Rev Bras Anestesiol. 2016;66(6):628–636

Sociedade Brasileira de Anestesiologia

REVISTA BRASILEIRA DE ANESTESIOLOGIA

Publicação Oficial da Sociedade Brasileira de Anestesiologia
www.sba.com.br

SCIENTIFIC ARTICLE

Pain after major elective orthopedic surgery of the lower limb and type of anesthesia: does it matter?☆

Diogo Luís Pereira[a,*], **Hugo Lourenço Meleiro**[b], **Inês Araújo Correia**[b], **Sara Fonseca**[a,c]

[a] *Universidade do Porto, Porto, Portugal*
[b] *Centro Hospitalar São João, Porto, Portugal*
[c] *Centro Hospitalar São João, Departamento de Anestesiologia, Porto, Portugal*

Received 14 April 2015; accepted 5 June 2015
Available online 19 March 2016

KEYWORDS
Arthroplasty;
General anesthesia;
Neuraxial anesthesia;
Preoperative pain;
Postoperative pain;
Chronic pain;
Chronic postoperative pain

Abstract
Background and objectives: Total knee arthroplasty and total hip arthroplasty are associated with chronic pain development. Of the studies focusing on perioperative factors for chronic pain, few have focused on the differences that might arise from the anesthesia type performed during surgery.
Methods: This was a prospective observational study performed between July 2014 and March 2015 with patients undergoing unilateral elective total knee arthroplasty (TKA) or total hip arthroplasty (THA) for osteoarthritis. Data collection and pain evaluation questionnaires were performed in three different moments: preoperatively, 24 hours postoperatively and at 6 months after surgery. To characterize pain, Brief Pain Inventory (BPI) was used and SF-12v2 Health survey was used to further evaluate the sample's health status.
Results: Forty and three patients were enrolled: 25.6% men and 74.4% women, 51,2% for total knee arthroplasty and48.8% for total hip arthroplasty, with a mean age of 68 years. Surgeries were performed in 25.6% of patients under general anesthesia, 55.8% under neuraxial anesthesia and 18.6% under combined anesthesia. Postoperatively, neuraxial anesthesia had a better pain control. Comparing pain evolution between anesthesia groups, neuraxial anesthesia was associated with a decrease in ''worst'', ''medium'' and ''now'' pain at six months. Combined anesthesia was associated with a decrease of ''medium'' pain scores at six months. Of the three groups, only those in neuraxial group showed a decrease in level of pain interference in ''walking ability''. TKA, ''worst'' pain preoperatively and general were predictors of pain development at six months.

☆ Performed in Centro Hospitalar São João (CHSJ), Alameda Prof. Hernâni Monteiro, 4200–319 Porto, Portugal.

* Corresponding author.
E-mail: mimed09064@med.up.pt (D.L. Pereira).

http://dx.doi.org/10.1016/j.bjane.2015.06.002

Conclusions: Patients with gonarthrosis and severe pain preoperatively may benefit from individualized pre- and intraoperative care, particularly preoperative analgesia and neuraxial anesthesia.

PALAVRAS-CHAVE
Artroplastia;
Anestesia geral;
Anestesia neuroaxial;
Dor pré-operatória;
Dor pós-operatória;
Dor crônica;
Dor crônica pós-operatória

Dor após cirurgia eletiva ortopédica de grande porte em membro inferior e o tipo de anestesia: isso importa?

Resumo
Justificativa e objetivos: A artroplastia total de joelho e a artroplastia total de quadril estão associadas ao desenvolvimento de dor crônica. Dentre os estudos que avaliam os fatores perioperatórios para a dor crônica, poucos abordam as diferenças que podem surgir do tipo de anestesia realizada durante a cirurgia.
Métodos: Estudo observacional, prospectivo, realizado entre julho de 2014 e março 2015 com pacientes submetidos à ATJ unilateral eletiva ou ATQ para a osteoartrite. A coleta de dados e a avaliação da dor por meio de questionários foram realizadas em três momentos distintos: no pré-operatório, em 24 horas de pós-operatório e aos seis meses após a cirurgia. O Inventário Breve da Dor (IBD) foi usado para caracterizar a dor o e o Questionário SF-12v2 foi usado para avaliar melhor o estado de saúde da amostra.
Resultados: Quarenta e três pacientes foram inscritos: 25,6% homens e 74,4% mulheres, 51,2% para ATJ e 48,8% ATQ, com média de idade de 68 anos. A cirurgia foi realizada em 25,6% dos pacientes sob anestesia geral, em 55,8% sob anestesia neuroaxial e em 18,6% sob anestesia combinada. No pós-operatório, a anestesia neuraxial apresentou melhor controle da dor. Na comparação da evolução da dor entre os grupos, a anestesia neuraxial foi associada a uma diminuição de ''pior'', ''médio'' e ''sem'' dor em seis meses. A anestesia combinada foi associada a uma diminuição do escore ''médio'' de dor em seis meses. Dos três grupos, apenas aqueles no grupo neuraxial apresentaram uma diminuição do nível de interferência da dor na ''capacidade de caminhar''. ATJ, ''pior'' dor no pré-operatório e anestesia geral foram preditivos de desenvolvimento de dor aos seis meses.
Conclusões: Os pacientes com gonartrose e dor intensa no pré-operatório podem obter benefício de cuidados individualizados no pré e intraoperatório, particularmente de analgesia no pré-operatório e anestesia neuraxial.

Introduction

Total Knee Arthroplasty (TKA) and Total Hip Arthroplasty (THA) are common elective procedures whose demand is continually rising due to ageing population.[1] According to the Portuguese Arthroplasty Register 4234 primary TKA and 4440 primary THA were performed in Portugal in 2013, 80 and 63 of these, respectively, in Centro Hospitalar São João.[2]

The major aim of these surgeries is to relief pain, improve quality of life, physical activity and mobility, allowing a better social and psychological well-being.[3] Various authors have studied this and pain relief was identified as the most important factor concerning quality of life, followed by psychological well-being and restoration of physical activity.[4] Despite the high satisfaction rates published,[5] up to 20% of TKA[5] and 7% of THA[6] patients remain dissatisfied after surgery and require post-surgical supplementary medical treatment, producing an additional burden for the national healthcare system.[7]

The final decision to undergo surgery is based on a surgeon–patient agreement. The clinical criteria are different between orthopaedic centres[8] and even willingness among patients depends on age, gender, race, socioeconomic status and pain.[9] This difference is even higher among orthopaedic surgeons, rheumatologists and primary care providers. The only common criteria among all is pain not responsive to drug therapy.[10]

Chronic post-surgical pain has been associated to TKA and THA in several studies. Despite the technological and technical improvements,[11,12] there is still a group of patients with pain after surgery.[13] Pain-related distress, such as frustration, anger and depression, do not correlate solemnly to the pain intensity but also with individual belief, expectation and perception of their condition.[14]

During the last years, investigators are searching for chronic pain predictors after TKA and THA in order to diminish its incidence. Preoperative pain intensity, disease duration and post-surgical anxiety were considered the main

predictors for chronic pain development after an uncomplicated surgery.[15] Other factors that have shown relation with chronic pain include female sex, younger age at the time of surgery[16,17] and pain in other locations.[18]

Differences in postoperative pain control due to anesthesia technique (neuraxial anesthesia versus general anesthesia) for lower limb joint replacement have been demonstrated. Neuraxial anesthesia improves postoperative outcomes by relieving pain, reducing pulmonary complications, allowing early mobilization and shortening the length of hospital stay.[19,20] It is also associated with a decrease in systemic infections[21] and mortality.[22]

The aim of this study is to evaluate if the type of anesthesia interferes with postoperative pain in a population of patients submitted to TKA or THA.

Methods

After approval of the Ethics Committee of Centro Hospitalar São João (CHSJ), in Porto, Portugal, a prospective observational study was performed between July 2014 and March 2015 with patients undergoing unilateral elective TKA or THA for osteoarthritis. Exclusion criteria were: age <18 years, inability to give informed consent, failure to understand Portuguese language, refusal to participate, American Society of Anesthesiologists (ASA) physical status >3, analgesic allergy, peptic disease, previous surgery on the same location and time between surgery and chronic pain evaluation less than 6 months. The patients enrolled signed the statement of informed consent. Chronic pain definition is not consensual in the literature. The authors considered chronic pain as pain that is present at least 6 months after the surgery.[23,24]

Data was obtained by electronic health record consultation and evaluation questionnaires performed in three different moments. The first (T0), comprised the patient recruitment during the anesthesiology appointment 15 days prior to the surgery in which the informed consent declaration was given and signed. Authors also collected socio-demographic data, type of surgery, ASA physical status, pain and health status from the patient's point of view. The second (T1), was obtained 24 h after surgery. Authors recorded the type of anesthesia (General anesthesia (GA), Neuraxial anesthesia (NA) or Combined anesthesia (CA) – general plus neuraxial anesthesia) and evaluated pain. Data mentioning the analgesic medication used was also registered. The third (T2) was conducted by phone, at least 6 months after surgery, when the authors re-evaluated pain.

Surgery was performed by a team of orthopaedics in the hospital's orthopaedic unit, with no interference or limitation by the investigation team for the purpose of this work. Anesthesia was classified as General if only intra-operative intravenous and/or inhalatory anesthetics and analgesics were used with ventilation assistance, as Neuraxial if a subarachnoid or epidural block was performed with or without intra or postoperative epidural analgesia and combined if both criteria overlapped.

Pain was assessed as a dependent variable in both the intensity and interference domains, using Brief Pain Inventory (BPI) in T0 and T2. In T1, only the intensity domains of BPI were used to assess pain. These questionnaires are validated for the Portuguese population[25–27] to calculate the psychological, socioeconomically and quality of life related to pain.

Health Status by the patient's point of view was assessed by short form SF-12® Health Survey questionnaire (SF-12v2 Standard 4 week) in T0 using the 2009 norms. It has been validated[28] and used in previous studies.[29] The Portuguese version wording and format was modified. License for the use of the SF-12v2 was granted.

All the domains recommended by the Initiative on Methods, Measurement and Pain Assessment in Clinical Trials (IMMPACT) which include physical and emotional function, pain severity, pain medication usage, pain quality and the temporal aspects of pain were assessed.[30]

Questionnaires

Brief Pain Inventory (BPI)

BPI evaluates the multidimensional perspective of pain, namely severity, localization, functional interference and strategic therapies.[31] It relies on a numeric range scale (NRS) that evaluates pain intensity from 0 to 10 (0 no pain, 1–3 mild pain, 4–6 moderate pain, 7–9 severe pain, 10 worst pain). BPI captures two broad pain domains: the sensory intensity of pain and the degree to which pain interferes with different areas of life. The 17 items scale also captures pain location, pain medication use and response to treatments. This questionnaire is a valid, sensitive and reproductive instrument of characterization of pain with extensive use in several studies.[32–34]

Study Short Form 12 (SF-12)

SF-12 is a multipurpose short-form generic measure of health status from the patient's point of view. The 12 items in the SF-12 are a subset of those in the SF-36, and include 1 or 2 items from each of the 8 health concepts: physical functioning, role limitations due to physical health problems, bodily pain, general health, vitality (energy/fatigue), social functioning, role limitations due to emotional problems and mental health (physical distress, psychological distress and psychological well-being). The Physical and Mental health Composite Scale scores (PCS & MCS) derive from the 8 health concepts and are transformed to a *T score* (mean = 50, standard deviation = 10). A mean of 45 or greater indicates at least average overall functioning or well-being and scores less than 40 indicating significant impairment.

Statistical analysis

All statistical analysis was performed using Software SPSS® version 22.0 (IBM Corporation, New York, USA).

Continuous variables were expressed as mean and standard deviation as well as median and range. Dichotomous outcomes were expressed as the number of events and percentage.

Normality tests were conducted using Shapiro–Wilk test for a $p < 0.05$. When non-normal distribution was considered, Kruskal–Wallis one-way analysis of variance was performed

for comparison between groups when assessing continuous or ordinal variables. One-way ANOVA was used when normality was considered.

Crosstabs were used to compare nominal variables between the groups. Exact Fisher test was used to determine the correlation when 3 groups were compared. If two groups analysis was carried, the investigational team used chi-square test instead.

Wilcoxon signed-rank test was used when comparing two related samples. If both variables followed a normal distribution, paired *t* test was used instead.

A logistic regression model was performed to ascertain the effects of the surgical procedure, ''worst'', ''least'', and ''now'' pain pre and postoperatively and type of anesthesia on the likelihood of having pain at 6 months. Medium pain score variable was excluded of the model due to multicollinearity.

All reported *p*-values are two tailed, with a *p*-value of 0.05 indicating statistical significance.

Results

107 patients were evaluated during the anesthesiology appointment prior to the surgery (T0), 43 had the surgery cancelled or rearranged for a date that did not comprise the study timeframe, 2 were excluded for incomplete BPI in T0. Of the 62 that completed T0 and T1, 3 were excluded for not meeting the 6 months minimum time after surgery and 16 for not answering the phone call on T2 (response ratio 73%), leaving a final sample of 43 patients.

Demographics

Basic demographics of the 43 patients can be found in Table 1.

Sample comprised 25.6% men and 74.4% women, 51.2% TKA and 48.8% THA. Mean age at the time of surgery was 68 years and mean body mass index (BMI) was 29.88. The majority of the sample (81.4%) scored ASA 2 physical status and 14% scored ASA 3. Concerning anesthesia type, 25.6% patients were submitted to GA, 55.8% to NA and 18.6% to CA. Pain was reported by 42 patients (97.7%) at T0, by 40 (93%) patients at T1 and by 20 patients (46.5%) at T2.

Surgery ($p = 0.456$), age ($p = 1.000$), sex ($p = 0.648$), BMI ($p = 0.807$), ASA physical status score ($p = 0.321$) and health status level from the patient's point of view (PCS, $p = 0.065$; MCS, $p = 0.147$) did not interfere with the anesthesia type choice (Table 2).

Table 1 Basic demographics of the total sample.

Gender		
M	*n* (%)	11 (25.6)
F	*n* (%)	32 (74.4)
Age (years)	Mean ± SD	68 ± 9
BMI	Mean ± SD	29.88 ± 4.14
General anesthesia	*n* (%)	11 (25.6)
Neuraxial anesthesia	*n* (%)	24 (55.8)
Combined anesthesia	*n* (%)	8 (18.6)
Surgical intervention		
TKA	*n* (%)	22 (51.2)
THA	*n* (%)	21 (48.8)
ASA physical score		
1	*n* (%)	2 (4.7)
2	*n* (%)	35 (81.4)
3	*n* (%)	6 (14)
Pain in T0		
TKA	*n* (%)	21 (95.5)
THA	*n* (%)	21 (100)
Total	*n* (%)	42 (97.7)
Pain in T1		
TKA	*n* (%)	20 (90.9)
THA	*n* (%)	20 (95.2)
Total	*n* (%)	40 (93)
Pain in T2		
TKA	*n* (%)	15 (68.2)
THA	*n* (%)	5 (23.8)
Total	*n* (%)	20 (46.5)

T0, preoperatively; T1, 24 hours postoperatively; T2, 6 months postoperatively; BMI, Body Mass Index; ASA, American Society of Anesthesiologists (ASA) physical status.

Pain and pain related results

Preoperative (T0) pain evaluation

At T0, when BPI questionnaire was applied in pain intensity domains, no differences were found between the 3 anesthesia groups (Table 3).

24 h after surgery (T1) pain evaluation

At T1, in the intensity domain of BPI, pain ''now'' was statistically significant ($p = 0.035$), with GA reporting a median pain of 4 (min = 0, max = 8) while NA and CA reported a median of 0 (Neuraxial: min = 0, max = 7; combined: min = 0, max = 6).

''Worst'', ''least'' and ''medium'' pains were similar between groups (*p*-values 0.544, 0.185 and 0.456 respectively). In all groups there were patients that reported the maximum of pain intensity, with no statistical difference being found in the ''worst'' pain (GA: median = 8, min = 5, max = 10; NA: median = 8, min = 3, max = 10; CA: median = 7.50, min = 5, max = 10). Although ''least'' pain had similar scores with median score varying between 0 and 1 among the three groups, the CA and GA groups scored higher intensity levels (CA: median = 0, min = 0, max = 5; NA: median = 0, min = 0, max = 3; GA: median = 1, min = 0, max = 6, $p = 0.185$).

6 Months after surgery (T2) pain evaluation

At T2, 20 patients (46.5%) reported pain. The anesthesia group with a higher percentage of cases was CA group (62.5%). However, no statistical significance was found between anesthesia type groups ($p = 0.645$).

CA and NA were associated with lower scores of ''worst'' and ''least'' pains. Nonetheless, no statistical significance was found among groups ($p = 0.352$ and $p = 0.496$ respectively).

Comparing the evolution of pain between anesthesia groups (Fig. 1), NA was associated with a decrease in

Table 2 Demographics according to anesthesia.

		General anesthesia	Neuraxial anesthesia	Combined anesthesia	*p*
Surgery					0.456[a]
TKA	*n* (%)	4 (36.4)	14 (58.3)	4 (50)	
THA	*n* (%)	7 (63.6)	10 (41.7)	4 (50)	
Age					1.000[a]
<65	*n* (%)	4 (36.4)	8 (33.3)	3 (37.5)	
>65	*n* (%)	7 (63.6)	16 (66.7)	5 (62. 5)	
Sex					0.648[a]
M	*n* (%)	4 (36.4)	5 (20.8)	2 (25)	
F	*n* (%)	7 (63.6)	19 (79.2)	6 (75)	
BMI					0.807[a]
<25	*n* (%)	1 (9.1)	2 (9.1)	1 (14.3)	
>25	*n* (%)	7 (63.6)	10 (41.7)	4 (57.1)	
>30	*n* (%)	3 (27.3)	10 (41.7)	2 (28.6)	
ASA					0.321[a]
<3	*n* (%)	8 (72.7)	22 (91.7)	7 (87.5)	
=3	*n* (%)	3(27. 3)	2(8. 3)	1(12. 5)	
SF-12					
PCS	Mean ± SD	27.54 ± 8.21	31.60 ± 5.58	26.20 ± 5.49	0.065[b]
MCS	Mean ± SD	50.68 ± 11.85	43.35 ± 11.94	40.34 ± 12.97	0.147[b]

BMI, Body Mass Index; ASA, American Society of Anesthesiologists (ASA) physical status; PCS, Physical Composite Scale; MCS, Mental Composite Scale.

[a] Ficher's Exact Test.

[b] One-way ANOVA.

''worst'', ''medium'' and ''now'' pain ($p = 0.037$, $p = 0.019$, $p = 0.011$, respectively) between T0 and T2 and ''worst'' pain between T1 and T2. CA was associated with a decrease of ''medium'' pain scores between T0 and T2 ($p = 0.041$) and T1 and T2 ($p = 0.041$).

Pain interference domain

At T0, all patients that reported pain, complained of some sort of interference in their daily life due to pain (Table 4), particularly in general activity, mood, walking ability and normal work. In T0, GA was associated with interference of pain on mood preoperatively when compared with the other type of anesthesia ($p = 0.046$).

At T2, general activity, walking ability and normal work scored higher medians. However not all patients reporting pain complained of interference in their life due to pain, with no statistical difference found between type of anesthesia groups.

Although many patients reported a decrease of pain interference between T0 and T2, only those in NA group

Table 3 Pain related variables according to anesthesia.

	General anesthesia			Neuraxial anesthesia			Combined anesthesia			
	n (%)	Mean ± SD	Median (min–max)	*n* (%)	Mean ± SD	Median (min–max)	*n* (%)	Mean ± SD	Median (min–max)	*p*
Pain at T0	10 (91)			24 (100)			8 (100)			0.422[a]
Worst pain		7 ± 1.94	7 (4–10)		7.50 ± 1.72	8 (3–10)		7.25 ± 2.82	7.50 (3–10)	0.720[b]
Least pain		2.20 ± 2.04	2 (0–6)		2.29 ± 2.81	2 (0–6)		3.13 ± 2.4	3 (0–6)	0.525[b]
Medium pain		5.20 ± 2.49	5 (2–10)		5.13 ± 1.85	5 (2–10)		5.50 ± 2.07	6 (2–8)	0.905[c]
Now pain		3.4 ± 3.27	2 (0–10)		3.88 ± 3.06	4.50 (0–10)		5.50 ± 2.45	6 (0–8)	0.311[c]
Pain at T1	9 (81.8)			23 (95.8)			8 (100)			0.240[a]
Worst pain		7.89 ± 2.21	8 (5–10)		7 ± 2.05	8 (3–10)		7.50 ± 2.20	7.50 (5–10)	0.544[c]
Least pain		2 ± 2.45	1 (0–6)		0.65 ± 1.03	0 (0–3)		1 ± 1.92	0 (0–5)	0.185[b]
Medium pain		4.67 ± 2.12	4 (2–8)		3.48 ± 1.28	4 (0–5)		4 ± 1.85	3.50 (2–7)	0.456[b]
Now pain		4.11 ± 2.89	4 (0–8)		1.74 ± 2.14	0 (0–7)		1.38 ± 2.56	0 (0–6)	**0.035**[b,d]
Pain at T2	5 (50)			10 (41.7)			5 (62.5)			0.645[a]
Worst pain		7.40 ± 2.61	8 (3–10)		5.40 ± 2.86	4.50 (3–10)		6.80 ± 2.95	5 (4–10)	0.352[b]
Least pain		2.80 ± 3.11	2 (0–7)		1.60 ± 3.34	0 (0–10)		1 ± 1.73	0 (0–4)	0.496[b]
Medium pain		2.50 ± 2.65	2 (0–6)		2.80 ± 3.55	1 (0–10)		2 ± 1.73	1 (1–5)	0.930[b]
Now pain		3.20 ± 3.42	3 (0–8)		1.70 ± 3.65	0 (0–10)		0	0 (0)	0.138[b]

Mean scores with standard deviation and median score with maximum and minimum of the intensity of pain in its ''worst'', ''least'', ''medium'' and ''now''. BPI scores, using a 0–10 numeric range scale (NRS). T0, pre-operatively, T2, post operatively.

[a] Fisher's Exact Test.

[b] Kruskal–Wallis one-way analysis of variance.

[c] One-way ANOVA.

[d] $p < 0.05$.

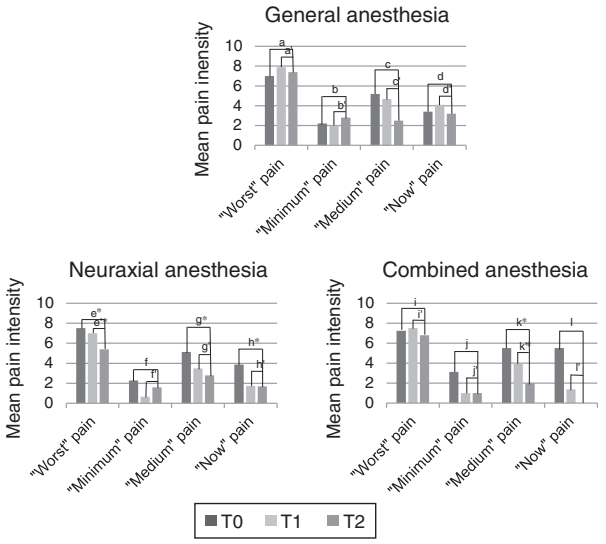

Figure 1 Comparison of pain intensity using all the domains of pain in BPI between T0 (pre-operatively) and T2 (6 months post operatively) using Wilcoxon signed-rank test. a, $p = 1.000$; a′, $p = 0.586$; b, $p = 0.891$; b′, $p = 1.000$; c, $p = 0.144$; c′, $p = 0.066$; d, $p = 0.892$; d′, $p = 0.588$; e, $p = 0.037$; e′, $p = 0.028$; f, $p = 0.102$; f′, $p = 0.416$; g, $p = 0.019$; g′, $p = 0.412$; h, $p = 0.011$; h′, $p = 0.915$; i, $p = 0.581$; i′, $p = 0.257$; j, $= 0.144$; j′, $p = 0.157$; k, $p = 0.041$; k′, $p = 0.041$; l, $p = 0.066$; l′, $p = 0.180$; $^{*}p < 0.05$.

showed a lower level of interference in ''walking ability'' ($p = 0.007$).

Predicting pain

A logistic regression (Table 5) was performed to ascertain the effects of surgical procedure, ''worst'', ''least'' and ''now'' pain pre and postoperatively and type of anesthesia on the likelihood to have pain at 6 months.

TKA ($p = 0.007$), ''worst'' pain preoperatively ($p = 0.043$) and NA ($p = 0.042$) were associated with development of pain at 6 months.

Discussion

Total joint arthroplasty is the gold-standard treatment for ''end-stage'' osteoarthritis.[35] Several risk factors related to the patient, surgery or postoperative period, have been recently identified for continuous pain and disability after total joint arthroplasty. Patients' non-modifiable characteristics such as younger age, female sex, low income and lack of education are associated with a higher probability of developing chronic postsurgical pain.[16,17,36,37] Equally, modifiable factors such as anxiety, depression, pain catastrophizing, comorbidities, obesity, BMI, high-intensity baseline pain, unrealistic patients' expectations, and extent, local and incision type have also proved to be associated with the development of pain.[38,39] From these, obesity and BMI have shown a negative impact on pain and function after primary elective TKA and THA.[40,41]

Postoperative analgesia is a developing area and anesthesia is an essential part when choosing the analgesia protocol. The type of anesthesia depends on multiple factors, related to the patient's features and preferences, the anesthesiologist's experience and to the surgery and rehabilitation requirements.

In this study, the authors explored the factors that may influence postoperative pain control and chronic pain development after THA and TKA and the relation between them and the anesthesia technique.

Most of the patients of this study were selected for NA (55.8%). This choice did not depend on preoperative factors such as surgical intervention, age, gender, BMI and ASA physical status and probably reflected the anesthesiologist's or anesthesiology department's preferences. On a retrospective review of THA and TKA, performed in 400 USA hospitals, Memtsoudis et al. reported that 74.8% were submitted to GA, 11% to NA and 14.2% to CA,[42] which may also reflect local or personal preferences or the time of data collection (2006 until 2010).

Daily activities, such as dressing, walking, climbing up or down a flight of stairs might pose a challenge for most of the patients preoperatively. So it is understandable that patients' expectations after surgery are high, hoping to regain activity and improvement of pain.[43,44] In this study, all patients that reported pain in the preoperative period complained of some interference in their life due to pain, particularly in general activity, mood, walking ability and normal work. But only GA was associated with interference of pain on mood. The authors cannot exclude that patients' mood may have influenced the anesthetic technique choice by the anesthesiologist. At 6 months after surgery, the authors did not find any relation between

Table 4 Interference of pain.

	General anesthesia			Neuraxial anesthesia			Combined anesthesia		
	T0	T2	*p*	T0	T2	*p*	T0	T2	*p*
Interference of pain, *n* (%)	10 (91)	10 (0–10)		24 (100)	9 (38)		8 (100)	5 (63)	
General activity (Mean ± SD)	7.90 ± 1.85	7 ± 4.47	0.893[a]	6.71 ± 2.59	5 ± 3.39	0.310[a]	7.5 ± 1.51	7.50 ± 2.08	1.000[a]
Mood (Mean ± SD)	8.10 ± 2.2	5.4 ± 4.56	0.416[a]	4.92 ± 3.51	2 ± 3.42	0.106[a]	5.63 ± 3.78	1.50 ± 1.92	0.593[a]
Walking ability (Mean ± SD)	8.20 ± 1.62	6 ± 3.84	0.322[b]	7.88 ± 1.96	5.11 ± 2.98	0.007[b,c]	8.13 ± 1.89	6.25 ± 2.99	0.174[b]
Normal work (Mean ± SD)	8.60 ± 0.97	7 ± 4.12	0.285[a]	6.79 ± 2.28	5.78 ± 3.73	0.498[a]	7.63 ± 2.13	4.75 ± 4.57	0.102[a]
Relations with other people (Mean ± SD)	3.40 ± 4.22	2.60 ± 3.71	0.109[a]	3.63 ± 3.49	1.11 ± 3.33	0.136[a]	3.38 ± 3.38	0	0.317[a]
Sleep (Mean ± SD)	5.70 ± 3.40	3.80 ± 4.02	0.461[a]	3.25 ± 3.07	2.78 ± 3.7	0.175[a]	4.88 ± 3.14	2.50 ± 5	0.180[a]
Enjoyment of life (Mean ± SD)	4.50 ± 3.87	3.40 ± 2.07	0.144[a]	4.21 ± 3.30	1.78 ± 3.35	0.671[a]	4.88 ± 3.9	0	0.180[a]

Mean scores and standard deviation of the interference of pain in daily aspects of life. BPI scores, using a 0–10 numeric range scale (NRS). T0, pre-operatively; T2, post operatively.

[a] Wilcoxon signed-rank test.

[b] Paired *t* test used, ''walking ability'' followed a normal distribution in both T0 and T2.

[c] $p < 0.05$.

Table 5 Logistic regression assessing the likelihood of development pain at 6 months.

	Estimate	Standard error	Wald	Sig	OR	95% CI for OR	
						Lower bound	Superior bound
Total knee arthroplasty[b]	5.606	2.077	7.286	0.007[c]	271.924	4.643	15925.872
PCS	−0.052	0.117	0.195	0.659	0.950	0.755	1.194
MCS	−0.078	0.055	2.022	0.155	0.925	0.831	1.030
Neuraxial anesthesia[a]	−4.202	2.064	4.144	0.042[c]	0.015	0.000	0.855
Combined anesthesia[a]	−1.437	1.926	0.557	0.456	0.238	0.005	10.358
''Worst'' pain preoperatively	0.835	0.404	4.103	0.043[c]	0.039	2.306	1.044
''Least'' pain preoperatively	0.018	0.296	0.057	0.811	0.952	1.018	0.570
''Now'' pain preoperatively	0.145	0.220	0.596	0.440	0.510	1.156	0.751
''Worst'' pain 24 h postoperatively	−0.274	0.351	0.563	0.453	0.436	0.760	0.382
''Least'' pain 24 h postoperatively	−0.850	0.454	3.294	0.070	0.061	0.427	0.175
''Now'' pain 24 h postoperatively	0.070	0.295	0.129	0.720	0.813	1.072	0.602

PCS, Physical Composite Scale; MCS, Mental Composite Scale.
The model explained 65% (Nagelkerke R2) of the presence of pain and correctly classified 82.5% of cases.
[a] Compared to reference category General anesthesia.
[b] Dichotomous variable: TKA = 1, THA = 0.
[c] $p < 0.05$.

anesthesia and interference of pain on daily life activities. Many patients reported a decrease of pain interference between T0 and T2. However only those in NA group showed a lower level of interference in ''walking ability''.

TKA has been associated with a higher likelihood of chronic postoperative pain development than THA.[12] In fact, a higher number of patients submitted to TKA complain of pain at 6 months, as demonstrated by Wylde et al. in 2011 and Pinto et al. in 2013.[18,45] The author's study further supports these results by finding that 68.2% of the TKA patients and 23.8% of the THA group complained of pain at 6 months after surgery. Pinto et al. also reported the pain interference in daily activities, with higher results being found on our sample. This might have occurred due to our higher mean of age.

Acute postsurgical pain has been described as a chronic postoperative pain predictor.[46–49] However, presurgical pain has showed a stronger predictive value[50,51] which seems plausible in face of the long-term influence that it might pose on the neuro-physiologic processes underlying chronic postoperative pain development.[15,52] In our model all postsurgical pain intensity variables failed to show significance in predicting pain at 6 months. Only ''worst'' pain preoperatively showed predicting capability, supporting the importance of presurgical pain as predictor.

In this sample, NA showed a protective trend in pain development at 6 months when compared to GA (OR < 1). In fact, NA was associated with lower ''worst'', ''medium'' and ''now'' pain between T0 and T2. Although the authors did not find any similar studies that assessed the prediction of chronic postoperative pain between THA/TKA and anesthesia type, this has been demonstrated in other surgical models. In fact, inguinal herniorrhaphy,[53] caesarean section[50,54] or hysterectomy[55] have shown a higher likelihood of developing pain at 6 months with GA when compared with NA.

Patients on the NA or CA group had a better pain control on the ''now'' pain intensity scale, at 24 h postoperatively. This is probably the result of the postoperative analgesic protocol. In fact, patients on the NA and CA groups had a stronger analgesic protocol (based on neuroaxial opioid and local anesthetic plus systemic analgesics and/or NSAID) than GA group (based on systemic NSAID's, Paracetamol and Weak opioids, with strong opioids being used as rescue medication). Macfarlane, in an extended review, reported similar results with NA showing benefits on pain in the first 72 h and on opioid consumption.[19] Other studies only demonstrated benefits of spinal anesthesia in the first 6 h after TKA[56] or THA,[57] but in these cases, patients only received intrathecal local anesthetics (with no opioid). Nonetheless, a better pain control has been associated with a shorter recovery time, faster mobilization and discharge, which may improve life quality.[58]

The authors recognize some limitations on this study that may compromise its external validity. The sample is small due to the follow-up losses, all patients are from a single academic institution, authors did not evaluate complications resulting from anesthesia or surgery nor post discharge events and did not take in account other anesthesia/analgesia methods such as peripheral nerve blocks.

Conclusion

In this prospective study, total knee arthroplasty, ''worst'' pain preoperatively and general anesthesia are predictors of chronic pain development.

Patients with gonarthrosis and severe pain preoperatively may benefit from individualized pre- and intraoperative care, particularly preoperative analgesia and neuraxial anesthesia.

This study was observational and the results may be a reflection of the patients' characteristics or due to being a small sample instead of the effects caused by the type of anesthesia. A randomized controlled trial comparing the type of anesthesia and the pain development at 6 months for each specific arthroplasty is recommended.

Nonetheless, this study is another important step towards a better comprehension of the development of chronic pain after a major arthroplasty of the lower limb.

Conflicts of interest

The authors declare no conflicts of interest.

References

1. Hootman JM, Helmick CG. Projections of US prevalence of arthritis and associated activity limitations. Arthritis Rheum. 2006;54:226–9.
2. Traumatology P.S.o.O.a. 2014 [cited 2014 09-11-2014]; Available from: http://www.rpa.spot.pt/Main-Sections/Hospitals.aspx].
3. Mancuso CA, Sculco TP, Wickiewicz TL, et al. Patients' expectations of knee surgery. J Bone Joint Surg Am. 2001;83-a:1005–12.
4. Yoo JH, Chang CB, Kang YG, et al. Patient expectations of total knee replacement and their association with sociodemographic factors and functional status. J Bone Joint Surg Br. 2011;93:337–44.
5. Bourne RB, Chesworth BM, Davis AM, et al. Patient satisfaction after total knee arthroplasty: who is satisfied and who is not? Clin Orthop Relat Res. 2010;468:57–63.
6. Anakwe RE, Jenkins PJ, Moran M. Predicting dissatisfaction after total hip arthroplasty: a study of 850 patients. J Arthroplasty. 2011;26:209–13.
7. Azevedo LF, Costa-Pereira A, Mendonça L, Dias CC, Castro-Lopes JM. The economic impact of chronic pain: a nationwide population-based cost-of-illness study in Portugal. Eur J Health Econ. 2016;17:87–98.
8. Cobos R, Latorre A, Aizpuru F, et al. Variability of indication criteria in knee and hip replacement: an observational study. BMC Musculoskelet Disord. 2010;11:249.
9. Mota RE, Tarricone R, Ciani O, et al. Determinants of demand for total hip and knee arthroplasty: a systematic literature review. BMC Health Serv Res. 2012;12:225.
10. Cross WW 3rd, Saleh KJ, Wilt TJ, Kane RL. Agreement about indications for total knee arthroplasty. Clin Orthop Relat Res. 2006;446:34–9.
11. Hetaimish BM, Khan MM, Simunovic N, et al. Meta-analysis of navigation vs conventional total knee arthroplasty. J Arthroplasty. 2012;27:1177–82.
12. Gothesen O, Espehaug B, Havelin LI, et al. Functional outcome and alignment in computer-assisted and conventionally operated total knee replacements: a multicentre parallel-group randomised controlled trial. Bone Joint J. 2014;96-b:609–18.
13. Beswick AD, Wylde V, Gooberman-Hill R, et al. What proportion of patients report long-term pain after total hip or knee replacement for osteoarthritis? A systematic review of prospective studies in unselected patients. BMJ Open. 2012;2:e000435.
14. Jeffery AE, Wylde V, Blom AW, et al. It's there and I'm stuck with it'': patients' experiences of chronic pain following total knee replacement surgery. Arthritis Care Res (Hoboken). 2011;63:286–92.
15. Pinto PR, McIntyre T, Ferrero R, et al. Risk factors for moderate and severe persistent pain in patients undergoing total knee and hip arthroplasty: a prospective predictive study. PLoS One. 2013;8:e73917.
16. Bonnin MP, Basiglini L, Archbold HA. What are the factors of residual pain after uncomplicated TKA? Knee Surg Sports Traumatol Arthrosc. 2011;19:1411–7.
17. Singh JA, Gabriel S, Lewallen D. The Impact of gender, age, and preoperative pain severity on pain after TKA. Clin Orthopaedics Rel Res. 2008;466:p.2717–23.
18. Wylde V, Hewlett S, Learmonth ID, et al. Persistent pain after joint replacement: prevalence, sensory qualities, and postoperative determinants. Pain. 2011;152:566–72.
19. Macfarlane AJ, Prasad GA, Chan VW, et al. Does regional anesthesia improve outcome after total knee arthroplasty? Clin Orthop Relat Res. 2009;467:2379–402.
20. Hu S, Zhang ZY, Hua YQ, et al. A comparison of regional and general anaesthesia for total replacement of the hip or knee: a meta-analysis. J Bone Joint Surg Br. 2009;91:935–42.
21. Liu J, Ma C, Elkassabany N, et al. Neuraxial anesthesia decreases postoperative systemic infection risk compared with general anesthesia in knee arthroplasty. Anesth Analg. 2013;117:1010–6.
22. Hunt LP, Ben-Shlomo Y, Clark EM, et al. 90-Day mortality after 409,096 total hip replacements for osteoarthritis, from the National Joint Registry for England and Wales: a retrospective analysis. Lancet. 2013;382:1097–104.
23. Schug S, P.-Z.E. Chronic pain after surgery or injury. Pain clinical updates. 2011.
24. Christa Harstall MO. How prevalent is chronic pain? Pain Clin Updates. 2003. XI(N. 2).
25. Azevedo LF, Costa Pereira A, Dias C, et al. Tradução, adaptação cultural e estudo multicêntrico de validação de instrumentos para rastreio e avaliação do impacto da dor crónica. Dor. 2007;15:6–65.
26. Ferreira PL. Development of the Portuguese version of MOS SF-36. Part II -Validation tests. Acta Med Port. 2000;13:119–27.
27. Ferreira PL. Development of the Portuguese version of MOS SF-36. Part I. Cultural and linguistic adaptation. Acta Med Port. 2000;13:55–66.
28. Bullinger M, Alonso J, Apolone G, et al. Translating health status questionnaires and evaluating their quality: The IQOLA Project Approach. J Clin Epidemiol. 1998;51:913–23.
29. Silveira MF, Almeida JC, Freire RS, et al. Psychometric properties of the quality of life assessment instrument: 12-item health survey (SF-12). Cien Saude Colet. 2013;18:1923–31.
30. Dworkin RH, Turk DC, Farrar JT, et al. Core outcome measures for chronic pain clinical trials: IMMPACT recommendations. Pain. 2005;113:9–19.
31. Cleeland CS, Ryan KM. Pain assessment: global use of the brief pain inventory. Ann Acad Med Singapore. 1994;23:129–38.
32. Caraceni A, Cherny N, Fainsinger R, et al. Pain measurement tools and methods in clinical research in palliative care: recommendations of an Expert Working Group of the European Association of Palliative Care. J Pain Symptom Manage. 2002;23:239–55.
33. Keller S, Bann CM, Dodd SL, et al. Validity of the brief pain inventory for use in documenting the outcomes of patients with noncancer pain. Clin J Pain. 2004;20:309–18.
34. Tan G, Jensen MP, Thornby JI, et al. Validation of the brief pain inventory for chronic nonmalignant pain. J Pain. 2004;5:133–7.
35. Choong PF, Dowsey MM. Update in surgery for osteoarthritis of the knee. Int J Rheum Dis. 2011;14:167–74.
36. Clement ND, Muzammil A, Macdonald D, et al. Socioeconomic status affects the early outcome of total hip replacement. J Bone Joint Surg Br. 2011;93:464–9.
37. Lavernia CJ, Alcerro JC, Contreras JS, et al. Ethnic and racial factors influencing well-being, perceived pain, and physical function after primary total joint arthroplasty. Clin Orthop Relat Res. 2011;469:1838–45.
38. Singh JA, Lewallen DG. Medical and psychological comorbidity predicts poor pain outcomes after total knee arthroplasty. Rheumatology (Oxford). 2013;52:916–23.
39. Singh JA, Lewallen DG. Medical comorbidity is associated with persistent index hip pain after total hip arthroplasty. Pain Med. 2013;14:1222–9.
40. Dowsey MM, Liew D, Stoney JD, et al. The impact of preoperative obesity on weight change and outcome in total knee

replacement: a prospective study of 529 consecutive patients. J Bone Joint Surg Br. 2010;92:513–20.
41. Jarvenpaa J, Kettunen J, Soininvaara T, et al. Obesity has a negative impact on clinical outcome after total knee arthroplasty. Scand J Surg. 2012;101:198–203.
42. Memtsoudis SG, Sun X, Chiu YL, et al. Perioperative comparative effectiveness of anesthetic technique in orthopedic patients. Anesthesiology. 2013;118:1046–58.
43. Palazzo C, Jourdan C, Descamps S, et al. Determinants of satisfaction 1 year after total hip arthroplasty: the role of expectations fulfilment. BMC Musculoskelet Disord. 2014;15:53.
44. Nakahara H, Okazaki K, Mizu-Uchi H, et al. Correlations between patient satisfaction and ability to perform daily activities after total knee arthroplasty: why aren't patients satisfied? J Orthop Sci. 2015;20:87–92.
45. Pinto PR, McIntyre T, Ferrero R, et al. Persistent pain after total knee or hip arthroplasty: differential study of prevalence, nature, and impact. J Pain Res. 2013;6:691–703.
46. Hanley MA, Jensen MP, Smith DG, et al. Preamputation pain and acute pain predict chronic pain after lower extremity amputation. J Pain. 2007;8:102–9.
47. Eisenach JC, Pan PH, Smiley R, et al. Severity of acute pain after childbirth, but not type of delivery, predicts persistent pain and postpartum depression. Pain. 2008;140:87–94.
48. Peters ML, Sommer M, de Rijke JM, et al. Somatic and psychologic predictors of long-term unfavorable outcome after surgical intervention. Ann Surg. 2007;245:487–94.
49. Puolakka PA, Rorarius MG, Roviola M, et al. Persistent pain following knee arthroplasty. Eur J Anaesthesiol. 2010;27:455–60.
50. Brandsborg B, Nikolajsen L, Hansen CT, et al. Risk factors for chronic pain after hysterectomy: a nationwide questionnaire and database study. Anesthesiology. 2007;106:1003–12.
51. Lingard EA, Katz JN, Wright EA, et al. Predicting the outcome of total knee arthroplasty. J Bone Joint Surg Am. 2004;86-a:2179–86.
52. Lewis GN, Rice DA, McNair PJ, et al. Predictors of persistent pain after total knee arthroplasty: a systematic review and meta-analysis. Br J Anaesth. 2015;114:551–61.
53. Paajanen H, Scheinin T, Vironen J. Commentary: nationwide analysis of complications related to inguinal hernia surgery in Finland: a 5 year register study of 55,000 operations. Am J Surg. 2010;199:746–51.
54. Nikolajsen L, Sorensen HC, Jensen TS, et al. Chronic pain following Caesarean section. Acta Anaesthesiol Scand. 2004;48:111–6.
55. Gupta A, Gandhi K, Viscusi ER. Persistent postsurgical pain after abdominal surgery. Tech Reg Anesth Pain Manag. 2011;15:140–6.
56. Harsten A, Kehlet H, Toksvig-Larsen S. Recovery after total intravenous general anaesthesia or spinal anaesthesia for total knee arthroplasty: a randomized trial. Br J Anaesth. 2013;111:391–9.
57. Harsten A, Kehlet H, Ljung P, et al. Total intravenous general anaesthesia vs. spinal anaesthesia for total hip arthroplasty: a randomised, controlled trial. Acta Anaesthesiol Scand. 2015;59:298–309.
58. Husted H, Lunn TH, Troelsen A, et al. Why still in hospital after fast-track hip and knee arthroplasty? Acta Orthop. 2011;82:679–84.