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The Necessity Of Dural Tenting Sutures In Modern Neurosurgery: Protocol For A Systematic Review

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Keywords:	craniotomy, extradural hematoma, dural tenting sutures

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Title page

The Necessity Of Dural Tenting Sutures In Modern Neurosurgery: Protocol For A Systematic Review

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Guarantor of the review

Łukasz Przepiórka

Contributions

ŁP conceived the presented idea and prepared the manuscript; PK critically revised the manuscript, AM validated the final version of the manuscript; JŻ analyzed the data; DJ, JF, and KW contributed to the design of the study; PŁ and PL helped supervise the project; RR, DS, and TT provided the methodologic background. All authors reviewed the final manuscript.

Amendments

In the event of protocol amendments, the date of each amendment will be accompanied by a description of the change and the rationale.

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35 Abstract

36 Introduction

37 The ongoing need for dural tenting sutures in a contemporary neurosurgical practice has been
38 questioned in the literature for over two decades. In the past, these sutures were supposed to
39 prevent blood collecting in the potential space between the skull and the dura by elevating the
40 latter. Theoretically, with modern hemostasis and proper postoperative care, this technique
41 should not be necessary and the surgery time can be shortened. Unfortunately, there is no
42 evidence-based proof to either support or reject this hypothesis.

43 Methods and analysis

44 The systematic review will be performed according to the Preferred Reporting Items for
45 Systematic Reviews and Meta-Analysis (PRISMA) statement and The Cochrane Handbook for
46 Systematic Reviews of Interventions. Eight electronic databases of peer-reviewed journals will be
47 searched, as well as other sources. Eligible articles will be assessed against inclusion criteria.
48 The intervention is not tenting the dura and this will be compared with the usual dural tenting
49 sutures. Where possible, “summary of findings” tables will be generated.

50 Ethics and dissemination

51 Ethical committee approval is not required for a systematic review protocol. Findings will be
52 presented at international neurosurgical conferences and published in a peer-reviewed medical
53 journal.

54 Systematic review registration

55 PROSPERO 2018 CRD42018097089

56 Keywords

57 Dural tenting sutures, craniotomy, extradural hematoma

58 Strengths and limitations of this study

- 59 • To the best of our knowledge, this will be the first systematic review evaluating the necessity of
60 dural tenting sutures.
- 61 • To obtain enough patient data, observational studies will be included with randomized
62 controlled trials.
- 63 • The choice of inclusion criteria remains controversial.

64 Introduction

65 In the early days of neurosurgery, extradural hemorrhage (EDH) contributed to high mortality after
66 craniotomies. Almost a century ago, Walter Dandy reported dural tenting sutures as an effective
67 way of preventing postoperative EDH.¹ Over time, his technique gained in popularity and
68 significance to finally become a neurosurgical standard. Dural tenting is a well-known method of
69 stitching the dura to the bone or pericranium after craniotomy. This decreases the extradural
70 space where EDH could arise and compresses dural vessels, which are potential sources of EDH.
71 These sutures are known by many names (Table 1).² In addition, some terms distinguish dural
72 tenting sutures that are placed in the center of the dural opening from those near the edge. These
73 Poppen sutures are named after J.L. Poppen, and are one of his many contributions to
74 neurosurgery.³

75 Throughout the last 20 years, several researchers have expressed their growing doubt about the
76 role of tenting sutures in contemporary neurosurgical practice. There have been several
77 retrospective reports questioning the ongoing need for dural tenting sutures.^{2 4-6} Apparently,
78 Dandy's explanation about hemostasis under hypotensive conditions being deceiving and
79 eventually causing EDH may be obsolete. These days, proper anesthesiology, including
80 normovolemia and normotension, enables real-time evaluation of the hemostasis. The latter has
81 been further improved by modern hemostatic agents, such as bone wax, electrocautery, oxidized
82 cellulose polymer materials, collagen sponges, etc. Altogether, these improvements may be
83 enough for effective extradural hemostasis. Reports of some surgeons avoiding dural tenting
84 sutures, in some papers^{5 7} or in day-to-day practice, further supports this explanation.

85 Study rationale

86 There is a risk of EDH formation – supposedly decreased with the use of dural tenting sutures –
87 in the postoperative period and this should not be ignored. However, as mentioned earlier, studies

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3 88 (the majority retrospective) have implied not tenting the dura is safe. Dural tenting prolongs the
4
5 89 time of surgery, which may be a reason to omit these sutures. Moreover, the sutures may
6
7 90 potentially increase the risk of adverse effects, such as cerebrospinal fluid (CSF) leak and
8
9 91 damage to cortical matter or blood vessels with subsequent subdural or intracerebral hemorrhage.
10
11 92 There have also been several reports of more unusual complications like subdural hygroma,⁸
12
13 93 granuloma,⁹ or pial arteriovenous fistula.¹⁰ Thus, refraining from dural tenting sutures would
14
15 94 shorten the surgery and reduce the operative risk.

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18 95 Therefore, evaluation of this procedure is interesting not only from the surgical point of view, but
19
20 96 also by modern, evidence-based standards. Not a single systematic review has been performed
21
22 97 to date to establish the necessity of dural tenting. Moreover, its impact on short-term postoperative
23
24 98 headaches or CSF leak has not been established in an evidence-based manner. Thus, a
25
26 99 systematic review is necessary and subsequently allows for a meta-analysis. However, many
27
28 100 researches have evoked *a priori* preparation of protocols for a systematic review.¹¹ The aim of
29
30 101 registration and/or publication of protocols is to increase the quality of subsequent systematic
31
32 102 reviews. This is achieved by external editorial systems reducing publication bias and improving
33
34 103 transparency and accuracy.

35 36 37 38 39 104 Objective

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41 105 To prepare a protocol for a systematic review that will determine the safety of not tenting the dura
42
43 106 during an elective craniotomy.

44 45 46 47 107 Methods and analysis

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49 108 The review will be conducted according to the Cochrane Handbook for Systematic Reviews of
50
51 109 Intervention¹² and data will be reported in coherence with the PRISMA statement
52
53 110 recommendations.¹¹ The quality of evidence for each outcome will be assessed according to the
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3 111 Grading of Recommendations Assessment, Development, and Evaluation (GRADE) framework.¹³
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5 112 EndNote X8.2 (or newer version) and Review Manager 5.3 (or newer version) software will be
6
7 113 used for electronic data management. This review has been registered with PROSPERO
8
9 114 (registration number: CRD42018097089). Moreover, this protocol follows the PRISMA-P 2015
10
11 115 statement.¹⁴
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14 116 Eligibility criteria

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16
17 117 The type of studies included will be primarily randomized controlled trials (RCT) and quasi-RCTs.
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19 118 Moreover, to obtain enough statistical power, the study will also include cross-over studies,
20
21 119 published in English literature after 1970, and case series.
22
23

24 120 Participants

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26 121 The participants will include all patients who qualify for a craniotomy, regardless of their diagnosis.
27
28 122 Demographic criteria will not be limited.
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31 123 Interventions and comparisons

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33
34 124 As tenting the dura is a widely accepted reference method, it is the authors' firm belief that the
35
36 125 intervention should be not tenting the dura. Thus, patients with dural tenting sutures would
37
38 126 constitute a control group. However, different allocations of control and intervention groups will
39
40 127 be included as well as a comparison of dural tenting and not tenting. The intervention will be
41
42 128 considered in a dichotomous manner using minimum information, such as "tenting the dura" and,
43
44 129 conversely, "not tenting the dura", regardless of the number, position, or type of sutures.
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47 130 Outcomes

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49 131 The outcomes that are considered likely to be meaningful are: reoperation due to EDH and the
50
51 132 postoperative 30-day mortality. However, the latter is not suitable for a primary endpoint as it is
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53 133 affected by many factors (for instance, preoperative condition of the patient and type of
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3 134 intracranial lesion) and the heterogeneity of the group. Thus, reoperation due to EDH should be
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5 135 the primary outcome, as it is the most accurate way to measure the safety of not tenting the dura.
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8 136 Information sources

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10 137 The systematic review will cover standard bibliographic databases: MEDLINE, PUBMED,
11
12 138 EMBASE, Google Scholar, Cochrane Library, ProQuest, ScienceDirect, as well as trial registers
13
14 139 (clinicaltrials.gov, EU register, ISRCTN), conference abstracts and grey literature searched with
15
16 140 Google Web Search, and systematic review registers (PROSPERO). Moreover, the references
17
18 141 of all relevant articles will be scanned.
19
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21 142 Search strategy

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24 143 The search strategy for PUBMED and EMBASE is presented in Table 2. Table 3 provides
25
26 144 additional search phrases that may support and/or modify the main search. A PRISMA flow
27
28 145 diagram will be included in the review.
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30

31 146 Study records

32 147 Selection process

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35 148 All search results will be imported into EndNote and the software will remove any duplicates.
36
37 149 Then, two independent reviewers (ŁP, PK) will perform a preliminary screening of titles and
38
39 150 abstracts for inclusion. At this stage, all conflicts will be included. Next, the full text of studies will
40
41 151 be obtained, and two reviewers will apply inclusion criteria to identify relevant studies to be
42
43 152 included in the systematic review. Conflicts will be discussed, and when needed, a third reviewer
44
45 153 (AM) will be involved. The review will contain a table of included and excluded studies with their
46
47 154 characteristics and reasons for inclusion and exclusion.
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155 Data collection process and data items

156 Data will be extracted by one author (ŁP) using a previously prepared standardized form at the
157 study level. The following data will be obtained: 1) characteristics of the group of participants (age,
158 sex, diagnosis); 2) type of surgery (supratentorial vs. infratentorial vs. skull base, elective vs.
159 emergency, craniotomy vs. craniectomy) and indication (aneurysm, tumor, trauma, epilepsy, etc.);
160 3) definition of an intervention (number of tenting sutures, information about wound drainage,
161 hemostatic agents used during closure of the dura) and a control group; and 4) outcome measures
162 (number of EDH, number of reoperations, deaths, midline shift, size and volume of extradural
163 collections), as discussed earlier.

164 Risk of bias in individual studies

165 The risk of bias in the individual studies will be assessed at the study level. It will be performed
166 by one author (ŁP) using the Cochrane Collaboration's Risk of Bias Tool [15](#) and checked by a
167 second reviewer (PK).

168 Data Synthesis

169 There will be two categories of data collection depending on the type of endpoint, either binary or
170 continuous. Risk ratios will be calculated to measure the risk of specific events, such as
171 reoperation due to extradural hematoma, CSF leak, death, and the standardized mean
172 differences for the midline shift, volume, and size of the extradural collection. We will pool the
173 results using a random-effects meta-analysis, with standardized mean differences for continuous
174 outcomes and risk ratios for binary outcomes, and calculate 95% confidence intervals and two
175 sided P values for each outcome. The heterogeneity of effect measures between the studies will
176 be assessed using both the χ^2 test and the I² statistic. We will consider an I² value greater than
177 50% to be indicative of substantial heterogeneity.

178 Subgroup analysis

179 If sufficient data are available, we plan to conduct subgroup analyses according to craniotomy vs.
180 craniectomy, supratentorial vs. infratentorial surgery, skull base vs. no skull base in range of the
181 surgery, and elective vs. emergency surgery. Such actions will allow the identification of potential
182 sources of heterogeneity.

183 Discussion

184 The choice of proper eligibility criteria is important when conducting a systematic review. In this
185 protocol, there was a lot consideration regarding the choice of population, intervention,
186 comparison and outcome (PICO). Some authors regard only craniotomies as suitable for the
187 study, in contrast to craniectomies. The reason for this is that restored bone allows the
188 measurement of the potential fluid collection volume in intracranial-extradural space and the
189 assessment of how it affects the whole brain in the closed cranial cavity. Nevertheless, it is
190 reasonable to include studies with craniectomies.

191 Other valuable endpoints could include any new neurologic deficit or previously existing
192 deterioration, an external or internal CSF leak requiring treatment, deterioration of postoperative
193 headaches, extradural fluid collection (EDH, CSF, air, etc.), and the midline shift. None of these
194 will be included if there is not enough data for testing.

195 Examining the most basic and elementary procedures may, surprisingly, be the most challenging
196 and intimidating task. Due to a lack of such actions, it is possible that most brain surgeons have
197 been using surgical techniques that bring no benefit and only extend the operation. Hence, there
198 is a great need for this study. The results may finally determine if dural tenting sutures are
199 necessary in modern neurosurgery.

Tables

Dural tenting sutures synonyms
Hitch sutures
Tack-up sutures
Dural periosteal sutures
Tacking sutures
Stay sutures
Suspension sutures
Sleeper sutures
Dandy sutures
Poppen sutures

Table 1. Synonyms of dural tenting sutures

Search strategy for PubMed database

"dural sutures" OR "dural tenting sutures" OR "dura mater sutures" OR "dural stitches" OR
 "dural tenting stitches" OR "dura mater stitches" OR "hitch sutures" OR "hitch sutures of the
 dura" OR "hitching of the dura" OR "dural hitching" OR "hitch sutures of the dura" OR "hitching
 the dura" OR "hitching of the dura"
 OR "tenting sutures" OR "tenting stitches" OR "tenting of the dura" OR "dural tenting" OR "dural
 tenting sutures" OR "dural tenting stitches" OR "tack-up sutures" OR "tack-up stitches" OR
 "tack-up dura" OR "tack-up dural" OR "tacking sutures" OR "tacking sutures" OR "tacking dura
 sutures" OR "tacking dural sutures" OR "tacking dura" OR "tacking dural stitches" OR "tacking
 dural stitches" OR "tacking up dura" OR "tacking up sutures" OR "tacking up stitches" OR
 "dural periosteal sutures" OR "dural periosteal stitches" OR "stay sutures" OR "dural stay
 sutures" OR "stay sutures" OR "dural stay stitches" OR "suspension sutures" OR "suspension
 dural sutures" OR "suspension dura sutures" OR "suspension stitches" OR "suspension dural
 stitches" OR "suspension dura stitches" OR "dural suspension" OR "suspending the dura" OR
 "suspension of the dura" OR "sleeper sutures" OR "sleeper stitches" OR "epidural sutures" OR
 "epidural stitches" OR "dural suture" OR "dural tenting suture" OR "dura mater suture" OR
 "dural stitch" OR "dural tenting stitch" OR "dura mater stitch" OR "hitch stitch" OR "hitch stitch
 of the dura" OR "hitching of the dura" OR "dural hitching" OR "hitch stitch of the dura" OR
 "hitching the dura" OR "hitching of the dura" OR "tenting suture" OR "tenting stitch" OR "tenting
 of the dura" OR "dural tenting" OR "dural tenting suture" OR "dural tenting stitch" OR "tack-up
 suture" OR "tack-up stitch" OR "tack-up dura" OR "tack-up dural" OR "tacking stitch" OR
 "tacking suture" OR "tacking dura suture" OR "tacking dural suture" OR "tacking dura" OR
 "tacking dural stitch" OR "tacking dural stitch" OR "tacking up dura" OR "tacking up suture"
 OR "tacking up stitch" OR "dural periosteal suture" OR "dural periosteal stitch" OR "stay suture"
 OR "dural stay suture" OR "stay stitch" OR "dural stay stitch" OR "suspension suture" OR
 "suspension dural suture" OR "suspension dura suture" OR "suspension stitch" OR
 "suspension dural stitch" OR "suspension dura stitch" OR "dural suspension" OR "suspending
 the dura" OR "suspension of the dura" OR "sleeper suture" OR "sleeper stitch" OR "epidural
 suture" OR "epidural stitch"

Table 2. PubMed search strategy

Additional search phrases in PubMed database

("Dura Mater/surgery"[Mesh]) AND ("Hematoma, Epidural, Cranial/prevention and control"[Mesh])
((("Dura Mater"[Mesh] OR "Dura Mater"[TW])) AND ("Suture Techniques"[Mesh] OR ["Suture Techniques"[TW]))
("Dura Mater"[Mesh]) AND "Hematoma, Epidural, Cranial/prevention and control"[Mesh]
((("Postoperative Period"[Mesh] OR "Postoperative Period"[text word])) AND "Hematoma, Epidural, Cranial"[Mesh])

Table 3. Additional search phrases in PubMed database.

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1
2
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7

8 **Competing interests statement.**
9

10 None to declare.
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Secondary Subject Heading:	Neurology, Surgery
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Contributions

ŁP conceived the presented idea and prepared the manuscript; PK critically revised the manuscript, AM validated the final version of the manuscript; JŻ analyzed the data; DJ, JF, and KW contributed to the design of the study; PŁ and PL helped supervise the project; RR, DS, and TT provided the methodologic background. All authors reviewed the final manuscript.

Amendments

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Sponsor

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35 **Abstract**

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50 **Ethics and dissemination**

51 Ethical committee approval is not required for a systematic review protocol. Findings will be
52 presented at international neurosurgical conferences and published in a peer-reviewed medical
53 journal.

54 **Systematic review registration**

55 PROSPERO 2018 CRD42018097089

56 **Keywords**

57 Dural tenting sutures, craniotomy, extradural hematoma

58 **Strengths and limitations of this study**

- 59 • To the best of our knowledge, this will be the first systematic review evaluating the necessity of
60 dural tenting sutures.
- 61 • To obtain enough patient data, observational studies will be included with randomized
62 controlled trials.
- 63 • The choice of inclusion criteria remains debatable as there may not be enough randomized
64 clinical trials and, thus, other types of studies may be included.

65 Introduction

66 In the early days of neurosurgery, extradural hemorrhage (EDH) contributed to high mortality after
67 craniotomies. Almost a century ago, Walter Dandy reported dural tenting sutures as an effective
68 way of preventing postoperative EDH.¹ Over time, his technique gained in popularity and
69 significance to finally become a neurosurgical standard. Dural tenting is a well-known method of
70 stitching the dura to the bone or pericranium after craniotomy. This decreases the extradural
71 space where EDH could arise and compresses dural vessels, which are potential sources of EDH.
72 These sutures are known by many names (Table 1).² In addition, some terms distinguish dural
73 tenting sutures that are placed in the center of the dural opening from those near the edge, as
74 was originally described by Dandy. These central tenting sutures are named after J.L. Poppen,
75 and are one of his many contributions to neurosurgery.³

76 Throughout the last 20 years, several researchers have expressed their growing doubt about the
77 role of tenting sutures in contemporary neurosurgical practice. There have been several
78 retrospective reports questioning the ongoing need for dural tenting sutures.^{2 4-6} Apparently,
79 Dandy's explanation about intraoperative hemostasis under hypotensive conditions being
80 deceiving and subsequently causing EDH may be obsolete. These days, proper anesthesiology,
81 including normovolemia and normotension, enables real-time evaluation of the hemostasis. The
82 latter has been further improved by modern hemostatic agents, such as bone wax, electrocautery,
83 oxidized cellulose polymer materials, collagen sponges, etc. Altogether, these improvements may
84 be enough for effective and actual extradural hemostasis. Reports of some surgeons avoiding
85 dural tenting sutures, in some papers^{5 7} or in day-to-day practice, further support this explanation.

86 Study rationale

87 There is a risk of EDH formation – supposedly decreased with the use of dural tenting sutures –
88 in the postoperative period and this should not be ignored. However, as mentioned earlier, studies

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3 89 (the majority retrospective) have implied not tenting the dura is safe. Dural tenting prolongs the
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5 90 time of surgery, which may be a reason to omit these sutures. Moreover, the sutures may
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7 91 potentially increase the risk of adverse effects, such as cerebrospinal fluid (CSF) leak and
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9 92 damage to cortical matter or blood vessels with subsequent subdural or intracerebral hemorrhage.
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11 93 There have also been several reports of more unusual complications like subdural hygroma,⁸
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13 94 granuloma,⁹ or pial arteriovenous fistula.¹⁰ Thus, refraining from dural tenting sutures would
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15 95 shorten the surgery and reduce the operative risk.

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18 96 Therefore, evaluation of this procedure is interesting not only from the surgical point of view, but
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20 97 also by modern, evidence-based standards. Not a single systematic review has been performed
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22 98 to date to establish the necessity of dural tenting. Moreover, its impact on short-term postoperative
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24 99 headaches or CSF leak has not been established in an evidence-based manner. Thus, a
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26 100 systematic review is necessary and subsequently allows for a meta-analysis. However, many
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28 101 researches have evoked *a priori* preparation of protocols for a systematic review.¹¹ The aim of
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30 102 registration and/or publication of protocols is to increase the quality of subsequent systematic
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32 103 reviews. This is achieved by external editorial systems reducing publication bias and improving
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34 104 transparency and accuracy.

35 36 37 38 39 105 Objective

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41 106 To prepare a protocol for a systematic review that will determine the safety of not tenting the dura
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43 107 during an elective craniotomy.

44 45 46 47 108 Methods and analysis

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49 109 The review will be conducted according to the Cochrane Handbook for Systematic Reviews of
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51 110 Intervention¹² and data will be reported in coherence with the PRISMA statement
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53 111 recommendations.¹¹ The quality of evidence for each outcome will be assessed according to the
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3 112 Grading of Recommendations Assessment, Development, and Evaluation (GRADE) framework.¹³
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5 113 EndNote X8.2 (or newer version) and Review Manager 5.3 (or newer version) software will be
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7 114 used for electronic data management. This review has been registered with PROSPERO
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9 115 (registration number: CRD42018097089). Moreover, this protocol follows the PRISMA-P 2015
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11 116 statement.¹⁴
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14 117 Eligibility criteria

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17 118 The type of studies included will be primarily randomized controlled trials (RCT) and quasi-RCTs.
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19 119 Moreover, to obtain enough statistical power, the study will also include cross-over studies,
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21 120 published in English literature after 1970, and case series.
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24 121 Participants

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26 122 The participants will include all patients who qualify for a craniotomy, regardless of their diagnosis.
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28 123 Demographic criteria will not be limited.
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31 124 Interventions and comparisons

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34 125 As tenting the dura is a widely accepted reference method, it is the authors' firm belief that the
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36 126 intervention should be not tenting the dura. Thus, patients with dural tenting sutures would
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38 127 constitute a control group. However, different allocations of control and intervention groups will
39
40 128 be included as well as a comparison of dural tenting and not tenting. The intervention will be
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42 129 considered in a dichotomous manner using minimum information, such as "tenting the dura" and,
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44 130 conversely, "not tenting the dura", regardless of the number, position, or type of sutures.
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47 131 Outcomes

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49 132 The outcomes that are considered likely to be meaningful are: reoperation due to EDH and the
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51 133 postoperative 30-day mortality. However, the latter is not suitable for a primary endpoint as it is
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53 134 affected by many factors (for instance, preoperative condition of the patient and type of
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3 135 intracranial lesion) and the heterogeneity of the group. Thus, reoperation due to EDH should be
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5 136 the primary outcome, as it is the most accurate way to measure the safety of not tenting the dura.
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8 137 Information sources

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10 138 The systematic review will cover standard bibliographic databases: MEDLINE, PUBMED,
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12 139 EMBASE, Google Scholar, Cochrane Library, ProQuest, ScienceDirect, as well as trial registers
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14 140 (clinicaltrials.gov, EU register, ISRCTN), conference abstracts and grey literature searched with
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16 141 Google Web Search, and systematic review registers (PROSPERO). Moreover, the references
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18 142 of all relevant articles will be scanned.
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21 143 Search strategy

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24 144 The search strategy for PUBMED and EMBASE is presented in Table 2. Table 3 provides
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26 145 additional search phrases that may support and/or modify the main search. A PRISMA flow
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28 146 diagram will be included in the review.
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31 147 Study records

32 148 Selection process

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36 149 All search results will be imported into EndNote and the software will remove any duplicates.
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38 150 Then, two independent reviewers (ŁP, PK) will perform a preliminary screening of titles and
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40 151 abstracts for inclusion. At this stage, all conflicts will be included. Next, the full text of studies will
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42 152 be obtained, and two reviewers will apply inclusion criteria to identify relevant studies to be
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44 153 included in the systematic review. Conflicts will be discussed, and when needed, a third reviewer
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46 154 (AM) will be involved. The review will contain a table of included and excluded studies with their
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48 155 characteristics and reasons for inclusion and exclusion.
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156 Data collection process and data items

157 Data will be extracted by one author (ŁP) using a previously prepared standardized form at the
158 study level. The following data will be obtained: 1) characteristics of the group of participants (age,
159 sex, diagnosis); 2) type of surgery (supratentorial vs. infratentorial vs. skull base, elective vs.
160 emergency, craniotomy vs. craniectomy) and indication (aneurysm, tumor, trauma, epilepsy, etc.);
161 3) definition of an intervention (number of tenting sutures, information about wound drainage,
162 hemostatic agents used during closure of the dura) and a control group; and 4) outcome measures
163 (number of EDH, number of reoperations, deaths, midline shift, size and volume of extradural
164 collections), as discussed earlier.

165 Risk of bias in individual studies

166 The risk of bias in the individual studies will be assessed at the study level. It will be performed
167 by one author (ŁP) using the Cochrane Collaboration's Risk of Bias Tool [15](#) and checked by a
168 second reviewer (PK).

169 Data Synthesis

170 There will be two categories of data collection depending on the type of endpoint, either binary or
171 continuous. Risk ratios will be calculated to measure the risk of specific events, such as
172 reoperation due to extradural hematoma, CSF leak, death, and the standardized mean
173 differences for the midline shift, volume, and size of the extradural collection. We will pool the
174 results using a random-effects meta-analysis, with standardized mean differences for continuous
175 outcomes and risk ratios for binary outcomes, and calculate 95% confidence intervals and two
176 sided P values for each outcome. The heterogeneity of effect measures between the studies will
177 be assessed using both the χ^2 test and the I² statistic. We will consider an I² value greater than
178 50% to be indicative of substantial heterogeneity.

179 Subgroup analysis

180 If sufficient data are available, we plan to conduct subgroup analyses according to craniotomy vs.
181 craniectomy, supratentorial vs. infratentorial surgery, skull base vs. no skull base in range of the
182 surgery, and elective vs. emergency surgery. Such actions will allow the identification of potential
183 sources of heterogeneity.

184 Patients and Public Involvement

185 This type of study does not require patients and or public involvement.

186 Discussion

187 The choice of proper eligibility criteria is important when conducting a systematic review. In this
188 protocol, there was a lot consideration regarding the choice of population, intervention,
189 comparison and outcome (PICO). Some authors regard only craniotomies as suitable for the
190 study, in contrast to craniectomies. The reason for this is that restored bone allows the
191 measurement of the potential fluid collection volume in intracranial-extradural space and the
192 assessment of how it affects the whole brain in the closed cranial cavity. Nevertheless, it is
193 reasonable to include studies with craniectomies.

194 Other valuable endpoints could include any new neurologic deficit or previously existing
195 deterioration, an external or internal CSF leak requiring treatment, deterioration of postoperative
196 headaches, extradural fluid collection (EDH, CSF, air, etc.), and the midline shift. None of these
197 will be included if there is not enough data for testing.

198 Examining the most basic and elementary procedures may, surprisingly, be the most challenging
199 and intimidating task. Due to a lack of such actions, it is possible that most brain surgeons have
200 been using surgical techniques that bring no benefit and only extend the operation. Hence, there

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3 201 is a great need for this study. The results may finally determine if dural tenting sutures are
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5 202 necessary in modern neurosurgery.
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8 203 **Ethics and dissemination**
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10 204 Ethical committee approval is not required for a systematic review protocol. Findings will be
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12 205 presented at international neurosurgical conferences and published in a peer-reviewed medical
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Tables

Dural tenting sutures synonyms
Hitch sutures
Tack-up sutures
Dural periosteal sutures
Tacking sutures
Stay sutures
Suspension sutures
Sleeper sutures
Dandy sutures
Poppen sutures

Table 1. Synonyms of dural tenting sutures

Search strategy for PubMed database

"dural sutures" OR "dural tenting sutures" OR "dura mater sutures" OR "dural stitches" OR
 "dural tenting stitches" OR "dura mater stitches" OR "hitch sutures" OR "hitch sutures of the
 dura" OR "hitching of the dura" OR "dural hitching" OR "hitch sutures of the dura" OR "hitching
 the dura" OR "hitching of the dura"
 OR "tenting sutures" OR "tenting stitches" OR "tenting of the dura" OR "dural tenting" OR "dural
 tenting sutures" OR "dural tenting stitches" OR "tack-up sutures" OR "tack-up stitches" OR
 "tack-up dura" OR "tack-up dural" OR "tacking sutures" OR "tacking sutures" OR "tacking dura
 sutures" OR "tacking dural sutures" OR "tacking dura" OR "tacking dural stitches" OR "tacking
 dural stitches" OR "tacking up dura" OR "tacking up sutures" OR "tacking up stitches" OR
 "dural periosteal sutures" OR "dural periosteal stitches" OR "stay sutures" OR "dural stay
 sutures" OR "stay stitches" OR "dural stay stitches" OR "suspension sutures" OR "suspension
 dural sutures" OR "suspension dura sutures" OR "suspension stitches" OR "suspension dural
 stitches" OR "suspension dura stitches" OR "dural suspension" OR "suspending the dura" OR
 "suspension of the dura" OR "sleeper sutures" OR "sleeper stitches" OR "epidural sutures" OR
 "epidural stitches" OR "dural suture" OR "dural tenting suture" OR "dura mater suture" OR
 "dural stitch" OR "dural tenting stitch" OR "dura mater stitch" OR "hitch stitch" OR "hitch stitch
 of the dura" OR "hitching of the dura" OR "dural hitching" OR "hitch stitch of the dura" OR
 "hitching the dura" OR "hitching of the dura" OR "tenting suture" OR "tenting stitch" OR "tenting
 of the dura" OR "dural tenting" OR "dural tenting suture" OR "dural tenting stitch" OR "tack-up
 suture" OR "tack-up stitch" OR "tack-up dura" OR "tack-up dural" OR "tacking stitch" OR
 "tacking suture" OR "tacking dura suture" OR "tacking dural suture" OR "tacking dura" OR
 "tacking dural stitch" OR "tacking dural stitch" OR "tacking up dura" OR "tacking up suture"
 OR "tacking up stitch" OR "dural periosteal suture" OR "dural periosteal stitch" OR "stay suture"
 OR "dural stay suture" OR "stay stitch" OR "dural stay stitch" OR "suspension suture" OR
 "suspension dural suture" OR "suspension dura suture" OR "suspension stitch" OR
 "suspension dural stitch" OR "suspension dura stitch" OR "dural suspension" OR "suspending
 the dura" OR "suspension of the dura" OR "sleeper suture" OR "sleeper stitch" OR "epidural
 suture" OR "epidural stitch" OR "extradural stitch" OR "extradural suture"

Table 2. PubMed search strategy

Additional search phrases in PubMed database
("Dura Mater/surgery"[Mesh]) AND ("Hematoma, Epidural, Cranial/prevention and control"[Mesh])
(("Dura Mater"[Mesh] OR "Dura Mater"[TW])) AND ("Suture Techniques"[Mesh] OR ["Suture Techniques"[TW])
("Dura Mater"[Mesh]) AND "Hematoma, Epidural, Cranial/prevention and control"[Mesh]
(("Postoperative Period"[Mesh] OR "Postoperative Period"[text word])) AND "Hematoma, Epidural, Cranial"[Mesh]

Table 3. Additional search phrases in PubMed database.

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