José Pedro Moreira Tinoco da Costa

Predictors of poor outcome in patients submitted to minimally invasive transforaminal lumbar interbody fusion

Fatores preditivos de prognóstico em doentes submetidos a artrodeses lombar transforaminal minimamente invasiva
Júlio Pedro Moreira Tinoco da Costa
Predictors of poor outcome in patients
submitted to minimally invasive
transforaminal lumbar interbody fusion

Fatores preditivos de prognóstico em
doentes submetidos a artrodese lombar
transforaminal minimamente invasiva

Mestrado Integrado em Medicina

Área: Neurocirurgia
Tipologia: Dissertação

Trabalho efetuado sob a Orientação de:
Doutor Paulo Pereira
E sob a Coorientação de:
Dr. Pedro dos Santos Silva

Trabalho organizado de acordo com as normas da revista:
World Neurosurgery

março, 2018
Eu, José Pedro Moreira Tinoco da Costa, abaixo assinado, nº mecanográfico 201204540, estudante do 6º ano do Ciclo de Estudos Integrado em Medicina, na Faculdade de Medicina da Universidade do Porto, declaro ter atuado com absoluta integridade na elaboração deste projeto de opção.

Neste sentido, confirmo que NÃO incorri em plágio (ato pelo qual um indivíduo, mesmo por omissão, assume a autoria de um determinado trabalho intelectual, ou partes dele). Mais declaro que todas as frases que retirei de trabalhos anteriores pertencentes a outros autores, foram referenciadas, ou redigidas com novas palavras, tendo colocado, neste caso, a citação da fonte bibliográfica.

Faculdade de Medicina da Universidade do Porto, 22/03/2018

Assinatura conforme cartão de identificação:

[Signature]

José Pedro Moreira Tinoco da Costa
Projecto de Opção do 6º ano — DECLARAÇÃO DE REPRODUÇÃO

NOME
José Pedro Moreira Tinoco da Costa

NÚMERO DE ESTUDANTE
201204540

E-MAIL
pedrotinococosta@hotmail.com

DESIGNAÇÃO DA ÁREA DO PROJECTO
Neurocirurgia

TÍTULO DISSERTAÇÃO/HONORÁRIA (riscar o que não interessar)
Predictors of poor outcome in patients submitted to minimally invasive transforaminal lumbar interbody fusion

ORIENTADOR
Doutor Paulo Pereira

COORIENTADOR
Dr. Pedro dos Santos Silva

ASSINALE APENAS UMA DAS OPÇÕES:

<table>
<thead>
<tr>
<th>Opção</th>
<th>Assinado</th>
</tr>
</thead>
<tbody>
<tr>
<td>É AUTORIZADA A REPRODUÇÃO INTEGRAL DESTE TRABALHO APENAS PARA EFEITOS DE INVESTIGAÇÃO, MEDIANTE DECLARAÇÃO ESCRITA DO INTERESSADO, QUE A TAL SE COMPROMETE.</td>
<td>[ ]</td>
</tr>
<tr>
<td>É AUTORIZADA A REPRODUÇÃO PARCIAL DESTE TRABALHO (INDICAR, CASO TAL SEJA NECESSÁRIO, Nº MÁXIMO DE PÁGINAS, ILUSTRACOES, GRÁFICOS, ETC.) APENAS PARA EFEITOS DE INVESTIGAÇÃO, MEDIANTE DECLARAÇÃO ESCRITA DO INTERESSADO, QUE A TAL SE COMPROMETE.</td>
<td>[X]</td>
</tr>
<tr>
<td>DE ACORDO COM A LEGISLAÇÃO EM VIGOR, (INDICAR, CASO TAL SEJA NECESSÁRIO, Nº MÁXIMO DE PÁGINAS, ILUSTRACOES, GRÁFICOS, ETC.) NÃO É PERMITIDA A REPRODUÇÃO DE QUALQUER PARTE DESTE TRABALHO.</td>
<td>[ ]</td>
</tr>
</tbody>
</table>

Faculdade de Medicina da Universidade do Porto, 22/03/2018

Assinatura conforme cartão de identificação: [Assinatura]
ABSTRACT

Background: Minimally invasive transforaminal lumbar interbody fusion (MI-TLIF) has become an increasingly popular method for lumbar arthrodesis. While having similar long-term outcomes when compared to open TLIF, it decreases the amount of intraoperative blood loss and iatrogenic muscle damage, the intensity of postoperative pain and the duration of hospital stay. However, uncertainty remains about which factors contribute to outcomes in these patients.

Objective: The purpose of this study was to retrospectively analyze a cohort of patients submitted to MI-TLIF and to identify factors that can be associated with a worse postoperative outcome.

Methods: All data was assessed through the patients’ clinical records and, according to Odom’s criteria, postoperative clinical outcome at 12 months was defined in excellent, good, fair and poor.

Results: The main variables associated with worse prognosis (“poor” class according to Odom’s criteria) were: a period of sick leave longer than 3 months before the surgery, age under 50 years, lytic spondylolisthesis, L5-S1 fusion and occurrence of complications. These five conditions were included in a binomial logistic regression analysis, and three of them were independently associated to poor outcome: operative complications, age under 50 years and sick leave longer than 3 months before surgery.

Conclusions: Those who were younger, were on a period of sick leave longer than 3 months before surgery or suffered surgical complications tended to have less satisfactory results.

Key words: Clinical outcome, minimally invasive surgery, transforaminal lumbar interbody fusion, lumbar arthrodesis
INTRODUCTION

There are several widely used techniques for circumferential lumbar arthrodesis: anterior lumbar interbody fusion (ALIF), posterior lumbar interbody fusion (PLIF), transforaminal lumbar interbody fusion (TLIF) and lateral lumbar interbody fusion (LLIF) [1]. However, TLIF has gained popularity for the treatment of a variety of lumbar disorders such as degenerative and lytic spondylolisthesis, one or two level degenerative disc disease and recurrent disc herniations. In TLIF a unilateral single-staged posterolateral approach to the spinal canal and disc is used, resulting in decreased retraction on the nerve roots and dural sac, and hence a lower risk of postoperative neurological deficit [2-4] in comparison to PLIF. This procedure also avoids the ALIF abdominal approach and the inherent risks of vascular and visceral injuries. Furthermore, TLIF was shown to result in excellent rates of arthrodesis and decreased operative time and blood loss, decreased morbidity, and decreased costs when compared to other approaches [5].

An advancement of the TLIF technique allowed for a minimally invasive approach. Introduced by Foley et al. in 2002 [6, 7], the minimally invasive TLIF (MI-TLIF) has since become an increasingly popular method of lumbar arthrodesis. The procedure is performed via a muscle-dilating approach, using a tubular retractor through a paraspinal incision and significantly diminishes the amount of iatrogenic soft-tissue dissection [8]. This approach was designed to fulfil the same advantages of TLIF, but to further reduce the amount of intraoperative blood loss and iatrogenic muscle damage, the intensity of postoperative pain, and the duration of hospital stay [6]. The main disadvantages of MI-TLIF include additional exposure time to intraoperative radiation, potentially increased cost, and the need for the surgeon to overcome the learning curve [9, 11].

MI-TLIF has been shown to have similar rates of fusion and similar long-term functional outcomes when compared to open TLIF [4, 10]. However, there is still insufficient evidence to show which patients may benefit more with this technique. The purpose of this study is to retrospectively analyze a cohort of patients submitted to MI-TLIF and try to identify factors that can be associated with a worse surgical outcome.
METHODS

Study and inclusion criteria

A single center database from the Neurosurgery Department of a tertiary hospital including patients older than 18 years old submitted to 1- or 2-level MI-TLIF from 2007 to 2016 was retrospectively examined. The surgical indications included degenerative spondylolisthesis, degenerative disc disease, lytic spondylolisthesis, recurrent lumbar herniation, foraminal stenosis, and revision surgery. The hospital’s ethics committee approved the entire study protocol. Two hundred ninety (290) patients accomplished these criteria with seven (7) patients being excluded due to loss in follow-up. Two hundred eighty-three (283) patients were included in the final sample (figure 1).

![Figure 1. Flowchart of sample selection](image)

Clinical data

The clinical records of the patients were reviewed and demographic variables (age, gender, body mass index, work status), clinical data (indication for surgery, smoking, medication, history of spine surgery, neurologic disease, psychiatric disorder or rheumatologic diseases), and surgery-related data (levels operated, duration of procedure, length of stay, complications, reoperation) were collected.

Outcome was drawn from clinical records at 12 months postoperative evaluation in the outpatient clinic and it was defined according to Odom’s criteria in excellent, good, fair and poor. However, the full follow-up period was considered to assess reoperation rate.
Primary endpoint

This study primary endpoint was a statistically significant association between selected factors and bad clinical outcome ("poor" class according to Odom’s criteria).

Statistical analysis

Continuous variables were transformed in categorical data and the dependent variable (Outcome, according to Odom’s criteria) was dichotomized in “poor” or “other”. Statistical analysis was performed using Chi-Square test for each association and binomial logistic regression for multivariate analysis. The software used for statistical analysis was IBM SPSS Statistics, version 24.0 and G*Power, version 3.1.9.3.
RESULTS

Sample description and surgical data

A total of 283 patients were included in the study, of which one hundred and ninety-four (68.6%) were women. The mean age at the time of surgery was 57.19 ± 11.86 years and fifty patients (17.7%) were smokers. The median (interquartile range [IQR]) body mass index (BMI) was 28 [6] kg/m².

Two hundred and thirty-nine patients (84.5%) underwent a single-level surgery. Median surgery time was 145 [87] minutes. Forty-one patients (14.5%) experienced complications with 39% of these being dural tears corrected during the surgery without cerebrospinal fluid leak in the postoperative period. The median hospital stay was 4 [3] days. The median follow-up was 55 months, ranging from 14 to 131 months. Thirty-five patients (12.4%) were reoperated, most of them due to screw misplacement or hardware failure. Further demographic and surgical data of the sample are summarized in table 1.

<table>
<thead>
<tr>
<th>Profession before/after surgery</th>
<th>Patients, no. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employed</td>
<td>98 (34.6) / 61 (21.6)</td>
</tr>
<tr>
<td>Unemployed</td>
<td>27 (9.5) / 34 (12)</td>
</tr>
<tr>
<td>Retired</td>
<td>124 (43.8) / 148 (52.5)</td>
</tr>
<tr>
<td>Sick leave</td>
<td>33 (11.7) / 35 (12.4)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Previous Surgeries</th>
<th>Patients, no. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lumbar surgery</td>
<td>68 (24)</td>
</tr>
<tr>
<td>Cervical surgery</td>
<td>15 (5.3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Surgical indication</th>
<th>Patients, no. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degenerative SPL</td>
<td>147 (60)</td>
</tr>
<tr>
<td>Lytic SPL</td>
<td>53 (18.7)</td>
</tr>
<tr>
<td>Recurrent LDH</td>
<td>21 (7.4)</td>
</tr>
<tr>
<td>Degenerative disc disease</td>
<td>17 (6)</td>
</tr>
<tr>
<td>Degenerative scoliosis</td>
<td>3 (1.1)</td>
</tr>
<tr>
<td>Foraminal stenosis</td>
<td>28 (9.9)</td>
</tr>
<tr>
<td>Revision surgery</td>
<td>14 (4.9)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level of fusion</th>
<th>Patients, no. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L2-L3</td>
<td>2 (0.7)</td>
</tr>
<tr>
<td>L3-L4</td>
<td>19 (6.7)</td>
</tr>
<tr>
<td>L4-L5</td>
<td>135 (47.7)</td>
</tr>
<tr>
<td>L5-S1</td>
<td>82 (29)</td>
</tr>
<tr>
<td>L3-L4+L4-L5</td>
<td>22 (7.8)</td>
</tr>
<tr>
<td>L4-L5+S5-S1</td>
<td>23 (8.1)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Medical history</th>
<th>Patients, no. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes mellitus</td>
<td>41 (14.5)</td>
</tr>
<tr>
<td>Rheumatological disease</td>
<td>36 (12.7)</td>
</tr>
<tr>
<td>Neurological disease</td>
<td>13 (4.6)</td>
</tr>
<tr>
<td>Psychiatric disease</td>
<td>61 (21.6)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Medication</th>
<th>Patients, no. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corticosteroids</td>
<td>9 (3.2)</td>
</tr>
<tr>
<td>NSAIDs</td>
<td>60 (21.2)</td>
</tr>
</tbody>
</table>

Table 1. Patients’ demographics and surgical data (SPL – spondylolisthesis, LDH – lumbar disc herniation)
Clinical evaluation

According to Odom’s criteria, thirty-six (12.7%) patients had a poor result. The distribution for each category of Odom’s criteria is shown in table 2.

<table>
<thead>
<tr>
<th>Odom’s criteria</th>
<th>Patients, no. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>57 (20.1)</td>
</tr>
<tr>
<td>Good</td>
<td>111 (39.2)</td>
</tr>
<tr>
<td>Fair</td>
<td>79 (27.9)</td>
</tr>
<tr>
<td>Poor</td>
<td>36 (12.7)</td>
</tr>
</tbody>
</table>

Table 2. Odom’s criteria

Association between poor outcome and clinical variables

Age

Patients were divided into 2 groups: younger than 50 and older than 50 years old. Twenty-three out of the eighty-four patients (27.4%) younger than 50 years old had a poor outcome; in patients older than 50 years old group, only thirteen (6.5%) of the one hundred ninety-nine had bad outcomes (Chi-square, p<0.001). Age under 50 years old was related with a moderate degree of association (Phi=0.29) with worse surgical outcome.

Surgical indication

Fifty-three patients were submitted to MI-TLIF due to lytic SPL and twelve of these (22.6%) had poor outcome. On the other hand, from the two hundred and thirty patients with other surgical indications, twenty-four (10.4%) had bad results (Chi-square, p=0.030). Lytic SPL was the only surgical indication that seemed to affect the prognosis, with a low degree of association (Phi=0.14). No other relation was found between the other surgical indications and the outcome. However, revision surgeries were at the margin of statistical significance (Chi-square, p=0.068).

Working status

Patients were divided according to their working status (active worker, retired, unemployed and on sick leave) before and after surgery. Fifteen patients (26.8%) from those on sick leave for a period longer than 3 months before surgery had bad results versus 9.3% of patients with a working status other than sick leave longer than 3 months (Chi-
square, \( p=0.001; \) Phi=0.210). The association between the working status and poorer surgical outcome was then related to being on sick leave for more than 3 months.

**Levels operated**

While there is not a relation between the number of levels operated (1 versus 2 levels) and the surgical results (Chi-square, \( p=0.490 \)), L5-S1 fusion in 1 or 2 levels MI-TLIF was associated with worse prognosis (Chi-square, \( p=0.023; \) Phi=0.15).

**Complications**

Forty-one patients (14.5\%) had complications during or after the surgery and ten of these (24.4\%) had poor clinical outcomes versus twenty-six out of the two hundred forty-two (10.7\%) who had no complications (Chi-square, \( p=0.030; \) Phi=0.14).

The association between these previous five factors and bad prognosis is summarized in table 3.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Poor Odom no. patients (%)</th>
<th>p-Value</th>
<th>Phi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age &lt; 50 years old</td>
<td>23 (27.4)</td>
<td>&lt;0.001*</td>
<td>0.29</td>
</tr>
<tr>
<td>Lytic SPL</td>
<td>12 (22.6)</td>
<td>0.030*</td>
<td>0.14</td>
</tr>
<tr>
<td>Sick leave &gt; 3 months before surgery</td>
<td>15 (26.8)</td>
<td>0.001*</td>
<td>0.21</td>
</tr>
<tr>
<td>L5-S1</td>
<td>16 (19.5)</td>
<td>0.023*</td>
<td>0.15</td>
</tr>
<tr>
<td>Complications</td>
<td>10 (24.4)</td>
<td>0.030*</td>
<td>0.14</td>
</tr>
</tbody>
</table>

Table 3. Predictors of poor outcome.

**Remaining variables**

The patients’ gender, BMI (power: 99\%), previous spine surgical intervention, medical history, smoking habits (power: 49\%), number of levels operated and the duration of surgery did not seem to be related with “poor” prognosis (table 4). Also the time at which patients were submitted to MI-TLIF is not a prognosis factor once patients with longer follow up periods are not associated with worse results.
Psychiatric history and history of previous spinal surgical intervention

Although no other associations to bad prognosis (“poor” class according to Odom’s criteria) were found, some other factors also seem to predict less favorable outcomes (“fair”/“poor” classes according to Odom’s criteria). Patients with psychiatric disorder and previous lumbar surgery were associated with poor/fair clinical outcome (Table 5).

<table>
<thead>
<tr>
<th>Factors</th>
<th>p-Value</th>
<th>Phi</th>
</tr>
</thead>
<tbody>
<tr>
<td>History of lumbar surgery</td>
<td>0.026*</td>
<td>0.14</td>
</tr>
<tr>
<td>Psychiatric disorder</td>
<td>0.023*</td>
<td>0.14</td>
</tr>
</tbody>
</table>

Table 5. Predictors of poor/fair outcome.

Multivariate Analysis

The main variables associated with worse prognosis (“poor” class according to Odom’s criteria) were: a period of sick leave longer than 3 months before the surgery, age under 50 years old, lytic spondylolisthesis, L5-S1 fusion and occurrence of complications. These five conditions were included in a binomial logistic regression analysis (table 6). The model was statistically significant (Chi-square: 33.381 df:5, p<0.001), with a Nagelkerke R2 of 21% and correctly classified 87.3% of cases.
Three of them were independently associated with poor outcome: operative complications (OR: 3.26), age under 50 years old (OR: 3.93) and sick leave longer than 3 months before surgery (OR: 2.75).

Table 6. Binomial logistic regression analysis.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Coefficient</th>
<th>p-Value</th>
<th>OR</th>
<th>Lower</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age &lt; 50 years old</td>
<td>1.369</td>
<td>0.002</td>
<td>3.930</td>
<td>1.665</td>
<td>9.272</td>
</tr>
<tr>
<td>Lytic SPL</td>
<td>0.349</td>
<td>0.442</td>
<td>1.418</td>
<td>0.583</td>
<td>3.451</td>
</tr>
<tr>
<td>LS-S1 level</td>
<td>0.238</td>
<td>0.579</td>
<td>1.269</td>
<td>0.547</td>
<td>2.941</td>
</tr>
<tr>
<td>Sick leave&gt;3months before surgery</td>
<td>1.011</td>
<td>0.014</td>
<td>2.747</td>
<td>1.230</td>
<td>6.134</td>
</tr>
<tr>
<td>Complications</td>
<td>1.183</td>
<td>0.010</td>
<td>3.263</td>
<td>1.321</td>
<td>8.062</td>
</tr>
</tbody>
</table>
**DISCUSSION**

While age under 50 years old was shown to be an independent prognosis factor by the binomial logistic regression model, this didn’t happen neither with the diagnosis nor with the level operated. Therefore, it seems that there was an overlapping effect of L5-S1 fusion and lytic spondylolisthesis with age.

According to Lin et al. [12] the mean Oswestry Disability Index (ODI) score after MI-TLIF in older patients was higher than that in younger patients, being the higher rate of comorbidities commonly found in older patients a possible explanation for this finding. On the other hand, Wu et al. [13] didn’t find significant differences between younger and older than 65 years old patients submitted to MI-TLIF, with both groups experiencing similar fusion rates and clinical improvement. A possible explanation for our findings of younger patient having a higher incidence of poor outcome may be that younger patients are more likely to keep working and have more active lifestyles when compared to the elderly.

Park et al. [14] divided in subgroups patients with lytic spondylolisthesis, degenerative spondylolisthesis and degenerative segmental instability to understand if minimally invasive TLIF optimally and equivalently alleviated the symptoms and disabilities related to these pathologies. They concluded that the improvement was comparable among the 3 subgroups and that these diagnostics were all optimal surgical indications for minimally invasive TLIF. In our study patients with lytic spondylolisthesis had a worse prognosis, but in multivariate analysis this finding was not an independent factor for poor outcome.

Ekman et al. [15], not only associated female gender with worse postoperative results, but even suggested that it would seem reasonable to inform not working female patients who do not exercise and that are candidates to lumbar fusion due to lytic spondylolisthesis, about the lower probability of an excellent outcome. In our study, there was no apparent relation between the gender and the outcome.

The fact that psychiatric disorder only had a moderate association with fair/poor outcome but not a statistically significant association with bad outcome was not expected. In fact, according to other studies, patients reporting poorer emotional status such as depression prior to surgery were significantly more likely to report poorer functional outcomes and pain improvement postoperatively [16, 17]. Parker et al. [17] suggested that preoperative depression was an independent predictor of poor functional outcome after revision lumbar fusion. In another study [18] it was even suggested that psychological
predisposition could be used to select more effectively patients with the greatest opportunity for a successful outcome and, at the same time, reduce the indirect costs of spine surgery due to increased duration of missed work days.

The non-association between patients’ BMI and prognosis is consistent with findings from other studies. Lau et al. [19] and Park et al. [20] concluded that obese patients and normal BMI patients experienced similar complication rates, operative times, intraoperative blood loss, and length of hospital stay when undergoing MI-TLIF. Lau et al [9] also demonstrated that do not seem to exist significant differences in the complications rates between patients of different classes of obesity (Classes I, II or III) or between these and patients with normal BMI.

Although in this study revision surgery doesn’t seem to predict the surgical outcome (Chi-square, p=0.068), a higher number of patients would increase the chance of detecting an association due to the effect of sample size on the likelihood of finding a statistically significant result. The same applies to smoking habits (Chi-square, p=0.089, power=49%). An emerging body of literature suggests that there is a correlation between smoking and a higher incidence of postoperative complications with diminished postoperative results and clinical outcomes [21-23]. Glassman et al. [23] found smokers to have significantly higher nonunion rates and lower return to work rates and mean patient satisfaction scores.

Lau et al. [11] explained that the level of surgical difficulty and the learning curve could have a role in morbidity and outcome, resulting in higher complication rates in patients submitted to MI-TLIF. In our study, patients with surgical complications were associated with worst clinical outcomes. However, the learning curve, if we can extrapolate it based on the follow-up period, didn’t seem to affect the prognosis in a sense that patients submitted to MI-TLIF the longest (with longer follow-up periods) didn’t have worse results.
CONCLUSION

Preoperative variables were identified as predictors of poor surgical outcome after MI-TLIF, suggesting that the result of lumbar fusion can be more limited in younger patients and those with sick leave for more than 3 months. Also, the occurrence of operative complications can decrease the likelihood of improvement.
AGRADECIMENTOS

Ao Professor Doutor Paulo Pereira, o meu orientador, pelo profissionalismo e disponibilidade demonstrados ao longo de todas as diferentes fases deste trabalho.

Ao Dr. Pedro dos Santos Silva, coorientador, pela ajuda na elaboração e concretização do projeto.

Pelo apoio no tratamento dos dados, agradeço também à Dr.ª Marisa Cunha.
REFERENCES


ANEXOS

1. Parecer da comissão de ética
2. Normas da revista *World Neurosurgery*
Assunto: Pedido de autorização para realização de estudo/projecto de investigação

Nome do Investigador Principal: José Pedro Moreira Tinoco da Costa

Título do projecto de investigação: Fatores preditivos de prognóstico em doentes submetidos a artrodese lombar transforaminal minimamente invasiva

Pretendendo realizar no(s) Serviço(s) de Neurocirurgia do Centro Hospitalar de S. João – EPE o estudo/projecto de investigação em epígrafe, solito a V. Exa., na qualidade de Investigador/Promotor, autorização para a sua efectivação.

Para o efeito, anexa toda a documentação referida no dossier da Comissão de Ética do Centro Hospitalar de S. João respeitante a estudos/projectos de investigação, à qual endereçou pedido de apreciação e parecer.

Com os melhores cumprimentos.

Porto, 12 / Junho / 2017

O INVESTIGADOR/PROMOTOR

José Pedro Moreira Tinoco da Costa
7. **SEGURO**

a. *Este estudo/projeto de investigação prevê intervenção clínica que implique a existência de um seguro para os participantes?*

- **SIM** ☐ (Se sim, junte, por favor, cópia da Apólice de Seguro respectiva)
- **NÃO** ☐
- **NÃO APLICÁVEL** ☑

8. **TERMO DE RESPONSABILIDADE**

Eu, José Pedro Moreira Tinoco da Costa, abaixo-assinado, na qualidade de Investigador Principal, declaro por minha honra que as informações prestadas neste questionário são verdadeiras. Mais declaro que, durante o estudo, serão respeitadas as recomendações constantes da Declaração de Helsínquia (com as emendas de Tóquio 1975, Veneza 1983, Hong-Kong 1989, Somerset West 1996 e Edimburgo 2000) e da Organização Mundial da Saúde, no que se refere à experimentação que envolve seres humanos. Aceito, também, a recomendação da CES de que o recrutamento para este estudo se fará junto de doentes que não tenham participado em outro estudo no decurso do actual internamento ou da mesma consulta.

Porto, 12 / Junho 2017

______________________________

José Pedro Moreira Tinoco da Costa

O Investigador Principal

---

**PARECER DA COMISSÃO DE ÉTICA PARA A SAÚDE DO CENTRO HOSPITALAR DE S. JOÃO**

A Comissão de Ética para a Saúde APROVA, por unanimidade, o parecer do Relator, pelo que nada tem a opor à realização deste projeto de investigação.

Prof. Doutor ____________________

Presidente da Comissão de Ética
Parecer da Comissão de Ética para a Saúde do Centro Hospitalar de São João / Faculdade de Medicina da Universidade do Porto

Título do Projecto: Fatores preditivos de prognóstico em doentes submetidos a artródesis lombar transformaminal minimamente invasiva

Nome do Investigador Principal: José Pedro Moreira Tinoco da Costa


Objectivos do Estudo:
Comparar dois grupos de doentes submetidos a artródesis lombar transformaminal minimamente invasiva, de acordo com o outcome da cirurgia (favorável vs desfavorável). Identificar possíveis factores que possam actuar no sentido de um pior prognóstico pós-cirúrgico
Insere-se no âmbito do Mestrado Integrado em Medicina da FMUP, sob orientação do Prof. Doutor Paulo Pereira.

Beneficio/risco: N/A

Confidencialidade dos dados: Está garantido a anonimização dos dados obtidos.

Respeito pela liberdade e autonomia do sujeito de ensaio: N/A

Curriculum do investigador: Adequado à investigação.

Data previsível da conclusão do estudo: Março de 2018

Conclusão: Proponho um parecer favorável à realização deste projecto de investigação.

Porto, 14 de Julho de 2017

O Relator da CES, Dr. John Preto
DESCRIPTION

The journal's mission is to: To provide a first-class international forum and a 2-way conduit for dialogue that is relevant to neurosurgeons and providers who care for neurosurgery patients. The categories of the exchanged information include clinical and basic science, as well as global information that provide social, political, educational, economic, cultural or societal insights and knowledge that are of significance and relevance to worldwide neurosurgery patient care. To act as a primary intellectual catalyst for the stimulation of creativity, the creation of new knowledge, and the enhancement of quality neurosurgical care worldwide. To provide a forum for communication that enriches the lives of all neurosurgeons and their colleagues; and, in so doing, enriches the lives of their patients. Topics to be addressed in World Neurosurgery include: EDUCATION, ECONOMICS, RESEARCH, POLITICS, HISTORY, CULTURE, CLINICAL SCIENCE, LABORATORY SCIENCE, TECHNOLOGY, OPERATIVE TECHNIQUES, CLINICAL IMAGES, VIDEOS

IMPACT FACTOR

2016: 2.592 © Clarivate Analytics Journal Citation Reports 2017

EDITORIAL BOARD

Editor-in-Chief
Edward C. Benzel, MD, Emeritus Chairman, Department of Neurosurgery; Experience Officer & Director of Professional Development, Neurological Institute, Cleveland Clinic, 9500 Euclid Avenue / S-40, Cleveland OH 44195

Managing Editor
Christine Moore

Book Review
William J. Mack, United States

Calendar
Max Jägersberg, Switzerland

Editor's Choice
Charles Y. Liu, United States
Alexander Tuchman, United States
Jesse Winer, United States

News and Opinions
Christopher Kellner, United States

Neurosurgeons and the Arts
Gregory Trost, United States
Mehmet Zileli, Turkey

Social Media
Suzanne Tharin, United States

Section Editors
Communicating through Clinical Images
Garnette Sutherland, Canada

Cranial Base
Atul Goel, India
Takeshi Kawase, Japan
Varun Kshettry, United States
Basant K. Misra, India
Pablo Recinos, United States
Henry Schroeder, Germany
Marcos Tatagiba, Germany

Critical Care
Fernando Goldenberg, United States
Jorge Marcondes de Souza, Brazil
Alejandro Spiotta, United States

Doing More with Less
Peter Nakaji, United States

Education
Varun Kshettry, United States
Charles Y. Liu, United States
Francesco Tomasello, Italy

Endocrine & Pituitary
James Evans, United States
Sébastien Froelich, France
Daniel Prevedello, United States
Shaan Raza, United States
Pablo Recinos, United States

Endovascular
Azam Ahmed, United States
Jonathan Brisman, United States
Reza Dashti, United States
Alexander Khalessi, United States
Edwin Mogere, Kenya
Gustavo Pradilla, United States
Clemens M. Schirmer, United States

Epilepsy
Jorge Gonzalez-Martinez, United States
Charles Y. Liu, United States
Jun Park, United States
Edie Zusman, United States

From the Annals of
Paolo Cappabianca, Italy
Philip E, Stieg, USA

Great Hospitals
Russell Andrews, United States
History & Culture
Russell Andrews, United States

Hydrocephalus & CSF Pathway Pathologies
Richard Edwards, United Kingdom
Samer Elbabaa, United States
Mark Luciano, United States
Kenichi Nishiyama, Japan

Infection
G. Alexander Jones, United States
Leonidas Quintana, Chile
James R. Van Dellen, United Kingdom

Instrumentation Non-Spine
Ying Mao, China
Amir Samii, Germany

Neuroradiology/Imaging
Seok Keun Choi, Korea
Garnette Sutherland, Canada
Stefan Wolfsberger, Austria

Neurosurgery Nursing
Andrea L. Strayer, United States

Pain
Jeffrey A. Brown, United States
Oren Sagher, United States

Pediatrics
Philipp Aldana, United States
Samer Elbabaa, United States
J. Gordon McComb, United States
Dominic Venne, Canada

Peripheral Nerve
Rajiv Midha, Canada
Robert J. Spinner, United States

Politics, Socioeconomic & Legal
James Bean, United States

Radiosurgery
Caroline Chung, United States
Dong Gyu Kim, Korea
Jean Regis, France

Special Topics
Francesco Tomasello, Italy

Spine
Atul Goel, India
James Harrop, United States
R. John Hurlbert, United States
Sait Naderi, Turkey
João Pinheiro-Franco, Brazil
Florian Roser, United Arab Emirates
Salman Sharif, Pakistan
Volker K.H. Sonntag, United States
Michael P. Steinmetz, United States
Marjorie Wang, United States
Michael Y. Wang, United States
Reza Yassari, United States

Sports
Robert C. Cantu, United States
V. Miele, USA
Stereotactic Functional
Tipu Z. Aziz, United Kingdom
Jin Woo Chang, Korea
Brian Kopell, USA
Sean Nagel, USA

Trauma
Mathew Joseph, India
Michael Kelly, United States
Leonidas Quintana, Chile
Craig Rabb, USA
Shelly Timmons, United States
Edie Zusman, United States

Tumor
Oliver Bozinov, Switzerland
Isabelle Germano, United States
Giovanni Grasso, Italy
Rachel Grossman, Israel
John Kuo, United States
Aliasgar Mioyadi, India
Amir Samii, Germany
Garnette Sutherland, Canada
Michael Vogelbaum, United States
Stefan Wolfsberger, Austria
Fumio Yamaguchi, Japan

Vascular
Mark Bain, United States
Jonathan Brisman, United States
Jan-Karl Burkhardt, Switzerland
Reza Dashti, United States
Menno Germans, Netherlands
Juha A. Hernesniemi, Finland
Alexander Khalessi, United States
Jianmin Liu, China
Ying Mao, China
Gustavo Pradilla, United States
Clemens M. Schirmer, United States
Robert F. Spetzler, United States

Videos
Anil Nanda, United States

Women in Neurosurgery
Yoko Kato, Japan
GUIDE FOR AUTHORS

Submission checklist
You can use this list to carry out a final check of your submission before you send it to the journal for review. Please check the relevant section in this Guide for Authors for more details.

Ensure that the following items are present:

One author has been designated as the corresponding author with contact details:
• E-mail address
• Full postal address

All necessary files have been uploaded:
Manuscript:
• Include keywords
• All figures (include relevant captions)
• All tables (including titles, description, footnotes)
• Ensure all figure and table citations in the text match the files provided
• Indicate clearly if color should be used for any figures in print
Graphical Abstracts / Highlights files (where applicable)
Supplemental files (where applicable)

Further considerations
• Manuscript has been ‘spell checked’ and ‘grammar checked’
• All references mentioned in the Reference List are cited in the text, and vice versa
• Permission has been obtained for use of copyrighted material from other sources (including the Internet)
• A competing interests statement is provided, even if the authors have no competing interests to declare
• Journal policies detailed in this guide have been reviewed
• Referee suggestions and contact details provided, based on journal requirements

For further information, visit our Support Center.

Please ensure that the following items are present.

Required files to be uploaded:
• Cover Letter
• Manuscript including Title Page (containing title, all authors' complete names/affiliations, corresponding author name and contact details, key words and running title)
• Disclosure-Conflict of Interest
• Abbreviation List
• Highlights
• Figures, if applicable
• Tables, if applicable.

BEFORE YOU BEGIN

Ethics in publishing
Please see our information pages on Ethics in publishing and Ethical guidelines for journal publication.

Human and animal rights
If the work involves the use of human subjects, the author should ensure that the work described has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans; Uniform Requirements for manuscripts submitted to Biomedical journals. Authors should include a statement in the manuscript that informed consent was obtained for experimentation with human subjects. The privacy rights of human subjects must always be observed.
All animal experiments should comply with the ARRIVE guidelines and should be carried out in accordance with the U.K. Animals (Scientific Procedures) Act, 1986 and associated guidelines, EU Directive 2010/63/EU for animal experiments, or the National Institutes of Health guide for the care and use of Laboratory animals (NIH Publications No. 8023, revised 1978) and the authors should clearly indicate in the manuscript that such guidelines have been followed.

Declaration of interest
All authors must disclose any financial and personal relationships with other people or organizations that could inappropriately influence (bias) their work. Examples of potential conflicts of interest include employment, consultancies, stock ownership, honoraria, paid expert testimony, patent applications/registrations, and grants or other funding. Authors must disclose any interests in two places: 1. A summary declaration of interest statement in the title page file (if double-blind) or the manuscript file (if single-blind). If there are no interests to declare then please state this: 'Declarations of interest: none'. This summary statement will be ultimately published if the article is accepted. 2. Detailed disclosures as part of a separate Declaration of Interest form, which forms part of the journal's official records. It is important for potential interests to be declared in both places and that the information matches. More information.

Submission declaration and verification
Submission of an article implies that the work described has not been published previously (except in the form of an abstract, a published lecture or academic thesis, see 'Multiple, redundant or concurrent publication' for more information), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. To verify originality, your article may be checked by the originality detection service Crossref Similarity Check.

Preprints
Please note that preprints can be shared anywhere at any time, in line with Elsevier’s sharing policy. Sharing your preprints e.g. on a preprint server will not count as prior publication (see 'Multiple, redundant or concurrent publication' for more information).

Authorship
All authors should have made substantial contributions to all of the following: (1) the conception and design of the study, or acquisition of data, or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content, (3) final approval of the version to be submitted.

Changes to authorship
Authors are expected to consider carefully the list and order of authors before submitting their manuscript and provide the definitive list of authors at the time of the original submission. Any addition, deletion or rearrangement of author names in the authorship list should be made only before the manuscript has been accepted and only if approved by the journal Editor. To request such a change, the Editor must receive the following from the corresponding author: (a) the reason for the change in author list and (b) written confirmation (e-mail, letter) from all authors that they agree with the addition, removal or rearrangement. In the case of addition or removal of authors, this includes confirmation from the author being added or removed. Only in exceptional circumstances will the Editor consider the addition, deletion or rearrangement of authors after the manuscript has been accepted. While the Editor considers the request, publication of the manuscript will be suspended. If the manuscript has already been published in an online issue, any requests approved by the Editor will result in a corrigendum.

Article transfer service
This journal is part of our Article Transfer Service. This means that if the Editor feels your article is more suitable in one of our other participating journals, then you may be asked to consider transferring the article to one of those. If you agree, your article will be transferred automatically on your behalf with no need to reformat. Please note that your article will be reviewed again by the new journal. More information.
Copyright
Upon acceptance of an article, authors will be asked to complete a 'Journal Publishing Agreement' (see more information on this). An e-mail will be sent to the corresponding author confirming receipt of the manuscript together with a 'Journal Publishing Agreement' form or a link to the online version of this agreement.

Subscribers may reproduce tables of contents or prepare lists of articles including abstracts for internal circulation within their institutions. Permission of the Publisher is required for resale or distribution outside the institution and for all other derivative works, including compilations and translations. If excerpts from other copyrighted works are included, the author(s) must obtain written permission from the copyright owners and credit the source(s) in the article. Elsevier has preprinted forms for use by authors in these cases.

For open access articles: Upon acceptance of an article, authors will be asked to complete an 'Exclusive License Agreement' (more information). Permitted third party reuse of open access articles is determined by the author's choice of user license.

Author rights
As an author you (or your employer or institution) have certain rights to reuse your work. More information.

Elsevier supports responsible sharing
Find out how you can share your research published in Elsevier journals.

Role of the funding source
You are requested to identify who provided financial support for the conduct of the research and/or preparation of the article and to briefly describe the role of the sponsor(s), if any, in study design; in the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the article for publication. If the funding source(s) had no such involvement then this should be stated.

Funding body agreements and policies
Elsevier has established a number of agreements with funding bodies which allow authors to comply with their funder’s open access policies. Some funding bodies will reimburse the author for the Open Access Publication Fee. Details of existing agreements are available online. After acceptance, open access papers will be published under a noncommercial license. For authors requiring a commercial CC BY license, you can apply after your manuscript is accepted for publication.

Open access
This journal offers authors a choice in publishing their research:

Subscription
• Articles are made available to subscribers as well as developing countries and patient groups through our universal access programs.
• No open access publication fee payable by authors.

Open access
• Articles are freely available to both subscribers and the wider public with permitted reuse.
• An open access publication fee is payable by authors or on their behalf, e.g. by their research funder or institution.

Regardless of how you choose to publish your article, the journal will apply the same peer review criteria and acceptance standards.

For open access articles, permitted third party (re)use is defined by the following Creative Commons user licenses:

Creative Commons Attribution-NonCommercial-NoDerivs (CC BY-NC-ND)
For non-commercial purposes, lets others distribute and copy the article, and to include in a collective work (such as an anthology), as long as they credit the author(s) and provided they do not alter or modify the article.

The open access publication fee for this journal is USD 2600, excluding taxes. Learn more about Elsevier's pricing policy: https://www.elsevier.com/openaccesspricing.
Green open access
Authors can share their research in a variety of different ways and Elsevier has a number of green open access options available. We recommend authors see our green open access page for further information. Authors can also self-archive their manuscripts immediately and enable public access from their institution's repository after an embargo period. This is the version that has been accepted for publication and which typically includes author-incorporated changes suggested during submission, peer review and in editor-author communications. Embargo period: For subscription articles, an appropriate amount of time is needed for journals to deliver value to subscribing customers before an article becomes freely available to the public. This is the embargo period and it begins from the date the article is formally published online in its final and fully citable form. Find out more.

This journal has an embargo period of 12 months.

Elsevier Researcher Academy
Researcher Academy is a free e-learning platform designed to support early and mid-career researchers throughout their research journey. The "Learn" environment at Researcher Academy offers several interactive modules, webinars, downloadable guides and resources to guide you through the process of writing for research and going through peer review. Feel free to use these free resources to improve your submission and navigate the publication process with ease.

Language (usage and editing services)
Please write your text in good English (American or British usage is accepted, but not a mixture of these). Authors who feel their English language manuscript may require editing to eliminate possible grammatical or spelling errors and to conform to correct scientific English may wish to use the English Language Editing service available from Elsevier's WebShop.

Informed consent and patient details
Please ensure that you have obtained written consent from any patients that are identifiable from the images or videos in your manuscript before you submit your manuscript. Formal consents are not required for the use of entirely anonymised images from which the individual cannot be identified - for example, x-rays, ultrasound images, pathology slides or laparoscopic images, provided that these do not contain any identifying marks and are not accompanied by text that might identify the individual concerned. For identifiable images, if consent has not been obtained, it is generally not sufficient to anonymise a photograph simply by using eye bars or blurring the face of the individual concerned. For more information, please review the Elsevier Policy on the Use of Images or Personal Information of Patients or other Individuals.

Submission
Our online submission system guides you stepwise through the process of entering your article details and uploading your files. The system converts your article files to a single PDF file used in the peer-review process. Editable files (e.g., Word, LaTeX) are required to typeset your article for final publication. All correspondence, including notification of the Editor's decision and requests for revision, is sent by e-mail.

Manuscript types
- Original Article (available in full online only, but will be listed in the contents list of the printed journal and fully citable)
- Doing More with Less
- Clinical Images (see specific submission instructions below)
- Video Articles (see specific submission instructions below)
- Women in Neurosurgery
- Great Hospitals
- Neurosurgery Nursing
- Case Report
- Letter to the Editor (see specific submission instructions below)
- Historical Vignette
- Technical Note
- Literature Reviews
- Book Review (invited)
- Perspective (invited)
**Clinical Images:** Progress in neurosurgery has paralleled advances in lesion localization and imaging technologies. *World Neurosurgery* recently launched this new section to convey the nuances of our specialty through imagery. This is also a conduit by which neurosurgeons worldwide may communicate exciting discovery and experience through a common language, i.e., captivating clinical images. We thus encourage the submission of images or videos from cases that portray interesting, engaging and somewhat rare depiction of neurosurgical disease.

**Required submission criteria:**

- Text: A short description of 350 words or less
- Abstract: 50-150 word unstructured abstract (no headings)
- Title: The title should be clear and concise
- Authors: No more than three authors, with name, highest academic degree, affiliations, address and email for each
- Figure Legend: The legend should contain no more than 150 words, and include relevant patient history/physical examination, clinical course and response to treatment and if applicable, condition at follow-up.

**Video Articles:** Video Articles focus on important surgical procedures in the common interest of practicing neurosurgeons. A brief case presentation should be followed by 2D or 3D (preferred) operative video. Demonstration of interesting and innovative approaches should accompany illustrations of relevant operative anatomy. Judicious labelling of important anatomical structures are encouraged for better orientation of surgical field. Video files should be of high quality and not exceed 150 MB. Additional information on file formatting can be found [here](#).

**Manuscript criteria:**

- Title: Should not exceed 100 characters, including spaces
- Abstract: Up to 250 word unstructured abstract with discussion
- Patient information must be omitted from the video
- Authors are responsible to obtain consent from signed from any patients who could be identified from the videos. It is the responsibility of the corresponding author to declare in the cover letter that he has obtained relevant consent form, signed by the patient.

**Doing More with Less:** The Doing More with Less section of *World Neurosurgery* focuses on the particular needs of the lower-resource neurosurgery world, which includes most of the world. The Section solicits submissions of news articles, commentaries, and scientific and technical papers that relate to issues surrounding optimal patient care in resource-challenged environments. In particular, this call for scientific and technical papers focuses on methods for accomplishing neurosurgical goals with low-cost solutions that are practical to implement in neurosurgical operating theaters and care environments where minimal or basic tools and materials are available. During your submission process, please choose 'Doing More with Less' as your article type.

**Great Hospitals:** *World Neurosurgery* has recently reintroduced the topic of 'Great Hospitals.' We are seeking articles from institutions world-wide who have a rich history and a message to share. Such prior publications have provided an insight into their unique characteristics, attributes and strategies/modus operandi. If any of you have a message to share regarding your institution, please template a submission article after those already published in *World Neurosurgery*¹⁻⁵ and submit such for review as a 'Great Hospitals' article type.


**Neurosurgery Nursing:** *World Neurosurgery* solicits Neurosurgery Nursing submissions of news articles, commentaries, technical and scientific papers that relate to neurosurgery nursing’s role in interrelated and interprofessional neurosurgery patient care. This call for submissions includes historical perspectives, such as the evolution of neurosurgery nursing in a specific country/region; current state and future directions of neurosurgery nursing in your country/region; care coordination;
care collaboration; impact on issues of concern to the World Health Organization such as obesity, falls with head and/or spine injury, infectious diseases; care or health challenges; problem-solving care challenges; dissemination of neurosurgery nursing research.

During the submission process, please choose 'Neurosurgery Nursing' as your article and classification type.

**Women in Neurosurgery:** *World Neurosurgery* is accepting papers written by neurosurgeons, male or female, addressing the issues that women face in neurosurgery. Disseminating true facts via publications and educational efforts can aid in establishing equality in the world-wide neurosurgery community. This can only come from neurosurgeons themselves. *World Neurosurgery* encourages the submission of articles addressing these issues.

When submitting your manuscript, please select 'Women in Neurosurgery' as your article type.

**Letter to the Editor:** When discussing a prior *World Neurosurgery* manuscript, please cite the specific article in the main body of your letter and add it to the Reference List at the end of your manuscript. We request that you use a unique title for your Letter to the Editor:

- Letter is in response to a published manuscript, please begin your title as follows: Letter to the Editor Regarding (insert particular article title here)
- If you have been invited to respond to a Letter to the Editor, please start your title with: In Reply to the Letter to the Editor Regarding (insert particular article title here)

*Submit your article*

Please submit your article via [http://ees.elsevier.com/worldneurosurgery/](http://ees.elsevier.com/worldneurosurgery/).

**PREPARATION**

**Cover Letter**

Cover Letter Info to include the following: The author(s) should provide a cover letter with each submission, ensuring they include the following: A statement of non-duplication, with the following statements: "I, (corresponding author's name), certify that this manuscript is a unique submission and is not being considered for publication, in part or in full, with any other source in any medium."

**Use of word processing software**

It is important that the file be saved in the native format of the word processor used. The text should be in single-column format. When preparing your submission please double space the entire document with 1" margins. Each page should be numbered, with the first author's last name in the upper right hand corner. Keep the layout of the text as simple as possible. Most formatting codes will be removed and replaced on processing the article. In particular, do not use the word processor's options to justify text or to hyphenate words. However, do use bold face, italics, subscripts, superscripts etc. When preparing tables, if you are using a table grid, use only one grid for each individual table and not a grid for each row. If no grid is used, use tabs, not spaces, to align columns. The electronic text should be prepared in a way very similar to that of conventional manuscripts (see also the Guide to Publishing with Elsevier: [http://www.elsevier.com/guidepublication](http://www.elsevier.com/guidepublication)). Note that source files of figures, tables and text graphics will be required whether or not you embed your figures in the text. See also the section on Electronic artwork.

To avoid unnecessary errors you are strongly advised to use the 'spell-check' and 'grammar-check' functions of your word processor.

**Article structure**

**Subdivision - unnumbered sections**

Divide your article into clearly defined sections. Each subsection is given a brief heading. Each heading should appear on its own separate line. Subsections should be used as much as possible when cross-referencing text: refer to the subsection by heading as opposed to simply 'the text'.

**Introduction**

State the objectives of the work and provide an adequate background, avoiding a detailed literature survey or a summary of the results.

**Material and methods**

Provide sufficient details to allow the work to be reproduced by an independent researcher. Methods that are already published should be summarized, and indicated by a reference. If quoting directly from a previously published method, use quotation marks and also cite the source. Any modifications to existing methods should also be described.
Results
Results should be clear and concise.

Discussion
This should explore the significance of the results of the work, not repeat them. A combined Results and Discussion section is often appropriate. Avoid extensive citations and discussion of published literature.

Conclusions
The main conclusions of the study may be presented in a short Conclusions section, which may stand alone or form a subsection of a Discussion or Results and Discussion section.

Appendices
If there is more than one appendix, they should be identified as A, B, etc. Formulae and equations in appendices should be given separate numbering: Eq. (A.1), Eq. (A.2), etc.; in a subsequent appendix, Eq. (B.1) and so on. Similarly for tables and figures: Table A.1; Fig. A.1, etc.

Essential title page information
• Title. Concise and informative. Titles are often used in information-retrieval systems. Avoid abbreviations and formulae where possible.
• Author names and affiliations. Please clearly indicate the given name(s) and family name(s) of each author and check that all names are accurately spelled. You can add your name between parentheses in your own script behind the English transliteration. Present the authors' affiliation addresses (where the actual work was done) below the names. Indicate all affiliations with a lower-case superscript letter immediately after the author's name and in front of the appropriate address. Provide the full postal address of each affiliation, including the country name and, if available, the e-mail address of each author.
• Corresponding author. Clearly indicate who will handle correspondence at all stages of refereeing and publication, also post-publication. This responsibility includes answering any future queries about Methodology and Materials. Ensure that the e-mail address is given and that contact details are kept up to date by the corresponding author.
• Present/permanent address. If an author has moved since the work described in the article was done, or was visiting at the time, a 'Present address' (or 'Permanent address') may be indicated as a footnote to that author's name. The address at which the author actually did the work must be retained as the main, affiliation address. Superscript Arabic numerals are used for such footnotes.
• Highest academic degrees for all authors. Degrees are not listed in the author line but are necessary for other purposes.
• Departmental and institutional affiliations for all authors. When providing author names and affiliations, be sure to include department/division information and not only the institution.
• Key words (3 to 7). Provide an alphabetized list of 3 to 7 key words which will appear in print and used for indexing purposes.
• Abbreviations list. Provide an alphabetized list of all abbreviations used in the article, with each abbreviation/acronym followed by its complete spell out.

Abstract
A concise and factual abstract is required. The abstract should state briefly the purpose of the research, the principal results and major conclusions. An abstract is often presented separately from the article, so it must be able to stand alone. For this reason, References should be avoided, but if essential, then cite the author(s) and year(s). Also, non-standard or uncommon abbreviations should be avoided, but if essential they must be defined at their first mention in the abstract itself.

Abstracts should be 250 words, maximum.
Original Articles, Doing More With Less, Women in Neurosurgery, Great Hospitals, Neurosurgery Nursing and Technical Notes require a structured abstract with the following headings: Objective (or Background), Methods, Results, Conclusions.
Case Reports require a structured abstract with the following headings: Background, Case Description, Conclusions.
Historical Vignettes and Literature Reviews require an abstract, but it can be unstructured (no headings).
Clinical Images require a 50-150 word unstructured abstract (no headings).
Video Articles require a 250 word unstructured abstract.
Highlights
Highlights are mandatory for this journal. They consist of a short collection of bullet points that convey the core findings of the article and should be submitted in a separate editable file in the online submission system. Please use 'Highlights' in the file name and include 3 to 5 bullet points (maximum 85 characters, including spaces, per bullet point). You can view example Highlights on our information site.

Acknowledgements
Collate acknowledgements in a separate section at the end of the article before the references and do not, therefore, include them on the title page, as a footnote to the title or otherwise. List here those individuals who provided help during the research (e.g., providing language help, writing assistance or proof reading the article, etc.).

Formatting of funding sources
List funding sources in this standard way to facilitate compliance to funder's requirements:

Funding: This work was supported by the National Institutes of Health [grant numbers xxxx, yyyy]; the Bill & Melinda Gates Foundation, Seattle, WA [grant number zzzz]; and the United States Institutes of Peace [grant number aaaa].

It is not necessary to include detailed descriptions on the program or type of grants and awards. When funding is from a block grant or other resources available to a university, college, or other research institution, submit the name of the institute or organization that provided the funding.

If no funding has been provided for the research, please include the following sentence:
This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Units
Follow internationally accepted rules and conventions: use the international system of units (SI). If other units are mentioned, please give their equivalent in SI.

Math formulae
Please submit math equations as editable text and not as images. Present simple formulae in line with normal text where possible and use the solidus (/) instead of a horizontal line for small fractional terms, e.g., X/Y. In principle, variables are to be presented in italics. Powers of e are often more conveniently denoted by exp. Number consecutively any equations that have to be displayed separately from the text (if referred to explicitly in the text).

Embedded math equations
If you are submitting an article prepared with Microsoft Word containing embedded math equations then please read this (related support information).

Artwork
Electronic artwork
General points
• Make sure you use uniform lettering and sizing of your original artwork.
• Embed the used fonts if the application provides that option.
• Aim to use the following fonts in your illustrations: Arial, Courier, Times New Roman, Symbol, or use fonts that look similar.
• Number the illustrations according to their sequence in the text.
• Use a logical naming convention for your artwork files.
• Provide captions to illustrations separately.
• Size the illustrations close to the desired dimensions of the published version.
• Submit each illustration as a separate file.
A detailed guide on electronic artwork is available.
You are urged to visit this site; some excerpts from the detailed information are given here.

Formats
If your electronic artwork is created in a Microsoft Office application (Word, PowerPoint, Excel) then please supply 'as is' in the native document format.
Regardless of the application used other than Microsoft Office, when your electronic artwork is finalized, please 'Save as' or convert the images to one of the following formats (note the resolution requirements for line drawings, halftones, and line/halftone combinations given below):

- **EPS (or PDF):** Vector drawings, embed all used fonts.
- **TIFF (or JPEG):** Color or grayscale photographs (halftones), keep to a minimum of 300 dpi.
- **TIFF (or JPEG):** Bitmapped (pure black & white pixels) line drawings, keep to a minimum of 1000 dpi.
- **TIFF (or JPEG):** Combinations bitmapped line/half-tone (color or grayscale), keep to a minimum of 500 dpi.

**Please do not:**
- Supply files that are optimized for screen use (e.g., GIF, BMP, PICT, WPG); these typically have a low number of pixels and limited set of colors;
- Supply files that are too low in resolution;
- Submit graphics that are disproportionately large for the content.

**Color artwork**
Please make sure that artwork files are in an acceptable format (TIFF (or JPEG), EPS (or PDF) or MS Office files) and with the correct resolution. If, together with your accepted article, you submit usable color figures then Elsevier will ensure, at no additional charge, that these figures will appear in color online (e.g., ScienceDirect and other sites) in addition to color reproduction in print. Further information on the preparation of electronic artwork.

**Illustration services**
Elsevier's WebShop offers Illustration Services to authors preparing to submit a manuscript but concerned about the quality of the images accompanying their article. Elsevier's expert illustrators can produce scientific, technical and medical-style images, as well as a full range of charts, tables and graphs. Image 'polishing' is also available, where our illustrators take your image(s) and improve them to a professional standard. Please visit the website to find out more.

**Figure captions**
Ensure that each illustration has a caption. Supply captions separately, not attached to the figure. A caption should comprise a brief title (not on the figure itself) and a description of the illustration. Keep text in the illustrations themselves to a minimum but explain all symbols and abbreviations used.

**Tables**
Number tables consecutively in accordance with their appearance in the text. Each table requires its own title. All tables should be placed in their own file, separate from the manuscript file. Avoid vertical rules. Be sparing in the use of tables and ensure that the data presented in tables do not duplicate results described elsewhere in the article. Place footnotes to tables below the table body and indicate them with the following symbols in the following order:

- * (asterisk)
- † (dagger)
- ‡ (double dagger)
- § (section mark)
- II (parallel mark)
- ¶ (paragraph symbol)
- # (number sign)
- ** (etc.)
- *** (etc.)

All studies listed in a table must be cited in the table and included in the complete reference list, just as if the study in question were discussed and cited in the text of the article.

**References**

* Citation in text*
Please ensure that every reference cited in the text is also present in the reference list (and vice versa). Any references cited in the abstract must be given in full. Unpublished results and personal communications are not recommended in the reference list, but may be mentioned in the text. If these references are included in the reference list they should follow the standard reference style of the journal and should include a substitution of the publication date with either 'Unpublished results' or 'Personal communication'. Citation of a reference as 'in press' implies that the item has been accepted for publication.
Reference links
Increased discoverability of research and high quality peer review are ensured by online links to the sources cited. In order to allow us to create links to abstracting and indexing services, such as Scopus, CrossRef and PubMed, please ensure that data provided in the references are correct. Please note that incorrect surnames, journal/book titles, publication year and pagination may prevent link creation. When copying references, please be careful as they may already contain errors. Use of the DOI is encouraged.

A DOI can be used to cite and link to electronic articles where an article is in-press and full citation details are not yet known, but the article is available online. A DOI is guaranteed never to change, so you can use it as a permanent link to any electronic article. An example of a citation using DOI for an article not yet in an issue is: VanDecar J.C., Russo R.M., James D.E., Ambeh W.B., Franke M. (2003). Aseismic continuation of the Lesser Antilles slab beneath northeastern Venezuela. Journal of Geophysical Research, https://doi.org/10.1029/2001JB000884. Please note the format of such citations should be in the same style as all other references in the paper.

Data references
This journal encourages you to cite underlying or relevant datasets in your manuscript by citing them in your text and including a data reference in your Reference List. Data references should include the following elements: author name(s), dataset title, data repository, version (where available), year, and global persistent identifier. Add [dataset] immediately before the reference so we can properly identify it as a data reference. The [dataset] identifier will not appear in your published article.

References in a special issue
Please ensure that the words ‘this issue’ are added to any references in the list (and any citations in the text) to other articles in the same Special Issue.

Users of Mendeley Desktop can easily install the reference style for this journal by clicking the following link: http://open.mendeley.com/use-citation-style/world-neurosurgery
When preparing your manuscript, you will then be able to select this style using the Mendeley plug-ins for Microsoft Word or LibreOffice.

Reference style
Text: Indicate references by (consecutive) superscript arabic numerals in the order in which they appear in the text. The numerals are to be used outside periods and commas, inside colons and semicolons. For further detail and examples you are referred to the AMA Manual of Style, A Guide for Authors and Editors, Tenth Edition, ISBN 0-978-0-19-517633-9.

List: Number the references in the list in the order in which they appear in the text.
Examples:
Reference to a book:
Reference to a chapter in an edited book:
Reference to a website:
Reference to a dataset:

Journal abbreviations source
Journal names should be abbreviated according to the List of Title Word Abbreviations.

Cover and Filler Artwork
World Neurosurgery is changing the cover art and filler art motif. This motif involves the display of art by neurosurgeons. Hence, we are seeking art, in any visual form, for this endeavor on an ongoing basis. Such art might naturally include photography, photographs of sculptures or paintings, prose or
poetry, etc. We ask neurosurgeons to submit high resolution images, in a portrait setting, of such art. If a landscape image is submitted and selected please note that it will be cropped. These images will be considered for future World Neurosurgery journal covers and for filler art. When submitting your images, please include a brief description. These can be submitted directly to moorec2@ccf.org.

**Video**

Elsevier accepts video material and animation sequences to support and enhance your scientific research. Authors who have video or animation files that they wish to submit with their article are strongly encouraged to include links to these within the body of the article. This can be done in the same way as a figure or table by referring to the video or animation content and noting in the body text where it should be placed. All submitted files should be properly labeled so that they directly relate to the video file's content. In order to ensure that your video or animation material is directly usable, please provide the file in one of our recommended file formats with a preferred maximum size of 150 MB per file, 1 GB in total. Video and animation files supplied will be published online in the electronic version of your article in Elsevier Web products, including ScienceDirect. Please supply 'stills' with your files: you can choose any frame from the video or animation or make a separate image. These will be used instead of standard icons and will personalize the link to your video data. For more detailed instructions please visit our video instruction pages. Note: since video and animation cannot be embedded in the print version of the journal, please provide text for both the electronic and the print version for the portions of the article that refer to this content.

**AudioSlides**

The journal encourages authors to create an AudioSlides presentation with their published article. AudioSlides are brief, webinar-style presentations that are shown next to the online article on ScienceDirect. This gives authors the opportunity to summarize their research in their own words and to help readers understand what the paper is about. More information and examples are available. Authors of this journal will automatically receive an invitation e-mail to create an AudioSlides presentation after acceptance of their paper.

**Data visualization**

Include interactive data visualizations in your publication and let your readers interact and engage more closely with your research. Follow the instructions here to find out about available data visualization options and how to include them with your article.

**Supplementary material**

Supplementary material such as applications, images and sound clips, can be published with your article to enhance it. Submitted supplementary items are published exactly as they are received (Excel or PowerPoint files will appear as such online). Please submit your material together with the article and supply a concise, descriptive caption for each supplementary file. If you wish to make changes to supplementary material during any stage of the process, please make sure to provide an updated file. Do not annotate any corrections on a previous version. Please switch off the 'Track Changes' option in Microsoft Office files as these will appear in the published version.

**Research data**

This journal encourages and enables you to share data that supports your research publication where appropriate, and enables you to interlink the data with your published articles. Research data refers to the results of observations or experimentation that validate research findings. To facilitate reproducibility and data reuse, this journal also encourages you to share your software, code, models, algorithms, protocols, methods and other useful materials related to the project.

Below are a number of ways in which you can associate data with your article or make a statement about the availability of your data when submitting your manuscript. If you are sharing data in one of these ways, you are encouraged to cite the data in your manuscript and reference list. Please refer to the "References" section for more information about data citation. For more information on depositing, sharing and using research data and other relevant research materials, visit the research data page.

**Data linking**

If you have made your research data available in a data repository, you can link your article directly to the dataset. Elsevier collaborates with a number of repositories to link articles on ScienceDirect with relevant repositories, giving readers access to underlying data that gives them a better understanding of the research described.
There are different ways to link your datasets to your article. When available, you can directly link your dataset to your article by providing the relevant information in the submission system. For more information, visit the database linking page.

For supported data repositories a repository banner will automatically appear next to your published article on ScienceDirect.

In addition, you can link to relevant data or entities through identifiers within the text of your manuscript, using the following format: Database: xxxx (e.g., TAIR: AT1G01020; CCDC: 734053; PDB: 1XFN).

**Mendeley Data**
This journal supports Mendeley Data, enabling you to deposit any research data (including raw and processed data, video, code, software, algorithms, protocols, and methods) associated with your manuscript in a free-to-use, open access repository. Before submitting your article, you can deposit the relevant datasets to Mendeley Data. Please include the DOI of the deposited dataset(s) in your main manuscript file. The datasets will be listed and directly accessible to readers next to your published article online.

For more information, visit the Mendeley Data for journals page.

**Data statement**
To foster transparency, we encourage you to state the availability of your data in your submission. This may be a requirement of your funding body or institution. If your data is unavailable to access or unsuitable to post, you will have the opportunity to indicate why during the submission process, for example by stating that the research data is confidential. The statement will appear with your published article on ScienceDirect. For more information, visit the Data Statement page.

**AFTER ACCEPTANCE**

**Online proof correction**
Corresponding authors will receive an e-mail with a link to our online proofing system, allowing annotation and correction of proofs online. The environment is similar to MS Word: in addition to editing text, you can also comment on figures/tables and answer questions from the Copy Editor. Web-based proofing provides a faster and less error-prone process by allowing you to directly type your corrections, eliminating the potential introduction of errors.

If preferred, you can still choose to annotate and upload your edits on the PDF version. All instructions for proofing will be given in the e-mail we send to authors, including alternative methods to the online version and PDF.
We will do everything possible to get your article published quickly and accurately. Please use this proof only for checking the typesetting, editing, completeness and correctness of the text, tables and figures. Significant changes to the article as accepted for publication will only be considered at this stage with permission from the Editor. It is important to ensure that all corrections are sent back to us in one communication. Please check carefully before replying, as inclusion of any subsequent corrections cannot be guaranteed. Proofreading is solely your responsibility.

**Offprints**
The corresponding author, at no cost, will be provided with a PDF file of the article via e-mail (the PDF file is a watermarked version of the published article and includes a cover sheet with the journal cover image and a disclaimer outlining the terms and conditions of use). For an extra charge, paper offprints can be ordered via the offprint order form which is sent once the article is accepted for publication. Both corresponding and co-authors may order offprints at any time via Elsevier's WebShop. Authors requiring printed copies of multiple articles may use Elsevier WebShop's 'Create Your Own Book' service to collate multiple articles within a single cover.

**AUTHOR INQUIRIES**
Visit the Elsevier Support Center to find the answers you need. Here you will find everything from Frequently Asked Questions to ways to get in touch.

You can also check the status of your submitted article or find out when your accepted article will be published.

© Copyright 2018 Elsevier | https://www.elsevier.com