Is Placing Prophylactic Dural Tenting Sutures a Dogma?

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■ OBJECTIVE: **In this study, we investigated if and when dural tenting sutures are necessary during craniotomy.**

■ METHODS: **Results from 437 patients 18–91 years of age (average, 43.5 years) who underwent supratentorial craniotomy between 2014 and 2019 were evaluated. The patients were categorized into 1 of 3 groups: patients who had at least 3 prophylactic dural tenting sutures placed before opening of the dura (group 1); patients who had at least 3 dural tenting sutures placed after surgery was completed, during closure (group 2); or patients who had no dural tenting sutures (group 3 [control]). All such sutures in groups 1 and 2 were placed in the circumference of the craniotomy and dural junction. No central dural tenting sutures were placed in any of the patients.**

■ RESULTS: **Among the 437 patients, 344 underwent surgery for the first time and 93 were undergoing a second surgery. Cranial computed tomography imaging was performed for each patient 1 hour, 3 days, and 1 month after surgery. In group 1, 3 patients had a cerebral cortex contusion and 2 patients had acute subdural hematoma after the sutures were placed. In groups 2 and 3, none of the patients had a cerebral cortex contusion or acute subdural hematoma. Fewer complications were observed when dural tenting sutures were placed during postsurgical closure.**

■ CONCLUSIONS: **Placing dural tenting sutures is an important technique for ensuring hemostasis. However, when not needed, they seem to cause inadvertent complications. As our results suggest, knowing when and where to use them is equally important.**

INTRODUCTION

Craniotomy is an indispensable neurosurgical procedure, and many surgical approaches and craniotomy types exist. However, important complications related to craniotomy closure and the postcraniotomy period can occur. The use of dural tenting sutures between the dura and the galea or subaponeurotic tissue to prevent postoperative epidural hematoma (EDH) was first described by Walter Edward Dandy in 1932.[1] Horsley[2,3] and Cushing[4,5] also frequently used electrocoagulation in neurosurgical operations to prevent postoperative EDH.

However, the need for dural tenting suture placement, which has continued in neurosurgery for the past 2 decades, has begun to be questioned in light of modern hemostasis, hemostatic agents, and anesthesia. Are prophylactic dural tenting sutures really necessary, and if so, at which stage of the surgery should they be placed? In this study, 437 patients who underwent craniotomy between May 2016 and February 2021 at the Ankara University Department of Neurosurgery were evaluated. Complications such as the presence and number of EDHs, emerging new neurologic deterioration, cerebrospinal fluid (CSF) leak, cortex tissue damage, and dural tenting suture–related complications (e.g., subdural hygroma, foreign body reaction) were examined.

Key words
- Complication
- Craniotomy
- Dural tenting suture
- Epidural hematoma
- Iatrogenic
- Subdural hematoma

Abbreviations and Acronyms
CSF: Cerebrospinal fluid
CT: Computed tomography
EDH: Epidural hematoma

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MATERIALS AND METHODS

Patient Information

This prospective study included 437 patients who were older than 18 years. All patients participating in the study underwent a supratentorial craniotomy between May 2016 and February 2021 at the Ankara University Department of Neurosurgery. All intra-axial, extra-axial, and vascular pathologies were included in the study. Patients who underwent a posterior fossa craniotomy, craniotomy <2 cm in diameter, external ventricular drainage placement surgery, endoscopic intervention, or a biopsy procedure; emergency trauma patients with multiple head bone fractures; patients who had an epidural and/or subdural external drain placed during surgery; patients who underwent CSF drainage (e.g., lumbar puncture) after surgery; and patients using an anticoagulant(s) were excluded.

Surgical Technique

The 4-0 silk sutures were used in all patients. The patients included in the study were divided into 3 groups. Group 1 patients had at least 3 prophylactic dural tenting sutures placed before the dura was opened. The dura was grasped with Adson forceps, elevated upward with a dural needle, and grasped again with the forceps for placement of the tenting sutures to avoid possible cortex damage. In group 2 patients, the dura was opened, and after the surgery was completed, at least 3 dural tenting sutures were placed with the use of an operating microscope, which allowed viewing of the distance between the dura and the cortex. Dural tenting sutures were not used in any patients in group 3 (control group).

Bone wax was used on the bone margins, and oxidized regenerated cellulose was used at the bone–dura junction in all patients. Dural hemostasis was performed in all patients. In the patient groups receiving dural tenting sutures, the sutures were hung from their closest location to the bone, thereby causing the dura to adhere more strongly to the bone.

Statistical Analysis

All statistical analyses were performed using SPSS for Windows version 11.5 (SPSS Inc., Chicago, Illinois, USA). Descriptive statics are expressed as number (percentage) for categorical variables. The χ^2 and Fisher exact tests were used to analyze the relationship between 2 categorical variables. $P = 0.05$ was considered statistically significant.

Ethical Approval

This study was performed with approval from the Ankara University Ethics Committee (number 11-64-20).

RESULTS

All 437 patients underwent surgery performed at the Ankara University Department of Neurosurgery. The study consisted of 236 men and 201 women 18–91 years of age (average age, 43.5 years). Primary surgery was performed in 344 patients, and secondary surgery was performed in 93 patients. Most of the patients required surgery because of a tumor (Table 1). Groups 1, 2, and 3 included 146, 146, and 145 patients, respectively. As the statistical analysis suggested and confirmed, the preoperative surgical information of the patients constitutes a heterogenous group, and the data apply to real-time circumstances. Cranial computed tomography (CT) imaging was performed in all patients at 1 hour, 3 days, and 1 month after surgery.

Table 1. Preoperative Patient Information

Patient Characteristics	Group 1	Group 2	Group 3
Intrinsic tumor	71 (48.6)	67 (45.9)	65 (44.8)
Extrinsic tumor	64 (43.8)	69 (47.3)	67 (46.2)
Vascular lesion	11 (7.5)	10 (6.8)	13 (9.0)
Second surgery	0 (0.0)	0 (0.0)	93 (64.1)
Preoperative midline shift >1 cm	51 (34.9)	55 (37.7)	54 (37.2)

Values are number of patients (%).

In group 1, 3 of the patients had a cerebral cortex contusion, and 2 patients had acute subdural hematoma (Figure 1). In postoperative cranial CT images, an epidural collection ≤3 mm was detected in 6 patients, and an epidural collection >3 mm was detected in 3 patients.

In group 1, 1 patient who experienced neurologic deterioration that was caused by acute subdural hematoma required reoperation. CSF was accumulated under the skin in 7 patients and was treated with palliative measures. The cause of acute subdural hematoma in 2 patients was venous (n = 1) and arterial (n = 1) injury between the dura and the pia.

In group 2, no patient had cortical damage or acute subdural hematoma as a result of the dural tenting sutures. Epidural collections of ≤3 and >3 mm were detected in 5 and 4 patients, respectively. None of the patients required reoperation because of an epidural collection. CSF accumulated under the skin in 5 patients and was treated with palliative measures.

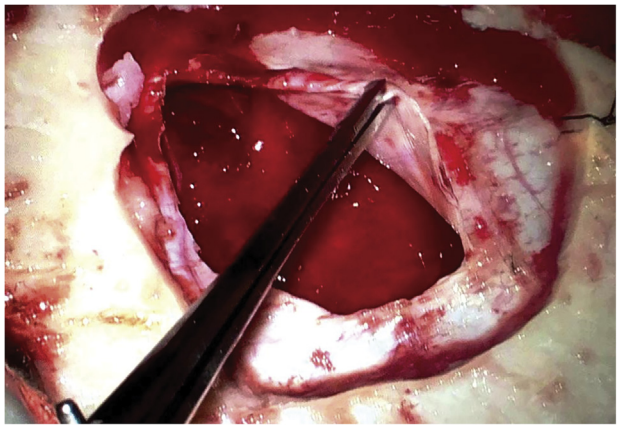

Figure 1. Acute subdural hematoma caused by a dural needle (patient who needed reoperation).

Table 2. Postoperative Complications

Complication	Group 1*	Group 2	Group 3
Contusion	3 (2.1)	0 (0.0)	0 (0.0)
Acute subdural hematoma	2 (1.4)	0 (0.0)	0 (0.0)
Epidural collection			
≤3 mm	6 (4.1)	5 (3.4)	7 (4.8)
>3 mm	3 (2.1)	4 (2.7)	3 (2.1)
CSF accumulation	7 (4.8)	5 (3.4)	5 (3.4)
Reoperation because of hematoma	1 (0.7)	0 (0.0)	0 (0.0)
Subdural hygroma (CT imaging first month after surgery)	8 (5.5)	5 (3.4)	4 (2.8)

Values are number of patients (%).
CSF, cerebrospinal fluid; CT, computed tomography.
*Patients in group 1 had more complications than those in the other 2 groups; however, this difference is not statistically significant.

In group 3, none of the patients had cerebral cortex contusion or acute subdural hematoma. Epidural collections of ≤3 and >3 mm were observed in 7 and 3 patients, respectively. CSF accumulated under the skin in 5 patients and was treated with palliative measures.

Regarding statistical analysis, we examined whether a difference between the groups existed in terms of postoperative complications. No significant difference was found for any of the variables between any of the groups ($P > 0.05$).

Subdural hygroma, detected by control CT imaging 1 month after surgery, was more frequent in group 1 than in groups 2 and 3, but this difference was not statistically significant (8 vs. 5 and 4 cases, respectively) (Table 2). Craniotomy sizes varied between 2 and 15 cm. We found no difference in postoperative complications according to craniotomy size among the 3 groups.

DISCUSSION

EDHs are one of the most important causes of acute and late morbidity and death after craniotomy.[1] Horsley,[2,3] Cushing,[5,6] and Poppen[7] developed many methods for avoiding these complications.

Insufficient control of patient blood pressure after the induction of anesthesia and inadequate imaging methods resulted in the routine neurosurgical use of dural tenting sutures to prevent EDH. Prophylactic dural tenting sutures are still used routinely today to prevent possible late and/or acute complications. In recent studies, the occurrences of an EDH of >3 mm after craniotomy ranged from 0.2% to 2.6%.[8-12]

The number of patients who had an EDH of >3 mm was not significantly different among the groups. The use of prophylactic epidural tenting sutures did not make any difference in the prevention of epidural collection. Except for in group 1, cortex injury and subdural hematoma were not observed. The obvious reason for this difference was the lack of space between the brain and dura as a result of increased intracranial pressure. Subdural hygromas and hematomas developing after surgery are an important neurosurgical entity.[13]

An expected but striking result was the greater rate of subdural hygromas in group 1. Even in very skillful and experienced hands, placing dural tenting sutures without actually visualizing the underlying cortex can result in cortical or dural bridging vein damage. These data support the idea that visualizing underlying tissue before dural tenting suture placement is a safer and more reliable approach regardless of the surgeon-related factors. Subdural hygromas are more common in elderly patients and in patients who undergo large-volume lesion excision. This gap, which is decompressed after surgery and is greater than the normal space

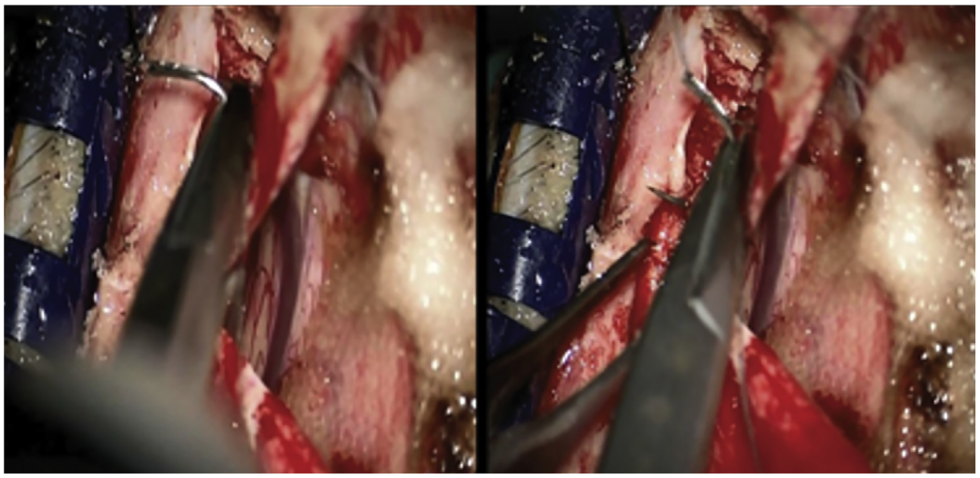

Figure 2. A safe gap between the cortex and the dura is visible.

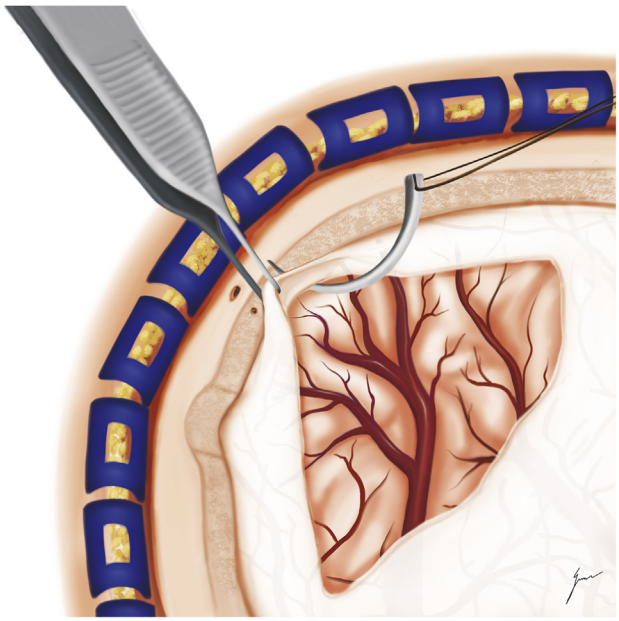

Figure 3. Schematic illustration of the dural tenting suture technique during postsurgical closure. The needle does not traverse the full dural thickness, and this can be achieved by clear visualization of the cortical side of the dura.

created between the excessively collapsed brain tissue and the dura, manifests itself as a hygroma in the late period. If the brain tissue does not expand sufficiently and this gap increases, a subdural hygroma that requires surgery may develop. More important, however, is that an increase in this gap may be a risk factor for the development of late dural bridging vein hemorrhage. Tumor size and location and degree of decompression (CSF drainage through the cisterna intraoperatively) are also factors changing this gap volume and can contribute to the formation of subdural hygromas. We did not assess these variables, and this is a limitation of our study.

In group 2 patients, dural sutures were placed using an operative microscope after lesion excision. A safe space between the dura and the cortex was observed with the microscope. Bridging veins between the cortex and the dura, which cannot be seen before opening the dura, were well visualized. The safe passage of the dural needle was observed under the microscope (Figure 2), which enabled safer placement of the dural tenting sutures (Figure 3).

Oxidized regenerated cellulose and bone wax were used in all 3 groups. Oxidized regenerated cellulose was not applied between the dura and the bone because this procedure can cause unnecessary dural dissection and epidural collection.

It is important to perform surgery while the patient has normotensive blood pressure during anesthesia. The Valsalva maneuver is frequently performed so that possible bleeding can be detected for hemostasis. However, if traditional prophylactic dural tenting sutures are to be used, the Valsalva maneuver should be performed after watertight dural closure.

The complication rates were similar to those reported in the literature. Pial fistulas, foreign body reactions, and CSF leakage caused by dural sutures were important complications reported in the literature. However, no patient in this series encountered any of these complications.[14,15] CSF accumulation resolved with palliative measures in all groups, and did not progress to CSF leakage.

Ninety-three patients in this study who had previously had a craniotomy underwent another procedure. These patients underwent their surgery at least 6 months before the second operation. In these patients, dural tenting sutures were used in neither the first nor the second operation. Because cranial epidural fibrosis is formed between the dura and cranial bone after the first surgery, dural tenting sutures were not needed.

Very few studies regarding the necessity for dural tenting sutures exist in the literature.[16-19] In these few studies, the need to use dural tenting sutures was questioned. However, for the first time, to our knowledge, our study included consideration of the timing for placement of the dural tenting sutures.

CONCLUSIONS

Placing dural tenting sutures is an important surgical technique for hemostasis. If these sutures are placed before the dura is opened, they seem to cause unnecessary complications. However, if they are placed after the dura is opened, a lower number of complications is seen. When no dural tenting sutures were used, no complications after surgery were reported. This result shows that placing tenting sutures might not be necessary; however, there is not enough evidence to support this claim. More research on this topic is needed.

As this study shows for the first time, the best time to place dural tenting sutures is during postsurgical closure. In patients who underwent a second operation, epidural tenting sutures were not necessary because epidural fibrosis was present and the dura was strictly adherent to overlying bone structures.

Dural tenting sutures may or may not be used by neurosurgeons, and they are used most commonly by choice. The questions of whether to use these sutures, when to place them, and how to place them require more study and research data to be evaluated further.

AUTHOR CONTRIBUTIONS

U. Eroglu contributed to conceptualization, methodology, and writing — review & editing. A. Cohen-Gadol contributed to methodology, writing — review & editing, and supervision. K. Erdoğan contributed to software and investigation. O. Özgüral contributed to validation and project administration. M. Bozkurt contributed to formal analysis. E. Gökalp contributed to formal analysis, resources, and visualization. K. D. Seçinti contributed to investigation. M. Zaimoğlu contributed to resources and data curation. F. Yakar contributed to data curation. E. Y. Sayacı contributed to writing original draft and visualization. B. Abbasoğlu contributed to visualization. M. A. Ünlü, Y. Ş. Çağlar, H. C. Ugur, and A. Attar

contributed to supervision. İ. Doğan contributed to project administration. G. Kahilogullari contributed to funding acquisition.

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REFERENCES

1. Dandy WE. Surgery of the brain. In: Lewis D, ed. Hagerstown, MD: WF Prior; 1945:144-162. Lewis' Practice of Surgery; 12.
2. Horsley V. Antiseptic wax. *Br Med J*. 1892;1:1165.
3. Horsley V. Remarks on ten consecutive cases of operations upon the brain and cranial cavity to illustrate the details and safety of the method employed. *Br Med J*. 1887;1:863-865.
4. Cushing H. The control of bleeding in operations for brain tumors: with the description of silver "clips" for the occlusion of vessels inaccessible to the ligature. *Ann Surg*. 1911;54:1-19.
5. Cushing H. Electro-surgery as an aid to the removal of intracranial tumors. *Surg Gynecol Obstet*. 1928;47:751-784.
6. Cushing H. The control of bleeding in operations for brain tumors. With the description of silver "clips" for the occlusion of vessels inaccessible to the ligature. *Trans Am Surg Assoc*. 1911;29:389-410.
7. Poppen JL. Prevention of postoperative extradural hematoma. *Arch Neurol Psychiatry*. 1935;34:1068-1069.
8. Kim SH, Lee JH, Joo W, et al. Analysis of the risk factors for development of post-operative extradural hematoma after intracranial surgery. *Br J Neurosurg*. 2015;29:243-248.
9. Lillemäe K, Järviö JA, Silvasti-Lundell MK, Antinheimo JJ-P, Hernesniemi JA, Niemi TT. Incidence of postoperative hematomas requiring surgical treatment in neurosurgery: a retrospective observational study. *World Neurosurg*. 2017;108:491-497.
10. Sinar EJ, Lindsay KW. Distant extradural haematoma complicating removal of frontal tumours. *J Neurol Neurosurg Psychiatry*. 1986;49:442-444.
11. Jeon JS, Chang IB, Cho BM, Lee HK, Hong SK, Oh SM. Immediate postoperative epidural hematomas adjacent to the craniotomy site. *J Korean Neurosurg Soc*. 2006;39:335-339.
12. Fukamachi A, Koizumi H, Nagaseki Y, Nukui H. Postoperative extradural hematomas: computed tomographic survey of 1105 intracranial operations. *Neurosurgery*. 1986;19:589-593.
13. Jha AN, Morris K. Iatrogenic *ex vacuo* subdural hygroma: and a complication of the modified "Poppen" suture. *J Neurol Neurosurg Psychiatry*. 1986;49:1084-1085.
14. Onodera H, Furuya Y, Uchida M, et al. Intracranial foreign body granuloma caused by dural tenting suture. *Br J Neurosurg*. 2011;25:652-654.
15. Nishiyama Y, Kanemaru K, Yoshioka H, Hanihara M, Horikoshi T, Kniouchi H. Intracranial pial arteriovenous fistula caused by dural tenting: case report. *Neurol Med Chir (Tokyo)*. 2014;54:242-244.
16. Swayne OB, Horner BM, Dorward NL. The hitch stitch: an obsolete neurosurgical technique? *Br J Neurosurg*. 2002;16:541-544 [discussion 544].
17. Winston KR. Efficacy of dural tenting sutures. *J Neurosurg*. 1999;91:180-184.
18. Przepiórka Ł, Kunert P, Żyłkowski J, et al. Necessity of dural tenting sutures in modern neurosurgery: protocol for a systematic review. *BMJ Open*. 2019;9:e027904.
19. Winston KR. Dural tenting sutures in pediatric neurosurgery. *Pediatr Neurosurg*. 1998;28:230-235.

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