neurosurgeons who practice in 8 university-based hospital (educational center for residency program) and 42 regional province hospitals. The survey results divided and grouped into three main aspects were risk factor of CSF

leakage, management of CSF leakage postoperatively, and dural closure technique in their daily practice.

We got the response from all the area in Indonesia which our neurosurgeon have been practice today. The respondents have been practice as neurosurgeons averages 8.18 ± 5.45 years and the majority doing the operation 10 to 30 cases (52.9%) per months and 96.5% were the brain surgery. In table.1 we demonstrated some data about the characteristics of the respondent in this survey.

CSF Leakage risk factors

We start with the questions about the risk factor for CSF leakage in neurosurgery procedure. We differentiate the risk factor in cranial, spinal and transsphenoidal surgery. In cranial surgery, we found that the three major risk factors were increased intracranial pressure (84.7%), history of previous treatment (surgery, radiotherapy or chemotherapy) (82.4%) and re-operation procedure (81.2%). Incidental durotomy (88.2%) in spinal surgery was the highest risk factor for CSF leakage and did not make the nasoseptae flap was the highest risk factors in transsphenoidal surgery (82.4%). Other chronic conditions of the patients, diabetes, aging and were the moderate risk factor for CSF leakage about 77.6%, 69.4%, and 62.4% and respectively (Figure 1).

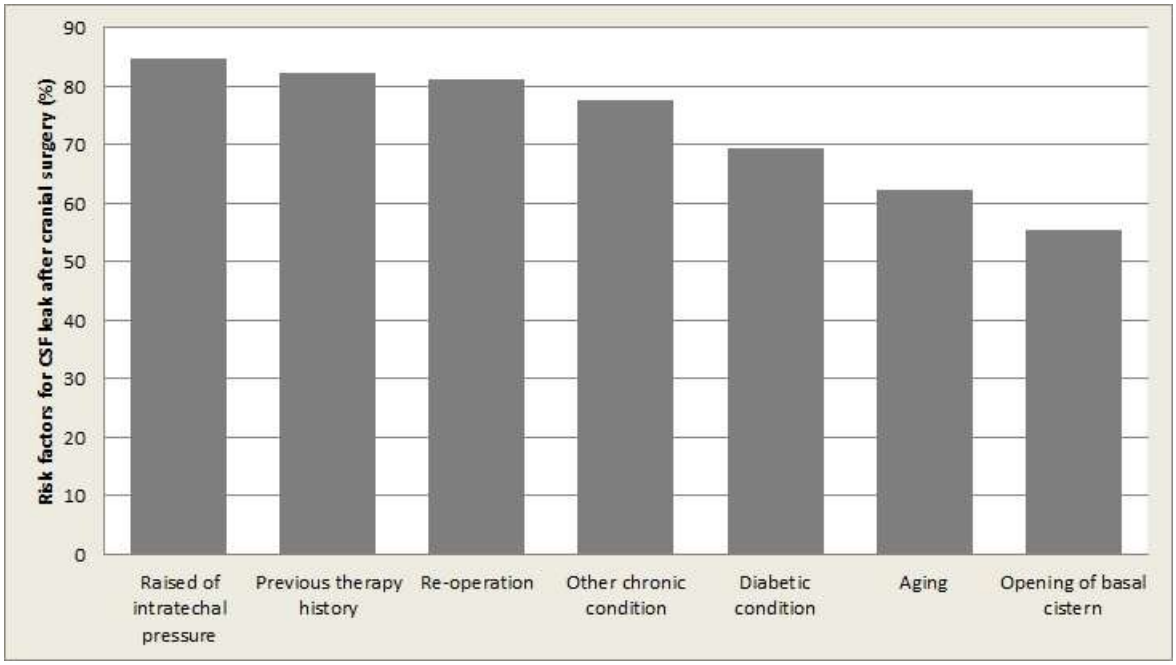

Figure 1. Risk Factor of CSF leak Cranial Surgery

Management of CSF leakage

If the CSF leakage occurred postoperatively, Indonesian neurosurgeon managed the leakage by preventing some maneuvers that stimulate ICP increasing (91.8%), used the medication to decreased CSF production (91.8%), and performed external drainage (78.8%). Early mobilization and prescribed

diuretics were uncommon in the management of CSF leakage among Indonesian neurosurgeons (Figure.2).

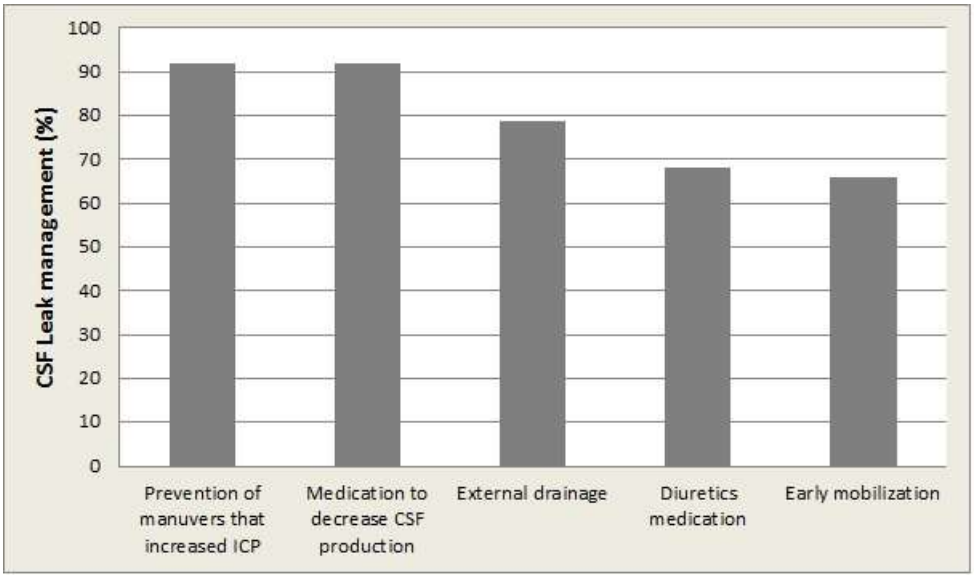

Figure 2. CSF Leak management

Dural Closure Technique

The technique of dural defect closure among the respondent was very varied. The top two major techniques were watertight continuous suture used autologous tissue and used the dural sealants as the additional covering (44.7%); watertight suture with autologous tissue without additional dural sealant (22.4%). Interestingly, using the synthetic materials to closed the dural defects was very low as well as heterologous materials (1.17%). The consideration in choosing the dural sealant was low cost (27%) and because of the combine of low cost and surgeon preference (23.5%). The most kind of dural sealant used by the neurosurgeon in Indonesia was Fibrinogen-thrombin sealant (69.4%). Indonesian neurosurgeon profile in the use of dural sealant showed in table-2.

Table 2. The Indonesian Neurosurgeon experience use a dural sealant in their operation

Statement	**Cranial Operation (%)**	**Spinal Operation (%)**	**Transphnoidal Operation (%)**
The using of dural sealant in neurosurgery			
-Always	10.6	11.8	40
- Depends on the pathology	69.4	54.1	12.9
-Never	20	34.1	47.1
The indications to use dural sealant*			
-Covering the watertight primary suture	45.9	37.6	23.5
-Existence of CSF leakage risk factor	87.1	87.1	63.5

**The respondents choice more than one answers*

Indonesia neurosurgeon's considerations to performed watertight suture in dural closure were depended on the location (lobe in cranial) or spinal leveling combine with pathological kinds (28.2%); or just because of the anatomical locations (24.7%) and because of the pathological problem (trauma, tumors, congenital, others) [11.8%]. To perform the watertight suture of the dura mater, the Indonesian neurosurgeon has the top two kinds of silk. They prefer to used non-absorbable silk (56.5%) and a combination of the non-absorbable silk and Vicryl (12.9%). In primary watertight suture for dural closure, the neurosurgeon prefers to make the suturing continuously (89.4%) than interrupted (10.6%). Overall reasons that Indonesian neurosurgeons consider choosing the dura mater closure technique were because of patient indication and national insurance cost covering (30.6%); just because of patient indication (23.5%); and just because of national insurance covering (14.1%). Interestingly, the consideration in choosing the dural closure technique did not based on the surgeon's confidence to the material to prevent the leakage; or because of shorter operation time.

DISCUSSION

This study was the first nationwide study to survey the practice of dural closure among Indonesian neurosurgeon. Although this study was not a consensus yet, but it still captured the experiences of Indonesian neurosurgeons in dural closure procedure. Since the new regulation of national health insurance in Indonesia released, the surgeon has to decide carefully to choose the material to use in dural closure (Bangash & Alkhotani, 2016).

Indonesian neurosurgeon practiced the technique for brain dural closure dominant by technique of watertight suture used autologous tissue. They believed that watertight dural closure is the best practice to close the dural defect, and when if not possible, the major respondent obtains the perfect closure by used additional autologous tissue and additional dural sealant. The study by Ha et al· and Eser et al· showed the perfect results when used dural sealant upon the dural suture and reduce the post-operative CSF leakage, instead another study with randomized controlled trial by Hutter et al[12] found that additional dural sealant was no statistically significant in reducing post-operative CSF leakage but still significant reduced the patients length of staying in intermediate care unit (Ha et al., 2016; Hutter et al., 2014; Eser et al., 2019).

Used the autologous tissue has more advantages than allograft tissue or synthesis one. Autologous tissue was not expensive, despite it needs more time to harvest the tissue prior to use. Abuzayed et al state in their research that using the autologous graft decreases the tissue reaction and viable to provide a patency blood flow supply serial with support the healing process at the dural defects (Abuzayed et al., 2009). Another result by Azzam et al· showed the CSF leakage of using autologous graft was lower (1.81%) than non-autologous graft (4.76%) (Azzam et al., 2018). Indonesia neurosurgeon did not use synthetic or xenograft material despite as Danish et al· reported that using non-suture xenograft would shorter operation times, minimizes the complication due to anesthesia and health cost (Danish et al., 2006).

Despite the number of technique and additional components used in dural closure, the problem of CSF leakage remains a problem in neurosurgery. Indonesian neurosurgeons prefer to used primary watertight closure in dural closure practice. Using the non-absorbable silk and continuously suture technique was believed as the best practice in dural closure in brain surgery. Kehler et al. study results also showed a higher risk of CSF leakage in no dural suture or only interrupted sutures and in another side dural closure with running suture showed less CSF leakage (Kehler et al., 2013). Different results showed by Megyesi et al. that interrupted simple suturing techniques have more resistant to higher pressure and more watertight (Megyesi et al., 2004).

Incidental durotomy in spine surgery managed by watertight continuous silk suture and additional fibrin-based sealant above the suture. Indonesia neurosurgeon choose this technique as a major treatment in spinal incidental durotomy if they found there were major risk factors for dural leak and depends on the pathologic process of the case (Table 2). Dafford and Anderson show the optimal management of this problem used 6-0 Prolene using interrupted or locked technique and hydrogel or fibrin base sealant to improve the results. Using the dural sealant after the watertight suture of the dural closure procedure showed better results to prevent CSF leak. Study results of Dafford et al and Kizmazoglu et al. support this fact (Kizmazoglu et al., 2019; Dafford & Anderson, 2015). The percent area of leakage after use the fibrin sealant reduced about 37% (compare to 80% for hydrogel sealant, and; 75% for cyanoacrylate sealants) in post-spinal duraplasty. Another result obtained by Esposito et al. that fibrin base dural sealant was safety accepted to prevent CSF leakage but this result came from single RCT research (Esposito et al., 2016). Despite a large systematic review involved RCT, prospective and retrospective cohort by Kinaci et al. reached the final conclusion that dural sealant does not reduce CSF leakage incidence, otherwise reduce the risk factor of surgical-site infection (Kinaci et al., 2018).

To date that our study captured the phenomenon that there were three reasons that the Indonesian neurosurgeon considers choosing the dura mater closure technique for all kinds of surgery of cranial, spinal and transsphenoidal. First, because of patient indication and national insurance cost covering (30.6%); just because of patients indication (23.5%); and the last, just because of national insurance covering (14.1%). Health cost was still a main problem in the country. National health insurance has a tight regulation to provide the best practice to support the neurosurgery field but still has some warnings to lead the neurosurgeon to choose some health products such as dural sealants. Our neurosurgeon had to extra careful in choosing the product if it is a true or not indication to use the sealant.

Worldwide, there were three national surveys about dural closure in German, Canada, and Italia (Oitment et al., 2018; Ivan et al., 2015; Black, 2002). All their results concluded that the dural tear in spinal surgery is a major risk factor for CSF leakage. Interestingly, our results also showed the same results that incidental durotomy in spinal surgery was the main risk factor for CSF leak after spinal surgery.

In the present study, Indonesia neurosurgeons opinion that the major risk factor for CSF leak in brain surgery was increased the intracranial pressure, history of previous treatment (surgery, radiotherapy or chemotherapy) and re-operation procedure (Figure.1); and did not make the nasoseptae flap was the highest risk factors in transsphenoidal surgery. This results consistent with the experience and consensus of Italian neurosurgeon. It is also relevant to some other literature that the previous history of therapy and increasing intrathecal pressure were the main risk factor for CSF leakage (Clajus et al., 2015). Another study by Bangash et al[14] showed different results, the previous chemotherapy or radiotherapy were not risked factors for CSF leakage. Eser et al· also concluded that previous surgery was independent predictors of postoperative CSF leakage (Eser et al., 2019). Multicenter analysis study by Kehler et al[16] showed that previous radiotherapy or chemotherapy and re-craniotomy were not roles as risk factors for CSF leakage. Diabetes was believed by Indonesia neurosurgeon as a moderate risk factor for postoperative CSF leakage, instead the study of Ha et al· identified diabetes and infratentorial location as the significant predictors for CSF leakage.

The limitations of our study include only a small number of responders and its results may not reflect the best practices of dural closure of all neurosurgeon in Indonesia. One possible bias that could occur relates to selection bias. Of the 170 targeted subjects, only 50% responded to the questionnaire. However, because all respondents came from the same neurosurgery training center, subject homogeneity can be guaranteed because they came from the same parent learning and training context.

CONCLUSIONS AND RECOMMENDATIONS

Dural closure or duraplasty is a critical step in neurosurgery. There are many techniques and materials used in this procedure. This study highlights the experience of Indonesia neurosurgeon in dural closure practice. Indonesian neurosurgeons prefer watertight closure with autologous grafts due to cost-effectiveness. One of the basic reasons for using autografts is solely due to considerations of national insurance coverage which pays according to a package system without taking into account the specifics of each patient's case. Another additional study is needed to achieve the national consensus in dural closure practice in Indonesia.

FURTHER STUDY

Further studies are recommended to develop a national consensus on dural closure practices in Indonesia by involving larger samples of neurosurgeons from diverse institutions. Future research should also compare clinical outcomes, complication rates, and cost-effectiveness between autologous grafts and alternative materials, taking into account the constraints of the national insurance system. In addition, exploring patient-reported outcomes and long-term follow-up would provide a more comprehensive evaluation to guide standardized, evidence-based duraplasty protocols suitable for the Indonesian healthcare context.

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