SCIENTIFIC ARTICLE

The impact of patients controlled analgesia undergoing orthopedic surgery[☆]

Aluane Silva Dias[a], Tathyana Rinaldi[a], Luciana Gardin Barbosa[a,b,*]

[a] *Hospital da Associação de Assistência à Criança Deficiente - AACD, São Paulo, SP, Brazil*
[b] *Intensive Care, Hospital das Clínicas, Faculdade de Medicina, Universidade de São Paulo (HC-FM-USP), São Paulo, SP, Brazil*

Abstract
Introduction: The currently common musculoskeletal disorders have been increasingly treated surgically, and the pain can be a limiting factor in postoperative rehabilitation.
Rationale: Patient controlled analgesia (PCA) controls pain, but its adverse effects can interfere with rehabilitation and in the patient discharge process. This study becomes important, since there are few studies evaluating this correlation.
Objectives: To compare the outcomes of patients who used and did not use patient controlled analgesia in postoperative orthopedic surgery with respect to pain, unscheduled need for O_2 (oxygen), and time of immobility and in-hospital length of stay.
Methods: This is an observational, prospective study conducted at Hospital Abreu Sodré from May to August 2012. The data was daily obtained through assessments and interviews of patients undergoing total hip arthroplasty (THA) and total knee arthroplasty (TKA), thoracolumbar spine arthrodesis (long PVA), cervical spine arthrodesis (cervical AVA) and lumbar spine arthrodesis (lumbar PVA).
Results: The study showed some differences between groups, namely: the painful level was higher in the group undergoing lumbar PVA without PCA compared with the group with PCA ($p = 0.03$) and in the group of long PVA without PCA in the early postoperative period. This latter group used O_2 for a longer time ($p = 0.09$).
Conclusion: In this study, PCA was useful for analgesia in patients undergoing lumbar PVA and probably would have influenced the usage time of O_2 in the group of long PVA in face of a larger sample. The use of PCA did not influence the time of leaving the bed and the in-hospital length of stay for the patients studied.
© 2014 Sociedade Brasileira de Anestesiologia. Published by Elsevier Editora Ltda. All rights reserved.

O impacto da analgesia controlada pelos pacientes submetidos a cirurgias ortopédicas

Resumo

Introdução: As disfunções musculoesqueléticas, comuns atualmente, têm sido cada vez mais tratadas cirurgicamente, e a dor é pode ser um fator limitante na reabilitação pós-operatória.

Justificativa: A Analgesia Controlada pelo Paciente (PCA) controla a dor, porém seus efeitos adversos podem interferir no processo de reabilitação e alta dos pacientes. Esta pesquisa torna-se importante, pois poucos estudos avaliam essa correlação.

Objetivos: Comparar a evolução dos pacientes que usaram e não usaram PCA no pós-operatório de cirurgias ortopédicas em relação à dor, necessidade de O_2 (oxigênio) não programada e tempo imobilismo e internação hospitalar.

Métodos: Estudo observacional, prospectivo, realizado no Hospital Abreu Sodré de maio a agosto de 2012. Obteve-se dados diários através de avaliação e entrevista dos pacientes submetidos à artroplastia total de quadril (ATQ) e joelho (ATJ), artrodese de coluna toracolombar (AVP longa), coluna cervical (AVA cervical) e coluna lombar (AVP lombar).

Resultados: O estudo evidenciou algumas diferenças entre os grupos, sendo elas: o nível álgico foi maior no grupo submetido à AVP lombar sem PCA em relação ao com PCA (p=0,03) e no grupo de AVP longa sem PCA no primeiro pós-operatório. Nesse último grupo, houve uso de O_2 por mais tempo (p=0,09).

Conclusão: Nesse estudo, a PCA mostrou-se útil para analgesia em pacientes submetidos à AVP lombar e provavelmente teria influência no tempo de uso de O_2 no grupo de AVP longa, caso a amostra fosse maior. O uso da PCA não influenciou no tempo de saída do leito e de internação hospitalar nos pacientes estudados.

Introduction

Currently, musculoskeletal disorders have become a common problem, in part due to increased life expectancy and incidence of obesity in the world population. These disorders cause functional limitations that invariably have a progressive course if not managed properly.[1–3]

Treatment may be conservative with control of symptoms through medication, physical or surgical rehabilitation, with repair and/or replacement of damaged joints.[2]

Surgical techniques have been improved rapidly in the last decades, but it does not always impact the postoperative rehabilitation of patients. Pain severity and length of hospital stay, especially when added to a previous status of limitation, in addition to complications associated with the anesthetic and surgical procedure,[4] result in greater morbidity and functional loss[5] and may affect prognosis.[6–8]

Pain is one of the main factors limiting ambulation, increasing the risk of thromboembolism by immobility and causing metabolic changes that affect other systems. Therefore, individualized pain management with the use of appropriate analgesic techniques is of paramount importance. Moreover, early intervention of rehabilitation aiming at a better postoperative recovery[6,9–11] may reduce the length of hospital stay and return to daily activities.[12,13]

There are several techniques of analgesia; however, the use of patient-controlled analgesia (PCA) is increasingly present in hospitals. This method, which is considered safe and effective for treating moderate to severe pain,[6,14,15] is used since the 1970s.

PCA pumps are infusion devices that allow various forms of programming and whose drug administration may be intravenous or epidural, continuously or through a device to request bolus doses (intermittent). The patient operates the device, if necessary. This analgesic technique is often used in cases of severe pain, such as after orthopedic surgery,[6] or chronic pain, such as patients with advanced malignancies undergoing palliative care.

On the other hand, the use of PCA may be associated with hypotension, urinary retention, and motor blockade, which limits mobilization and, with high doses of opioids, it may result in sedation, respiratory depression, constipation, confusion, urinary retention, nausea, vomiting, and pruritus.[7] It is noteworthy that respiratory depression is the most troubling adverse effect. It is expressed by decreased peripheral oxygen saturation (SpO_2) and respiratory rate, as suggested by some authors. The oxygen requirement for hypoxemia management may prolong hospitalization, with consequent delay in rehabilitation.[9,16,17]

Brazilian literature is scarce in studies assessing the impact of PCA in clinical outcome and rehabilitation of patients after orthopedic surgery. The aim of this study was to compare the outcome of patients submitted to orthopedic surgery, with and without PCA, regarding the need for supplemental O_2, patient bed time, length of hospital stay, and level of pain.

Thus, it is possible to identify situations that may affect the time it takes the patient to return to daily activities, in order to intervene with prophylactic resources and improve postoperative rehabilitation. These factors are important for the quality of care provided, and impact on cost

Table 1 Sample characterization.

Surgery	n with PCA – sex (f/m)	n without PCA – sex (f/m)	Mean age	Total
THA	4 (1/3)	19 (12/7)	64	23
TKA	23 (20/3)	23 (20/3)	67.5	46
Long AVP	22 (17/5)	8 (8/0)	21.6	30
Lumbar AVP	23 (14/9)	93 (61/32)	46.8	116
Cervical AVA		23 (17/6)	50.9	23
Total	72 (52/20)	166 (118/48)	50.1	238

f, female; m, male; n, number of patients.

reduction due to shorter hospital stays. The proposed study results may also serve as a guide for improving care protocols of physiotherapy service, besides contributing to a better understanding of PCA effects on orthopedic patients.

Methods

Prospective, observational study conducted through monitoring of patients at the AACD Hospital from May to August 2012.

A daily screening in hospital occupancy map was performed to include patients. All patients undergoing total hip arthroplasty (THA), total knee arthroplasty (TKA), arthrodesis via posterior approach of thoracolumbar spine (long AVP), arthrodesis via anterior approach of the cervical spine (cervical AVA), and arthrodesis via posterior approach of lumbar spine (lumbar AVP) were selected. Subsequently, the sample was divided into two groups: with and without PCA.

Exclusion criteria were patients who were not able to quantify pain using the numeric pain scale (NPS),[18–20] those with chronic lung disease (COPD, chronic restrictive pulmonary disease or of chest origin, asthma, O_2 dependency), and home users of noninvasive mechanical ventilation.

The study was approved by the institutional Ethics Research Committee. Selected patients were informed about the study and signed a written consent form. They were monitored daily by the investigators involved who filled out a form with data collected from medical records. When data were not available in the medical records, the missing data were collected via patient assessment.

The data collection form was filled once a day, with the patient at rest, from the first postoperative period to hospital discharge. Data were tabulated in spreadsheets, using Microsoft Excel 2010®, and analyzed statistically. Mann–Whitney test was used to compare age, body mass index (BMI), length of hospital stay, time of getting out of bed, use of O_2, and pain variables. Fisher exact test was used to evaluate the difference in gender distribution of patients. When patients were separated by length of stay or time for getting out of bed, the pain, BMI, and age variables were evaluated with the Kruskal–Wallis test, and Dunn's post-test was used for multiple comparisons. For additional analysis, such as correlations between oxygen use and BMI and age, the Spearman correlation was applied. The significance level was set at $p \leq 0.05$. The software used was GraphPad PRISM® version 5.

For daily patient assessment, the following tools were used:

(a) Data collection form;
(b) Pulse oximeter (noninvasive measurement system of oxyhemoglobin saturation);
(c) Numerical pain scale (NPS), which allows quantifying pain severity with numbers from zero to 10 (0 represents no pain and 10 the worst possible pain). The remaining numbers quantify intermediate pain [18–20]. In this study, the NPS was applied orally.

Results

The study included 270 patients, of which 32 were excluded for data collection failure, leaving a sample of 238 patients. Of these, 170 were women (mean age of 50.2 years) and 68 men (mean age of 47.6 years). Table 1 shows the sample characteristics.

Comparing groups undergoing THA and TKA with and without PCA, there was no statistical difference in pain, age, BMI, use of supplemental O_2, time of getting out of bed, and length of hospital stay. The only significant finding was regarding sex: more men than women used PCA ($p < 0.0001$).

In long AVP group, the use of supplemental O_2 was statistically significant ($p = 0.09$), indicating a tendency for O_2 consumption by patients who did not use PCA (Fig. 1). In the same group, there was no statistical difference in other analyzes.

Among patients undergoing lumbar AVP there was statistically significant difference between the groups with and
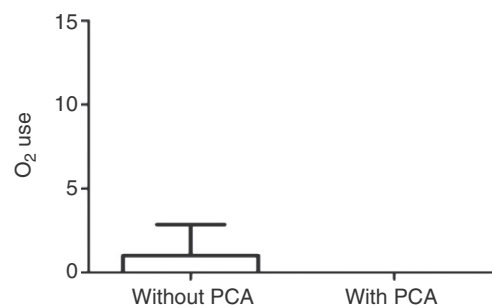

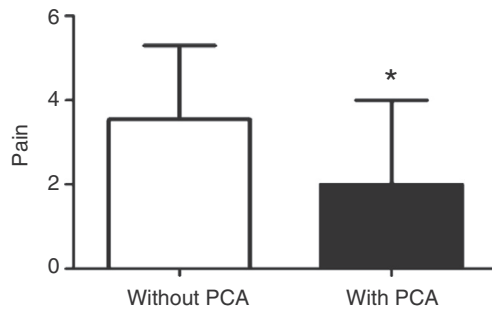**Figure 1** Relationship of O_2 use in patients of AVP long group, with and without PCA.

Figure 2 Relationship of pain with and without PCA in patients of lumbar AVP group. *Statistically significant difference between the two groups.
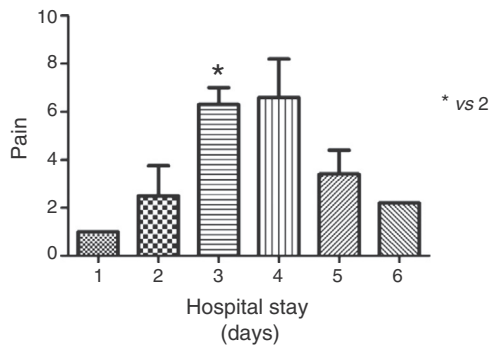

Figure 3 Relationship of postoperative pain and hospital stay in patients of cervical AVA group.

without PCA ($p = 0.031$). The NPS mean score was lower in first group (Fig. 2).

PCA was not used by patients undergoing cervical AVA. However, when pain scale was assessed, it was seen that patients reported more severe pain on the third postoperative day than on the second day (Fig. 3). An additional analysis of data comparing BMI value with time of getting out of bed revealed a close to significant value ($p = 0.068$) between the first and second postoperative periods, which indicates that this sample of patients with higher BMI tended to get out of bed later (Fig. 4).

Comparing the mean NPS of patients with PCA with those without PCA on the first postoperative day, an almost significant difference ($p = 0.058$) was found between the groups
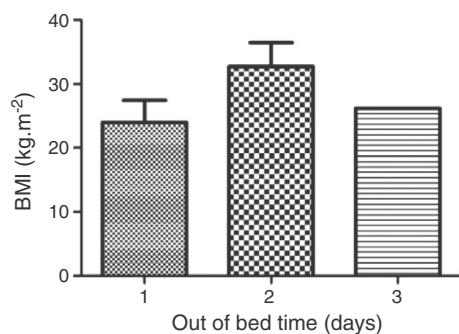

Figure 4 Relationship of BMI and time for leaving the bed in patients of cervical AVA group.
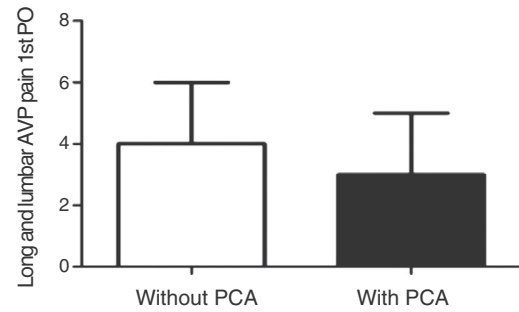

Figure 5 Relationship of pain in the first postoperative period between patients with and without PCA undergoing lumbar and long AVP.

with and without PCA undergoing lumbar and long AVP surgeries (Fig. 5). There was no statistical difference between TKA and THA surgeries.

Patients' pain was analyzed the day after PCA withdrawal, but there was no significant difference.

Table 2 shows the data correlated with the respective significant values (p-value < 0.05)

Discussion

The results of this study show that there was a predominance of women diagnosed with osteoarthritis, which corroborates the literature.[21]

Moreover, there was no statistical difference in any of the variables when the groups with and without PCA submitted to the THA and TKA surgeries were compared. Due to the role of PCA in pain management, it was expected that there would be some significant difference regarding pain. What could be seen was that patients associate pain with the operated limb mobilization periods and not with rest periods. Because data collection was not performed in periods of activity, this factor may have influenced the results, which causes a limitation in the study.

The results also showed that the majority of patients undergoing long AVP were young women. According to Lima Júnior et al.,[22] women tend to have greater curvatures of the spine, which required surgical intervention to prevent progression.

In this group of patients undergoing long AVP there was a nearly significant difference in the use of O_2 ($p = 0.09$) between groups with and without PCA, which could have been defined with a larger sample. Pain can be a very limiting factor in this group of patients because it is a major surgery that involves multiple spinal segments, including the accessory muscles of respiration, decreases chest expansion, and impacts on SpO_2 and time restricted to bed.

According to ours results, it was realized that there was no statistically significant value regarding PCA use and O_2 supplementation in the other groups.

As an additional finding, it was noticed that the majority of patients using O_2 had between 60 and 80 years. Possibly because elderly patients have previous limitations by the aging process itself and when added to a surgical

Table 2 Correlations performed with median, 1st and 3rd quartile, and *p*-value.

Data	Median without PCA/with PCA	1st quartile without PCA/with PCA	3rd quartile without PCA/with PCA	*p*-value
THA age	66/63.5	50/56	78/72.5	0.8076
THA BMI	27/30	23/25.25	32/33.25	0.441
THA *t*	4/4.5	4/3.25	4/7.25	0.4182
THA O_2	0/0.5	0/0	0/1	0.3145
THA out of bed	02/02	2/0	2/0	More than 2 per group is needed
THA pain	02/02	1/1.255	5/3.5	0.6847
TKA age	70/70	65/59	75/73	0.7333
TKA BMI	27/30	24/27	32/33	0.307
TKA *t*	4/4	4/3	5/5	0.8645
TKA O_2	0/0	0/0	1/1	0.6289
TKA out of bed	2/2	2/2	2/2	0.23
TKA pain	3/4	1/2	4/5	0.1136
Long AVP age	14.5/16	14/13.75	16.75/22.25	0.6205
Long AVP BMI	18/21	17/18	26/24.25	0.725
Long AVP *t*	6/5	4.25/5	8.5/7	0.6804
Long AVP O_2	0/0	0/0	3/0	0.0956
Long AVP out of bed	3/2.5	2/2	3/3	0.4215
Long AVP pain	4/3.5	1.5/1	4/4.25	0.9066
Lumbar AVP age	47.5/49	35/42	58.75/61	0.2455
Lumbar AVP BMI	27/27	24/25	30/31	0.384
Lumbar AVP *t*	3/3	2/3	4/5	0.4061
Lumbar AVP O_2	0/0	0/0	0/0	0.2131
Lumbar AVP out of bed	2/2	1/2	2/2	0.273
Lumbar AVP pain	3.5/2	2/1	5/4	0.0311
TKA and THA pain 1st PO	2/4	0/2	5/7	0.1071
Long and lumbar AVP pain 1st PO	4/3	2/1	6/5	0.0583
With PCA and without PCA – same patient	3/3	0/1	4.5/5	0.3007

THA, total hip arthroplasty; TKA, total knee arthroplasty; Long AVP, arthrodesis via posterior approach of thoracolumbar spine; Lumbar AVP, arthrodesis via posterior approach of lumbar spine; *t*, length of hospital stay; BMI, body mass index; O_2, oxygen use; 1st PO, first postoperative period.

procedure, it may complicate recovery and lead to respiratory complications.[4]

In studies of opioids in PCA pumps, respiratory depression occurs commonly among the first 12–24 h.[16] However, in this study, data were collected from the first postoperative day. Perhaps, this was the reason why there was no case of respiratory depression in this sample.

Regarding lumbar AVP surgery, the most common cause was herniated disk, which is in accordance with the current literature reporting that this is the main reason for spinal surgery in the adult population.[23] It was also the largest sample among the surgeries analyzed in this study. The mean age of patients undergoing lumbar AVP was 46.8 years. Accordingly, Vialle et al.[23] reported that disk herniation occurs mainly between the fourth and fifth decades of life, despite being described in all age groups.

Patients who used PCA pump after lumbar AVP seem to have been those who have benefited most from this resource. They reported lower levels of pain during hospital stay than those who did not use PCA. Perhaps this is justified by the fact that spinal surgery patients are encouraged to frequent change of position, which mobilizes the surgical site and cause pain. However, PCA may have a better impact in controlling this symptom although it is not possible to assert it based on these results, considering that analgesics and anti-inflammatory drugs used in combination with PCA were not monitored in this study. This is another limitation found.

After analyzing the lumbar and long AVP groups regarding pain only in the first postoperative period, the comparison of patients with and without PCA revealed that patients without PCA reported more pain (*p* = 0.058). This analysis was

performed with absolute values. Thus, the result reinforced the benefit of PCA in this group.

In this sample, patients undergoing cervical AVA did not use PCA pump after surgery and could not be allocated into two groups, as in the other. Therefore, additional correlations were made and, although not part of the study objective, we chose to quote them here. BMI was correlated with the time of getting out of bed, pain with the time of getting out of bed, and finally, pain with the length of hospital stay. It was found that the pain was more severe on the third day after surgery, with statistical significance compared to the second day. This may be due to the increased level of activities or the transition from intravenous to oral analgesia, by proximity to discharge.

The symptoms reported by patients could have an impact on the time of getting out of bed. However, it was not deemed necessary to make this correlation. That is because when analyzing the results of all groups it was noted that most patients tend to get out of bed on pre-scheduled days, if they have no clinical complications, which follows an institutional protocol for each surgery, regardless of PCA use. Rehabilitation protocols are increasingly present in clinical practice, with the goal of reducing functional loss, in addition to shorten hospital stay.[24]

As an additional finding of the study, it was noticed that patients with higher BMI were out of bed earlier compared with those with lower BMI ($p = 0.02$). This may be explained by the presence of other institutional protocol, indicating that patients with BMI >25 are considered high-risk group for the development of respiratory failure when restricted to bed for longer than 48 h. Thus, there is a differentiated care by the team to prevent respiratory complications in this group of patients.

According to the limitations found in this work, it is recommended that future studies perform the analysis from the early postoperative period. The control of analgesics used, in addition to PCA, as well as the application of SNP at rest and during activity periods may also contribute to more concrete results.

Conclusion

PCA proved to be useful for pain relief of patients undergoing lumbar AVP. It was also important for patients undergoing long AVP, which may have reduced de use of supplemental O_2, although not statistically significant probably due to the small sample size. The use of PCA did not correlate with the time of getting out of bed and length of hospital stay in either group of patients.

Conflicts of interest

The authors declare no conflicts of interest.

References

1. Piano LPA, Golmia RP, Scheinberg M. Artroplastia total de quadril e joelho: aspectos clínicos na fase perioperatória. Einstein. 2010;8:350–3.

2. Krauss I, Steinhilber B, Haupt G, et al. Efficacy of conservative treatment regimes for hip osteoarthritis – evaluation of the therapeutic exercise regime ''Hip School'': a protocol for a randomised, controlled trial. BMC Musculoskelet Disord. 2011;12:270–82.

3. Hootman JM, Helmick CG, Brady TJ. A public health approach to addressing arthritis in older adults: the most common cause of disability. Am J Public Health. 2012;102:426–33.

4. Leme EGL, Sitta MC, Toledo M, et al. Cirurgia ortopédica em idosos: aspectos clínicos. Rev Bras Ortop. 2011;46: 238–46.

5. Courtney MD, Edwards HE, Chang AM, et al. A randomised controlled trial to prevent hospital readmissions and loss of functional ability in high risk older adults: a study protocol. BMC Health Serv Res. 2011;11:202–9.

6. Barros GAM, Lemonica L. Considerações sobre analgesia controlada pelo paciente em hospital universitário. Rev Bras Anestesiol. 2003;53:69–82.

7. Fonseca NM, Ruzi RA, Ferreira FX, et al. Analgesia pós-operatória em cirurgia ortopédica: estudo comparativo entre o bloqueio do plexo lombar por via perivascular inguinal (3 em 1) com ropivacaína e a analgesia subaracnóidea com morfina. Rev Bras Anestesiol. 2003;53:188–97.

8. Almeida MCS, Locks GF, Gomes HP, et al. Analgesia pós-operatória: comparação entre infusão contínua de anestésico local e opioide via cateter peridural e infusão contínua de anestésico local via cateter na ferida operatória. Rev Bras Anestesiol. 2011;61:298–303.

9. Nett MP. Postoperative pain management. Orthopedic. 2010;33:23–6.

10. Paula GR, Reis VS, Ribeiro FA, et al. Assistência de enfermagem e dor em pacientes ortopédicos na recuperação anestésica no Brasil. Revista Dor. 2011;12:265–9.

11. Lee HK, Lee JH, Chon SS, et al. The effect of transdermal scopolamine plus intravenous dexamethasone for the prevention of postoperative nausea and vomiting in patients with epidural PCA after major orthopedic surgery. Korean J Anesthesiol. 2010;58:50–5.

12. Taylor JM, Gropper MA. Critical care challenges in orthopedic surgery patients. Crit Care Med. 2006;34:191–9.

13. Kauppila AM, Sintonen H, Aronen P, et al. Economic evaluation of multidisciplinary rehabilitation after primary total knee arthroplasty based on a randomized controlled trial. Arthrit Care Res. 2011;63:335–41.

14. Walder B, Schafer M, Henzi I, et al. Efficacy and safety of patient-controlled opioid analgesia for acute postoperative pain. Acta Anaesthesiol Scand. 2001;45:795–804.

15. Stiller CO, Lundblad H, Weidenhielm L, et al. The addition of tramadol to morphine via patient-controlled analgesia does not lead to better post-operative pain relief after total knee arthroplasty. Acta Anaesthesiol Scand. 2007;51:322–30.

16. Duarte LT, Fernandes MdoC, Costa VV, et al. Incidência de depressão respiratória no pós-operatório em pacientes submetidos à analgesia venosa ou peridural com opioides. Rev Bras Anestesiol. 2009;59:409–20.

17. Kopka A, Wallace E, Reilly G, et al. Observational study of perioperative $PtcCO_2$ and SpO_2 in nonventilated patients receiving epidural infusion or patient-controlled analgesia using a single earlobe monitor (Tosca). Br J Anaesth. 2007;99: 567–71.

18. Huskisson EC. Measurement of pain. Lancet. 1974;92:1127–31.

19. Andrade FA, Pereira LV, Sousa FAEF. Mensuração da dor no idoso: uma revisão. Rev Latino-Am Enfermagem. 2006;14:271–6.

20. Pereira LV, Sousa FAEF. Mensuração e avaliação da dor pós-operatória: uma breve revisão. Rev Latino-Am Enfermagem. 1998;6:77–84.

21. D'Ambrosia RD. Epidemiology of osteoarthritis. Orthopedics. 2005;28:201–5.

22. Lima Júnior PCde, Landim E, Avanzi O, et al. Escoliose idiopática do adolescente (EIA): perfil clínico e radiográfico da lista de espera para tratamento cirúrgico em hospital terciário de alta complexidade do Sistema Público de Saúde Brasileiro. Coluna/Columna. 2011;10:111–5.

23. Vialle LR, Vialle EN, Henao JES, et al. Hérnia discal lombar. Rev Bras Ortop. 2010;45:17–22.

24. Husted H, Lunn TH, Troelsen A, et al. Why still in hospital after fast-track hip and knee arthroplasty? Acta Orthopaed. 2011;82:679–84.