Orthopaedics & Traumatology: Surgery & Research (2012) 98, 879—886

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ORIGINAL ARTICLE

Surgical dural tears: Prevalence and updated management protocol based on 1359 lumbar vertebra interventions

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Accepted: 5 June 2012

KEYWORDS
Dural tear;
Incidental durotomy;
Cerebrospinal fluid leak;
Glue;
Fibrin sealant;
Iatrogenic meningocele

Summary
Introduction: The dural tear is a dreaded complication of lumbar surgery.
Hypothesis: Our management protocol has made it possible to deal with this problem effectively.
Materials and methods: Retrospective review of 1359 patients operated between 2000 and 2010. In the event of dural tear, a therapeutic protocol was applied: suturing the dural wound if possible. A collagen patch lined with a layer of fibrin glue protected the suture. If the suture was considered tight, a non-aspirating drain was set up for 48 h. In the other cases, no drain was set up. All the patients were left supine for 48 h and they received intravenous antibiotics for the same duration. We analyzed the number and the type of breaches, the possibility of suturing, clinical symptoms (headache), and delayed complications (dural fistula or meningoceles).
Results: The 1359 procedures included 23 dural tear complications (1.7%). The tears were often small in size and reparable. There were no late complications detected: no symptomatic fistula or meningocele. None of the patients had a second surgery.
Discussion: This protocol provided effective management of dural tears in lumbar surgery, with no application problems. We suggest a number of improvements: the use of the Valsalva maneuver to test the suturing, a stand-up test for the patient, and a systematic late MRI to detect meningoceles. There is no reason to change the other points in the protocol: suturing, controlled drainage for watertight wounds, no drainage for the non-watertight wounds, antibiotics, and supine bed rest position 48 h.
Level of evidence: Level IV. Retrospective study.

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doi:10.1016/j.otsr.2012.06.016

Introduction

The dural wound is a dreaded complication in lumbar surgery because of the cascade of more or less serious secondary effects, most particularly neurological (dural fistula, intracranial hematoma, meningitis), that can be set off.

Paradoxically, there are few standardized protocols to guide management of these patients. The objective of this study was to assess our patient management protocol, compare it with existing protocols, and propose improvements for the measures to be taken in these cases.

Material and methods

Material

This was a retrospective study: 1359 patients were operated by a single operator (SW) at the lumbar level from 2000 to 2010: these were interventions with a posterior spinal approach. Fractures were excluded because they generate dural wounds. The closed canal procedures were excluded, as were extended deformities. The series included 51% females, the mean age was 46 years (range, 16—88 years, SD = 15). The mean follow-up was 5 years.

The main diagnoses are reported in Table 1.

Protocol

The treatment protocol was consistent, following a decisional tree (Fig. 1).

In cases of saturable dural tear, polypropylene suture with a thick layer of fibrin glue lined with a layer of collagen was used.

Non-aspirating drainage was set up if the wound was perfectly watertight. The patient was kept in the supine position for 48 h and the drain removed after 48 h. Drainage was installed to prevent hematomas.

In cases of tears that could not be sutured (particularly in minimally invasive surgery), a collagen patch was applied followed by covering the zone with a thick layer of fibrin glue; no drainage was set up and the patient was kept in a supine position for 48 h.

In cases of dural breach with no arachnoid opening: a layer of fibrin glue covered with a layer of collagen was used; no supine position was imposed; drainage was used for conventional surgery and no drainage for cases of minimally invasive surgery.

Injectable antibiotic therapy was systematic for 48 h (cefazolin or vancomycin if the patient was allergic to penicillin).

Methods

The data were collected from a computerized registry of our interventions. This registry contains essential information: patient identity, diagnosis, surgical technique, and intra- and postoperative complications.

Using a query, we identified the dural wounds and studied the surgical reports and observations kept in the computerized patient file. The number and type of tears, whether suturing was possible, clinical symptoms (headache), and delayed complications (fistula or meningocele) were recorded.

The patients were systematically seen 1 month and 6 months after the intervention. MRI was not systematic.

PubMed was searched to establish the bibliography using the following keywords: ''dural tear,'' ''incidental durotomy,'' ''cerebrospinal fluid leak,'' ''glue,'' and ''fibrin sealant'' as well as the main sealants cited: Tissucol®; Tachosil®; Beriplast®; Duraseal®; Vivostat®; Pangen®; Surgicel®; and Bioglue®.

Articles that had a high number of patients operated, dural tears, those that proposed a complete protocol or a fully described or original technique were retained; literature reviews were also studied.

Results

Descriptive analysis

The 1359 procedures included 23 dural tears detected (1.7%) (Table 2).

There were four types of tears encountered: punctiform with leakage (7) or with no leakage (5), less than 1 cm (9), and between 1 and 2 cm (7).

In five cases, the breach was considered unsuturable given its location and the type of approach. The wounds were described as anterolateral.

Risk factor analysis

In this series, we found no particular risk factors: few revisions were complicated by dural tears (2/23; 8.7%).

Progression and later complications

There were no early revisions for dural cerebrospinal fluid leakage.

The later clinical progression was uneventful. Five MRIs were performed and did not show meningocele.

Table 1 Surgical indications of the patients included in the series.

Diagnosis	Frequency (%)	Treatment	
Herniated nucleus pulposus	40	Microdiscectomy[a]: 87%	open: 13%
Lumbar stenosis	40	37% with osteosynthesis	63% with no material
Spondylolisthesis	15	Arthrodesis with laminectomy, PLIF or TLIF	
Tumors	5	60% with osteosynthesis	40% laminectomy

[a] Minimally invasive procedure with microscope.

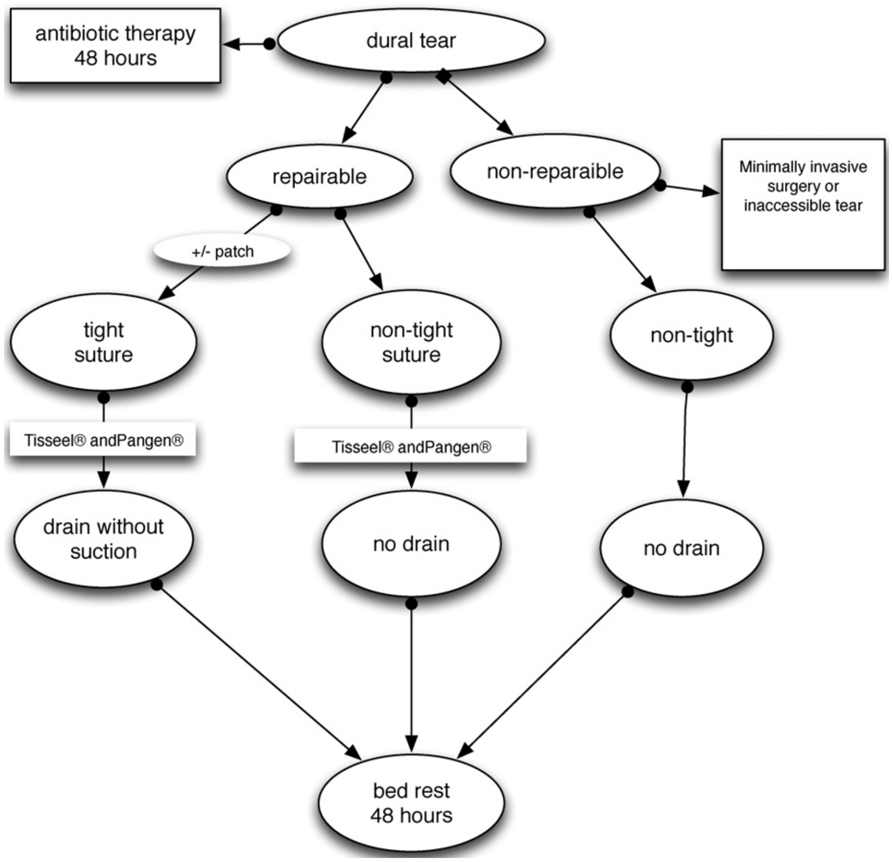

Figure 1 Management protocol for incidental dural tears.

Discussion

Composition of the series, tear rate, and general comments

This was a series of patients operated by a single operator. It was a series of standard lumbar pathology surgery with, however, a large proportion of minimally invasive surgeries (microdiscectomy).

The rate of dural wounds is highly variable: from 1% [1] to 14% [2]. Even when limited to lumbar pathology, the composition of series influences the tear rate. Minimally invasive techniques result in a low complication rate. Revision is a frequently cited risk factor for dural breach [3,4]; in the present series, revision surgeries (8.8%) did not result in more dural tears. The increasing use of minimally invasive techniques with microscope in these revisions has made reintervention easier.

Pertinence and limit of the protocol and comparison with the only existing complete protocol published

Our protocol has allowed us to effectively manage lumbar dural tears. There were no revisions, dural fistulae, or meningoceles. Simple to apply, this protocol did not give rise to any compliance problems. However, it should be noted that the number of dural tears is limited: the rarity of the incident encountered in a general series comparable to the other series should moderate the certainty of our conclusions.

Only a single study presents a complete protocol for managing dural tears: Khan et al. [5] report a large series of 153 breaches with a well-detailed management algorithm. All the dural tears were sutured, which excludes the most unfavorable situation. As in our study, a complete protocol should include the measures to take in cases of dural breaches that cannot be sutured, which can present the most difficult problems. The protocol presented by Khan et al. [5] does not include late evaluation of meningoceles, as in our study. This was a retrospective study like all the other comparable series.

Critical study of each point of the protocol:

Suturing

Suturing is the best way to treat dural tears. In case it is impossible to suture directly on the edges of the dura mater, many other techniques have been described: an adipose patch, aponeurotic tissue, which is always available, or (poly[lactic]-co-glycolic acid [PLGA, vicryl®]) patches are used.

A few rare articles (Narotam et al. [6], Black [7]) defend not suturing. This option is reasonable in three circumstances:

Table 2 Descriptive analysis.

Diagnosis	Intervention	Review	Type of tear	Repair
S	Laminectomy L3L5	No	< 1 cm	Suturing, glue, collagen
SPL	Laminectomy L4L5	No	< 1 cm	Suturing, glue, collagen
SPL	Laminectomy-arthrodesis L4L5	No	< 1 cm	Suturing, glue, collagen
SPL	Laminectomy-arthrodesis L4L5	No	< 1 cm	Suturing, glue, collagen
SPL	Laminectomy-arthrodesis L4L5	No	< 1 cm	Glue and collagen
S	Laminectomy-arthrodesis L3S1	No	< 1 cm	Suturing, glue, collagen
HNP	Discectomy-laminectomy	No	< 1 cm	Suturing, glue, collagen
S	Laminectomy L4L5	No	< 1 cm	Suturing, glue, collagen
S	Laminectomy-arthrodesis L4L5	No	< 2 cm	Suturing, glue, collagen
HNP	Discectomy - laminectomy	No	< 2 cm	Suturing, glue, collagen
HNP	Microdiscectomy L4L5	No	Punctiform with leakage	Glue and collagen
S	Laminectomy-arthrodesis L4L5	No	Punctiform with leakage	Suturing, glue, collagen
HNP	Microdiscectomy L4L5	No	Punctiform with leakage	Glue and collagen
HNP	Microdiscectomy L4L5	No	Punctiform with leakage	Glue and collagen
HNP	Microdiscectomy L4L5	No	Punctiform with leakage	Glue and collagen
HNP	Laminectomy L4L5	Yes	Punctiform with no leakage	Glue and collagen
S	Laminectomy L3L5	No	Punctiform with no leakage	Glue and collagen
SPL	Laminectomy - arthrodesis L4L5	No	Punctiform with no leakage	Glue and collagen
S	Laminectomy L4L5	No	Punctiform with no leakage	Suturing, glue, collagen
SPL	Laminectomy-arthrodesis L4L5	No	Punctiform with no leakage	Glue and collagen
SPL	Laminectomy - arthrodesis L4L5	No	Punctiform with no leakage	Glue and collagen
HNP	Microdiscectomy	Yes	Punctiform with no leakage	Glue and collagen
S	Laminectomy L4L5	No	Punctiform with no leakage	Glue and collagen

S: stenosis; SPL: spondylolisthesis; HNP: herniated nucleus pulposus.

- if there is a breach in the dura mater with no breach in the arachnoid. In this case, the risk of hernia of the arachnoid is balanced by the risk of cerebrospinal fluid (CSF) leakage through the needle holes during suturing;
- if the procedure is minimally invasive. In this case, suturing is very difficult to perform: some authors have described minimally invasive suturing techniques [8]. Clips exist whose use is for the moment described for closing an intentional dural opening [9]. In the present series, for the minimally invasive techniques, we chose not to convert to open surgery with laminectomy. The tears were small (< 1 cm). These minimally invasive techniques were discectomies under the microscope using Caspar's technique;
- if the tear is anterior and completely inaccessible to suturing.

In these three cases, we used glue-tissue and collagen without suturing.

Sealants

There are many publications on the various sealants. Several properties are used: the patch effect, the dead space filling effect, the adherence effect, and the interstice filling effect. The product must seal the breach, adhere to the edges of the tear, fill the dead space around the breach, and infiltrate into the interstices to prevent passage of CSF.

The main products used are presented in Tables 3 and 4. We retained the products frequently used in France, which have been the subject of considerable follow-up and publication. This is a selection that we believe is relevant although non-exhaustive.

None of the existing products fulfills all the functions necessary to permeability of a dural tear. The ideal would be to have a product that allows one to seal wide tears while firmly adhering to the edge of the tear without suturing: new products are appearing, one called NeuroFilm (Obex®), designed for this type of situation. However, they only allow closure of small tears (< 2 cm) and to date we have found no studies reporting on their efficacy.

Table 3 Characteristics of the main dural impermeability products.

	Name	Laboratory	Composition	Mode of action
Active on the coagulation cascade				
Human blood derivative	*Biological glue*			
	Tissucol® (tisseel®, USA)	Baxter	Human fibrinogen, human factor 13, human fibronectin, human plasminogen, bovine aprotinin, human thrombin, blood derivate	Gluing, adhesion, impermeability, reproduces the last phase of coagulation Spray
	Tachosil®	Nycomed	Human fibrinogen, human thrombin, equine collagen sponge, albumin	Equine collagen sponge soaked in human fibrinogen and thrombin stabilized by albumin. It associates the mechanical support and thrombocyte activation properties of a collagen sponge with the hemostatic and adhesive properties of coagulation factors
No specific action on the coagulation cascade	*Hemostatic bandage*			
	Pangen®	Urgo	Bovine collagen for 1 or calf dermis for 2	Activator and platelet hemostatic plug, activator of both coagulation pathways

Table 4 Characteristics of the main dural impermeability products.

	Name	Polymerization time	Indications	AFFSAPS indication
Active on the coagulation cascade				
Human blood derivative	*Biological glue*			
	Tissucol® (Tisseel®, USA)	Complete: 2 h. 70%: 10 min	Dural suturing complement	Adjuvant treatment designed to favor local hemostasis during surgery
	Tachosil®	3 min	Favors tissue gluing and reinforces sutures in vascular surgery. No guidelines for neurosurgery but authorized	Pulmonary and cardiovascular surgery
No specific action on the coagulation cascade	*Hemostatic bandage*			
	Pangen®		Impermeability complement	Hemostasis complement

The frequently used combination of collagen and fibrin has several effects: watertightness, sealing, and filling the dead space. Moreover, it has a beneficial effect on hemostasis.

This combination is found in a single product (Tachosil®) or in the two products used in association (Pangen® and Tissucol®) that we have used. Fibrin glue (Tissucol®, for example) is by far the most widely used product for sealing dural tears.

Can sealants be bypassed in preference for suturing, with the advantage of being more economical? Khan et al. [5] used suturing without sealant with a usual persistent fluid leakage rate.

In cases of watertight breaches, most publications on the subject even advise completion with a fibrin glue [2,3,7,10].

Drainage

Drainage is controversial: drainage, no drainage, variable drainage; all the combinations have their defenders. Drainage is proposed in our protocol in cases of dural tears that have been closed impermeably so as to prevent postoperative extradural hematomas.

Tafazal and Sell [4] raise the diverse attitudes in a study on British surgeons' practices in spinal surgery: some recommend the absence of drainage to prevent excessively draining CSF with the risk of immediate neurological complications. Others defend the utility of controlled drainage, preventing meningoceles and extradural hematomas. Table 5 summarizes these highly variable outlooks.

This variety of attitudes makes analysis difficult. It is challenging to compare the series reported by Khan et al. [5], in which all the breaches were sutured, with Hughes et al.'s series [10], which only reports 16 cases of non-sutured and drained breaches.

It should be retained from the bibliographic study that controlled drainage does not lead to serious neurological complications. On the other hand, its utility in terms of revision rates for persistent CSF leakage and meningocele occurrence remains uncertain.

In minimally invasive surgery, most authors report an absence of hemorrhagic risk and a small dead space. The risk of meningocele seems minimal.

The discussion most particularly concerns non-closed breaches. Sutured tears pose very few problems. In non-watertight suturing, it is not clear that draining results in fewer revisions, although the utility of draining to prevent meningocele can be discussed. The low complication rate has not led us to change the protocol on this point. These theoretical advantages of drainage seem low compared to the risks of cerebral complication because of excessive drainage of the CSF. Moreover, if the frequency of extradural hematomas is one out of 1000 and the frequency of dural tears is less than 5%, the value of drainage to prevent simultaneous complications of an extradural hematoma and a tear is relatively limited.

Bedrest

The goal of bedrest is to reduce the hydrostatic pressure of the CSF. This rest is a well-known recommendation that we have all continued to put into practice. Is it warranted? If the tear has closed and is watertight, suturing should resist an increase in pressure and thus standing in the early hours after surgery. The favorable results of our protocol and the study of other series encourage us not to change this 48-h rest requirement. Only Hodges et al. [11] report a series of 20 patients with a closed dural tear and rapid standing with no drainage. This series with one failure alone does not convince us that a change is necessary.

What seems more debatable is the duration of the rest period: in their protocol, Khan et al. [5] recommended a stand-up test that could result in prolongation of the decubitus position in cases of positional headache. This stand-up test, which conditions the length of time the patient remains in the supine position, seems to us to be a good idea.

Antibiotic therapy

All the patients with a dural wound had 48 h of antibiotics: during this period we followed the recommendations for prophylactic antibiotic therapy of the French Society of Anesthesia and Intensive Care (Société Française d'Anesthésie et de Réanimation [SFAR]), the reference in France [12]. During the 2000—2010 period, the recommendation was antibiotic therapy with cefazolin for spinal surgery with material, no antibiotics if material was not used. In cases of beta-lactam allergy or of patients suspected of antibiotic resistance, vancomycin was used.

When the breach has been recognized: if the patient had received antibiotic therapy, it was continued for 2 days, whereas if he or she had not had an initial antibiotic therapy, it was initiated. The guidelines have changed since in 2010 the SFAR advised antibiotic therapy in all cases of spinal surgery.

Although there is consensus on the pertinence of prophylactic antibiotic therapy at induction [13,14], the indication for prolonged antibiotic therapy, when a breach occurs, is subject to debate and rarely discussed in the literature. In their protocol, Khan et al. [5] do not discuss antibiotic therapy. We have chosen to prolong the initial antibiotic therapy by 48 h: none of the breaches in our series were complicated with infection.

Clinical monitoring and MRI

No symptomatic meningocele occurred in our series. We did not systematically look for this complication with MRI. No other authors have reported systematic use of MRI. In 1983, Teplick and Haskin [15] conducted a CT study on 750 patients who underwent surgery on the lower spine: the meningocele rate was 1.6%, most often with no dural wound identified intraoperatively. Cases of meningocele, even large ones, can regress completely [16].

Meningoceles can remain asymptomatic [17,18]. When they are symptomatic, surgical revision is proposed [17—19]. These authors performed surgical revision with removal of the meningocele and suturing of the dura mater. The use of a CSF derivation by a drain placed outside the surgical zone is sometimes proposed [17,20,21] as a complement to exeresis and suturing.

Only one team [21] reports percutaneous treatment of meningoceles by derivation and blood patch. The derivation often reported in the American literature is only infrequently reported in France.

Table 5 Diverse attitudes on British surgeons' practices.

	Number of breaches	Drainage	Suture	% Failure
Khan et al. [5]	385	Yes	All	1.55
Whang et al. [2]	88	Yes	All	1
Hughes et al. [10]	16	Yes	None	6
Narotam et al. [6]	110	No	None	2.7
Black [7]	27	No	None	3
Cammisa et al. [3]	66	Variable	90%	7.5
Guerin et al. [20]	51	Variable	70%	3

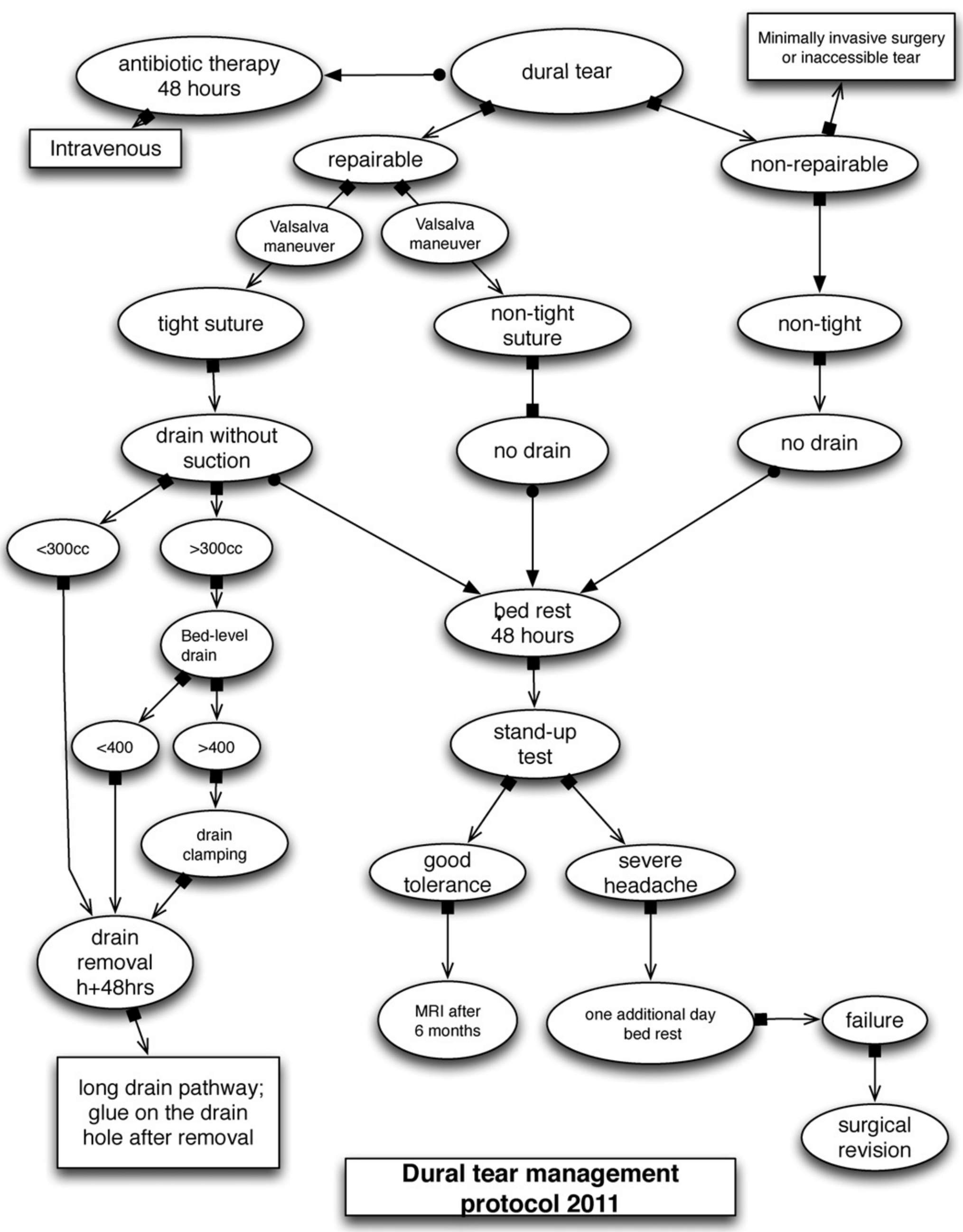

Figure 2 Proposal for modified management protocol for incidental dural tears.

Since one of the risks of breaches is the appearance of a meningocele, it seems reasonable to practice a systematic MRI in dural tears. This would provide prospective data on the true frequency of meningoceles and their progression. This practice risks complicating the decision because certain cases of meningocele do not cause discomfort and may even disappear spontaneously.

New protocol proposed

The study of our results and the comparison with the series published to date has led us to incorporate a few modifications: the protocol is more detailed, which should allow good compliance. It provides for more diverse situations. We have introduced the Valsalva maneuver, the stand-up test, and systematic MRI in the monitoring of dural tears. However, the main points of the protocol have not changed: no modification in drainage, rest, or antibiotic therapy (Fig. 2).

Conclusion

After studying our protocol used for managing lumbar dural tears, we propose a new improved protocol.

The important points of this protocol are suturing tears completed by fibrin glue and a layer of collagen, non-aspirating drainage if the suturing is watertight, 48 h of bed rest, and the stand-up test.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

Acknowledgements

Our thanks are extended to Prof. Fabrice Parker, neurosurgeon at the Hôpital Bicêtre, and his collaborators for their valuable comments on an earlier version of this article.

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