



# Preferences and Practices of Brazilian Orthopedists for Thromboprophylaxis Techniques in Total Knee Arthroplasty: Survey Among Members of the Brazilian Society of Knee Surgery (SBCJ)

## *Preferências e práticas de ortopedistas brasileiros por técnicas de tromboprofilaxia na artroplastia total do joelho: Levantamento entre membros da Sociedade Brasileira de Cirurgia do Joelho (SBCJ)*

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### Abstract

#### Keywords

- ▶ thrombosis
- ▶ thromboembolism
- ▶ embolism and thrombosis
- ▶ low-molecular weight heparin
- ▶ enoxaparin
- ▶ intermittent pneumatic compression devices

**Objective** The present study describes the preferences and current practices of a sample of knee surgeons in Brazil regarding thromboprophylaxis in total knee arthroplasty (TKA).

**Method** In the present internet survey, surgeons from the Brazilian Knee Surgery Society (SBCJ, in the Portuguese acronym) voluntarily answered an anonymous questionnaire including time of personal surgical experience, perceptions about the best thromboprophylaxis options, and actual practices in their work environment.

**Results** From December 2020 to January 2021, 243 participants answered the questionnaire. All, except for 3 (1.2%), reported using thromboprophylaxis, and most (76%) combined pharmacological and mechanical techniques. The most prescribed drug was enoxaparin (87%), which changed to rivaroxaban (65%) after discharge. The time of thromboprophylaxis initiation varied according to the length

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of training of the knee surgeon ( $p \leq 0.03$ ), and their preferences and practices differed according to the Brazilian region ( $p < 0.05$ ) and the health system in which the surgeons work (public or private sector;  $p = 0.024$ ). The option for mechanical thromboprophylaxis also depended on the training time of the surgeon.

**Conclusion** Thromboprophylaxis preferences and practices in TKA are diverse across Brazilian regions and health systems (public or private sectors). Given the lack of a national clinical guideline, most orthopedists follow either their hospital guidelines or none. The mechanical prophylaxis method and the little use of aspirin are the points that most diverge from international guidelines and practices.

## Resumo

**Objetivo** Descrever as preferências e práticas atuais de uma amostra de cirurgiões de joelho do Brasil quanto à forma de tromboprofilaxia na artroplastia total do joelho (ATJ).

**Método** Na presente pesquisa realizada pela internet, cirurgiões associados à Sociedade Brasileira de Cirurgia do Joelho (SBCJ) foram convidados a responder voluntariamente a um questionário anônimo incluindo o tempo de experiência cirúrgica pessoal, percepções sobre as melhores opções de tromboprofilaxia e as reais práticas no ambiente onde trabalham.

**Resultados** Entre dezembro de 2020 e janeiro de 2021, 243 participantes responderam ao questionário completo. Exceto por 3 (1,2%) participantes, todos declararam praticar tromboprofilaxia, a maioria (76%) combinando as formas farmacológica e mecânica. A droga mais prescrita é a enoxaparina (87%), com modificação para rivaroxabana (65%) após a alta. O momento de início da tromboprofilaxia variou conforme o tempo de formação do cirurgião de joelho ( $p \leq 0,03$ ) e as preferências e práticas variaram conforme a região do país ( $p < 0,05$ ) e o sistema de saúde no qual trabalham os cirurgiões (público ou privado;  $p = 0,024$ ). A opção por tromboprofilaxia mecânica também dependeu do tempo de formação do cirurgião.

**Conclusão** As preferências e práticas de tromboprofilaxia na ATJ são diversas nas regiões do Brasil e sistemas de saúde (público ou privado). Dada a inexistência de uma diretriz clínica nacional, a maior parte dos ortopedistas segue ou a diretriz de seu próprio hospital ou nenhuma. O método de profilaxia mecânica e a pouca utilização do ácido acetilsalicílico são os pontos que mais destoam das diretrizes e práticas internacionais.

## Palavras-chave

- ▶ trombose
- ▶ tromboembolia
- ▶ embolia e trombose
- ▶ heparina de baixo peso molecular
- ▶ enoxaparina
- ▶ dispositivos de compressão pneumática intermitente

## Introduction

Venous thromboembolism (VTE), including deep vein thrombosis (DVT) and pulmonary embolism (PE), is a potentially fatal complication from knee arthroplasty. Its prevention can use pharmacological and mechanical methods. These methods must be effective (that is, avoiding fatal outcomes) and safe (that is, not causing major bleeding).<sup>1,2</sup> Despite the great importance of this topic in the daily life of orthopedists, there is still no consensus on the best thromboprophylaxis regimen for total knee arthroplasty (TKA), either nationally or internationally.<sup>1-4</sup>

The present study describes the preferences and current practices of a sample of Brazilian orthopedic knee surgeons regarding thromboprophylaxis for TKA.

## Materials and Methods

The present research started after approval by the Research Ethics Committee of Universidade Federal do Pará and by the

Brazilian Knee Surgery Society (SBCJ, in the Portuguese acronym), in addition to registration on Plataforma Brasil.

The present online study collected data on perceptions and practices of knee surgeons working in Brazil; its report follows the guidelines for writing web-based research known as Checklist for Reporting Results of Internet E-Surveys (CHERRIES).<sup>5</sup>

We sent the open-ended questionnaire (▶ **Appendix 1, ▶ Supplementary material**, available online only) to all SBCJ members. First, it was sent by email on December 18, 2020 (▶ **Appendix 2, ▶ Supplementary material**, available online only) to 1,612 orthopedists. On December 27, 2020, a message sent via WhatsApp to all regional SBCJ groups (▶ **Appendix 3, Supplementary material**, available online only) invited orthopedists to participate in the research. We offered no reward for participation.

The answers were received until January 26, 2021. We requested the e-mail address of the participant, but no other identification method, to avoid duplicates. If the same participant (same e-mail address) answered the questionnaire

more than once, we considered only the last one and discarded any other. E-mail and WhatsApp messages were saved in the Google Forms platform website for automatic storage, with access restricted to researchers through a password. To complete the survey, all participants had to read and agree with an informed consent form (ICF) available as a link in the initial text (► **Appendix 4, Supplementary material**, available online only).

The questionnaire consisted of 51 questions divided into 4 sections. The first section gathered general information about the participant. The second and third sections inquired about their perioperative routine in TKA and thromboprophylaxis preferences and practices (pharmacological or mechanical techniques or both), respectively. A final section was reserved for optional comments. The thromboprophylaxis methods listed in the questionnaire were based on a literature review, on international guidelines, and on the combined clinical experience of the authors.

In a pilot phase, we tested the online questionnaire with 6 orthopedists; the average time for its completion was 4 minutes. Some questions have been reworded to avoid ambiguity and improve usability/functionality.

Of the 51 questions, 35 were multiple choice (including 2 allowing more than one choice), and 15 were discursive. Some questions linked to some answers (branching logic), so the number of total questions to each participant could range from 17 to 51. There was no randomization in the order of the questions. We adopted the same sequence to maintain the line of reasoning. During the completion of the questionnaire, the participant could go back and review their answers until the final submission. Except for the "Final Comments" field, all other questions were mandatory. Since the platform only captured data from fully answered questionnaires, there were no incomplete questionnaires.

For the statistical analysis, absolute and relative frequencies described the conduct and preferences of the surgeons according to the characteristics of interest. The Kirkwood and Sternes likelihood-ratio test verified associations. Data were tabulated in Microsoft Excel 2003 (Microsoft Corp., Redmond, WA, USA) and analyzed with IBM SPSS Statistics for Windows version 20.0 (IBM Corp., Armonk, NY, USA). The significance level was set at 5%.

## Results

We received 311 responses, including 65 duplicates excluded along with 1 participant who stated not performing routine TKA. Thus, we analyzed 245 questionnaires. This number corresponds to a response rate of 15.19% of the total SBCJ members during the study period, even though affiliation has not been verified.

► **Table 1** shows the profile of the participants and their concerns with TKA complications. ► **Table 2** shows their preferences and thromboprophylaxis practices. Except for 3 participants (1.2%), all surgeons used some form of thromboprophylaxis. Most orthopedists (76%) preferred a combination of pharmacological and mechanical techniques. The

most prescribed drug after surgery was enoxaparin (87%). All those prescribing thromboprophylaxis on admission also recommend their home use. Among those prescribing enoxaparin during hospitalization, only 30% maintain it after discharge; the other 70% switch to another oral drug. The most prescribed drug by these orthopedists was rivaroxaban (65%), mainly (86%) starting 24 hours after the last enoxaparin dosage. Among the orthopedists prescribing a drug other than enoxaparin during hospitalization, the majority (94%) did not change the medication after hospital discharge.

► **Table 3** associates the preferences and practices of the interviewee with the time since completing their knee specialization. There is a statistically significant association between time since training and some practices. Surgeons with < 10 years of experience started the pharmacological prophylaxis 12 hours after surgery ( $p = 0.030$ ) and used less continuous passive motion (CPM) devices ( $p = 0.023$ ) and portable pneumatic compression devices ( $p = 0.014$ ); in addition, they were less likely to stratify the thromboprophylaxis method according to the patient, meaning that they usually prescribe the same method for all patients ( $p < 0.001$ ). Orthopedists with 21 to 30 years of experience opt for graduated compression stockings ( $p = 0.022$ ) rather than for a fixed pneumatic compression device ( $p = 0.030$ ).

► **Table 4** shows some practices and preferences associated with the Brazilian region in which they work ( $p < 0.05$ ). Surgeons from the South and Central-West regions of Brazil frequently changed the drug after hospital discharge. The drug selected for home use also varies according to the Brazilian region. Mechanical prophylaxis was prescribed often in the South region, with fixed pneumatic compression standing out compared mainly with the North and Northeast regions. Mechanical thromboprophylaxis started earlier in the North region.

None of the preferences and practices showed a statistically significant association with the volume of surgical procedures ( $p > 0.05$ ; ► **Table 5**).

► **Table 6** shows that the use of CPM by surgeons who work predominantly in the Brazilian public health system (SUS, in the Portuguese acronym) is statistically lower when compared with that of surgeons from other services, such as private ones ( $p = 0.024$ ). These surgeons would also opt for different thromboprophylaxis techniques if they could ( $p = 0.008$ ).

## Discussion

The present online survey with Brazilian knee surgeons revealed a lack of a national clinical guideline, resulting in a wide range of thromboprophylaxis practices that do not comply with international standards. Although the interventions employed and preferred by orthopedists and the moment of their use vary according to the Brazilian region, the experience time of the surgeons, and the type of hospitals, they should be based on scientific evidence. The present study shows that this is the time to build a rational, evidence-

**Table 1** Participants profile and their perioperative routine for total knee replacement

Variable	Description
<b>Time since the conclusion of R4 in knee surgery</b>	
Up to 10 years	58 (23.6%)
11 to 20 years	81 (32.9%)
21 to 30 years	65 (26.4%)
> 30 years	42 (17.1%)
<b>Brazilian Region</b>	
North	27 (11%)
Northeast	44 (17.9%)
Southeast	134 (54.5%)
South	24 (9.8%)
Central-West	17 (6.9%)
<b>Which are your main knee replacement patients?</b>	
Health insurance/Private practice	168 (68.3%)
Brazilian Universal Healthcare System (SUS)	33 (13.4%)
Similar volumes from SUS/Private practice	45 (18.3%)
<b>Arthroplasties performed per month</b>	
0 to 4	143 (58.1%)
5 to 8	73 (29.7%)
≥ 9	30 (12.2%)
<b>Do you predominantly act as the main surgeon or the assistant surgeon?</b>	
Main surgeon	226 (91.9%)
Assistant surgeon	20 (8.1%)
<b>How concerned are you about the following potential complications in total knee arthroplasty? [Thromboembolism]</b>	
Not concerned	2 (0.8%)
Slightly concerned	20 (8.1%)
Moderately concerned	25 (10.2%)
Concerned	94 (38.2%)
Very concerned	105 (42.7%)
<b>How concerned are you about the following potential complications in total knee arthroplasty? [Infection]</b>	
Not concerned	3 (1.2%)
Slightly concerned	12 (4.9%)
Moderately concerned	7 (2.8%)
Concerned	50 (20.3%)
Very concerned	174 (70.7%)
<b>How concerned are you about the following potential complications in total knee arthroplasty? [Minor bleeding]</b>	
Not concerned	52 (21.1%)
Slightly concerned	70 (28.5%)
Moderately concerned	47 (19.1%)

**Table 1** (Continued)

Variable	Description
Concerned	65 (26.4%)
Very concerned	12 (4.9%)
<b>How concerned are you about the following potential complications in total knee arthroplasty? [Major bleeding]</b>	
Not concerned	14 (5.7%)
Slightly concerned	38 (15.4%)
Moderately concerned	43 (17.5%)
Concerned	85 (34.6%)
Very concerned	66 (26.8%)
<b>Which is the anesthesia protocol most used by your team for total knee replacement?</b>	
General	1 (0.4%)
Epidural	1 (0.4%)
Epidural with catheter	4 (1.6%)
Spinal	98 (39.8%)
Spinal + ultrasound-guided peripheral block	136 (55.3%)
Spinal + epidural	6 (2.4%)
<b>Do you believe that a tourniquet may increase the incidence of thromboembolic events in total knee replacement?</b>	
No	117 (47.6%)
Yes	129 (52.4%)
<b>How long do you keep a patient with no complications hospitalized after a primary knee replacement?</b>	
1 day	18 (7.3%)
2 days	138 (56.1%)
3 days	81 (32.9%)
> 3 days	9 (3.7%)
<b>How soon after surgery do you allow the patient to resume walking?</b>	
Within 24 hours	93 (37.8%)
From 24 to 48 hours	137 (55.7%)
From 48 to 72 hours	13 (5.3%)
> 72 hours	3 (1.2%)
<b>Do you use a tourniquet in most of your arthroplasties?</b>	
No	45 (18.3%)
Yes	201 (81.7%)
<b>If you often use a tourniquet, for how long do you do it?</b>	
From before skin incision up to the total closure of the surgical site	79 (39.3%)
From before skin incision up to the cementation of the prosthesis	121 (60.2%)
Only during cementation	1 (0.5%)

Abbreviation: R4, 4<sup>th</sup> year of residence (subspecialization in knee surgery)

**Table 2** Thromboprophylaxis techniques preferences and procedures from Brazilian knee surgeons for total knee replacement

Variable	Description
<b>In your routine, do you use any kind of thromboprophylaxis for total knee replacement?</b>	
No	3 (1.2%)
Yes	243 (98.8%)
<b>Which thromboprophylaxis type(s) do you use for total knee replacement?</b>	
Pharmacological alone	57 (23.5%)
Mechanical alone	1 (0.4%)
Pharmacological + mechanical	185 (76.1%)
<b>When do you start the pharmacological thromboprophylaxis?</b>	
Before surgery	15 (6.2%)
After surgery	227 (93.8%)
<b>Which drug do you use after surgery?</b>	
Acetylsalicylic acid	5 (2.1%)
Apixaban	3 (1.2%)
Dabigatran	4 (1.7%)
Enoxaparin	211 (87.2%)
Rivaroxaban	18 (7.4%)
Another drug	1 (0.4%)
<b>How long after surgery is the first dose administered?</b>	
Up to 2 hours	16 (6.6%)
3 to 6 hours	86 (35.5%)
7 to 11 hours	34 (14%)
12 hours	86 (35.5%)
≥ 24 hours	20 (8.3%)
<b>What is the frequency of administration of this drug during hospitalization?</b>	
Every 12 hours	8 (3.3%)
Once a day	234 (96.7%)
<b>For how long the patient must take this drug during hospitalization?</b>	
1 day	3 (1.2%)
2 days	29 (12%)
3 days	10 (4.1%)
Only while the patient cannot walk. When walking is resumed, I terminate the drug	2 (0.8%)
During the whole hospitalization period	198 (81.8%)
<b>The options you stated above indicate your current practice. Would you prefer another conduct if you could use other resources/drugs?</b>	
No, I am free to work as I prefer	189 (78.1%)
	27 (11.2%)

(Continued)

**Table 2** (Continued)

Variable	Description
Yes, but they are not available at the hospital(s) I work	
Yes, but they are not financed by health insurance providers	26 (10.7%)
<b>Do you prescribe pharmacological thromboprophylaxis after hospital discharge?</b>	
Yes	242 (100%)
<b>Do you prescribe the same drug used during hospitalization for home treatment after discharge?</b>	
No	153 (63.2%)
Yes	89 (36.8%)
<b>Which new drug do you prescribe for home use?</b>	
Acetylsalicylic acid	18 (11.8%)
Apixaban	30 (19.6%)
Dabigatran	6 (3.9%)
Rivaroxaban	99 (64.7%)
<b>For how long the patient must use this drug at home?</b>	
1 week	4 (1.7%)
10 days	68 (28.1%)
2 weeks	83 (34.3%)
3 weeks	40 (16.5%)
4 weeks	44 (18.2%)
> 4 weeks	3 (1.2%)
<b>The options you stated above indicate your current practice. Would you prefer another conduct if you could use other resources/drugs?</b>	
No, I am free to work as I prefer	203 (83.9%)
Yes, but the administration route prevents its home use	10 (4.1%)
Yes, but the cost would prevent its use by my patients	29 (12%)
<b>Do you prescribe mechanical thromboprophylaxis after total knee replacement?</b>	
No	72 (29.8%)
Yes	170 (70.2%)
<b>What type of mechanical prophylaxis do you use?*</b>	
Graduated compression stockings	140 (81.9%)
Continuous passive motion (CPM) device	25 (14.6%)
Fixed pneumatic compression device	39 (22.8%)
Portable pneumatic compression device	8 (4.7%)
<b>How do you use the device?</b>	
On the operated lower extremity alone	20 (11.7%)
On both lower extremities	151 (88.3%)
<b>When do you start the mechanical thromboprophylaxis?</b>	

(Continued)



**Table 2** (Continued)

Variable	Description
Before surgery	11 (6.4%)
During surgery	18 (10.5%)
Immediately after the end of surgery	105 (61.4%)
A couple of hours after the end of surgery	37 (21.6%)
<b>The options you stated above indicate your current practice. Would you prefer another conduct if you could use other resources/drugs?</b>	
No, I am free to work as I prefer	121 (70.8%)
Yes, but they are not available at the hospital(s) I work	17 (9.9%)
Yes, but they are not financed by health insurance providers	13 (7.6%)
Yes, but the device is not available where I work	3 (1.8%)
Yes, but the cost would prevent its use by my patients	17 (9.9%)
<b>Do you stratify your thromboprophylaxis method for knee replacement or do you use the same routine regimen for all patients?</b>	
I stratify it	82 (33.7%)
I use the same method for all patients	161 (66.3%)
<b>Do you follow any guideline regarding a thromboprophylaxis method?</b>	
No	88 (36.2%)
Yes, 2011 American Academy of Orthopaedic Surgeons (AAOS)	38 (15.6%)
Yes, 2012 American College of Chest Physicians (ACCP)	10 (4.1%)
Yes, the guidelines from the hospital I work	102 (42%)
Yes, 2019 National Institute for Health and Care Excellence (NICE)	5 (2.1%)

\*Among those who use it, some reported more than one type.

based national guideline to be adopted by both public and private hospitals.

Thromboprophylaxis remains a frequent practice. Only 3 participants (1.2%) claimed not to use any method. This percentage is consistent with the one observed in a survey during the Brazilian Congress of Orthopedics in 2007.<sup>6</sup> Despite the low number of participants denying thromboprophylaxis, we need to discuss the potential legal implications of its absence since there is international scientific evidence of its benefit. This discussion would help build a national consensus.

A total of 76% of orthopedists selected a combination of pharmacological and mechanical prophylaxis, regardless of other variables. As in previous studies,<sup>6-8</sup> the drug most commonly used during hospitalization was enoxaparin,

cited by 87% of the participants. This choice agrees with the American College of Chest Physicians (ACCP) guidelines, which recommend low molecular weight heparin (LMWH) for thromboprophylaxis in arthroplasties.<sup>1</sup> The American Academy of Orthopedic Surgeons (AAOS) recommends no particular agent.<sup>2</sup> In 2019, the National Institute for Health and Care Excellence (NICE) from the United Kingdom recommended one of the following three options: aspirin for 14 days, LMWH for 14 days combined with anti-embolism stockings until discharge, or rivaroxaban.<sup>9</sup> Therefore, Brazilian surgeons mostly follow the NICE guideline.

The moment to start LMWH is controversial both among participants and the literature.<sup>10,11</sup> The ACCP guidelines advocate that LMWH administration should not begin earlier than 12 hours after the end of the surgery and not less than 12 hours before its start.<sup>1</sup> In our survey, 94% of the participants started pharmacological prophylaxis after surgery, but at different times: most (56%) did it up to 11 hours after arthroplasty, while ~ 36% did it 12 hours after surgery, and ~ 8% did it  $\geq$  24 hours later. The earlier onset occurred mainly among more experienced orthopedists (those who completed their 4<sup>th</sup> year of residency [R4] 21 to 30 years ago). The choice to start prophylaxis 12 hours after the end of surgery is statistically higher among orthopedists with up to 10 years since R4 completion (knee subspecialty in Brazil), showing greater alignment with the ACCP guidelines even though they did not declare to follow it in the same proportion.

About 60% of the participants answered that they change their prescription for home use, especially those who initially select enoxaparin. The cost and subcutaneous administration of enoxaparin probably explain this switch. On the other hand, those who prescribe oral drugs during hospitalization usually maintain them for home use. The most common prescription for domiciliar use was rivaroxaban, selected by 54% of the participants. However, 85% of these orthopedists prescribed enoxaparin during hospitalization, maybe due to the guidelines of the hospital where they work, since 42% report following them. This preference for enoxaparin and rivaroxaban is consistent with an Australian study from 2019.<sup>8</sup>

The wide range in the duration of pharmacological prophylaxis in our research mirrors the uncertainty presented in the literature. The NICE recommends 14 days.<sup>9</sup> The ACCP suggests at least 10 days but recommends 35 days.<sup>1</sup> The AAOS guidelines state that the duration of prophylaxis must be individualized and discussed by the doctor and the patient.<sup>2</sup> Most participants opted for a 10- or 14-day prescription (28 and 34%, respectively), and only one-third report stratifying the regimen according to the patient.

Few participants preferred aspirin. In other countries, however, this drug has been increasingly used.<sup>8,12</sup> Because of its low risk of bleeding, easy oral administration, low cost, and prophylactic action against the main cause of death after arthroplasty (ischemic heart disease)<sup>13</sup>, we expected that the adherence to it would be much higher

**Table 3** Thromboprophylaxis techniques preferences and procedures from Brazilian knee surgeons for total knee replacement according to the time since R4 completion

Variable	R4 completion				p-value
	Up to 10 years	11 to 20 years	21 to 30 years	> 30 years	
<b>Which thromboprophylaxis type(s) do you use for total knee replacement?</b>					
Pharmacological alone	10 (17.5)	24 (29.6)	16 (25)	7 (17.1)	0.292
Mechanical alone	0 (0)	0 (0)	0 (0)	1 (2.4)	
Pharmacological + mechanical	47 (82.5)	57 (70.4)	48 (75)	33 (80.5)	
<b>When do you start the pharmacological thromboprophylaxis?</b>					
Before surgery	1 (1.8)	8 (9.9)	5 (7.8)	1 (2.5)	0.125
After surgery	56 (98.2)	73 (90.1)	59 (92.2)	39 (97.5)	
<b>Which drug do you use after surgery?</b>					
Acetylsalicylic acid	0 (0)	0 (0)	3 (4.7)	2 (5)	0.058
Apixaban	0 (0)	3 (3.7)	0 (0)	0 (0)	
Dabigatran	0 (0)	1 (1.2)	1 (1.6)	2 (5)	
Enoxaparin	54 (94.7)	72 (88.9)	54 (84.4)	31 (77.5)	
Rivaroxaban	3 (5.3)	5 (6.2)	6 (9.4)	4 (10)	
Another drug	0 (0)	0 (0)	0 (0)	1 (2.5)	
<b>How long after surgery is the first dose administered?</b>					
Up to 2 hours	2 (3.5)	3 (3.7)	5 (7.8)	6 (15)	0.030
3 to 6 hours	12 (21.1)	29 (35.8)	30 (46.9)	15 (37.5)	
7 to 11 hours	6 (10.5)	14 (17.3)	8 (12.5)	6 (15)	
12 hours	28 (49.1)	30 (37)	18 (28.1)	10 (25)	
≥ 24 hours	9 (15.8)	5 (6.2)	3 (4.7)	3 (7.5)	
<b>What is the frequency of administration of this drug during hospitalization?</b>					
Every 12 hours	2 (3.5)	2 (2.5)	0 (0)	4 (10)	0.042
Once a day	55 (96.5)	79 (97.5)	64 (100)	36 (90)	
<b>For how long the patient must take this drug during hospitalization?</b>					
1 day	0 (0)	1 (1.2)	2 (3.1)	0 (0)	0.002
2 days	1 (1.8)	11 (13.6)	10 (15.6)	7 (17.5)	
3 days	2 (3.5)	0 (0)	5 (7.8)	3 (7.5)	
Only while the patient cannot walk. When walking is resumed, I terminate the drug	0 (0)	0 (0)	2 (3.1)	0 (0)	
During the whole hospitalization period	54 (94.7)	69 (85.2)	45 (70.3)	30 (75)	
<b>The options you stated above indicate your current practice. Would you prefer another conduct if you could use other resources/drugs?</b>					
No, I am free to work as I prefer	41 (71.9)	59 (72.8)	55 (85.9)	34 (85)	0.104
Yes, but they are not available at the hospital(s) I work	8 (14)	13 (16)	2 (3.1)	4 (10)	
Yes, but they are not financed by health insurance providers	8 (14)	9 (11.1)	7 (10.9)	2 (5)	
<b>Do you prescribe the same drug used during hospitalization for home treatment after discharge?</b>					
No	40 (70.2)	55 (67.9)	39 (60.9)	19 (47.5)	0.101
Yes	17 (29.8)	26 (32.1)	25 (39.1)	21 (52.5)	
<b>Which new drug do you prescribe for home use?</b>					
Acetylsalicylic acid	1 (2.5)	8 (14.5)	6 (15.4)	3 (15.8)	0.560

(Continued)

**Table 3** (Continued)

Variable	R4 completion				p-value
	Up to 10 years	11 to 20 years	21 to 30 years	> 30 years	
Apixaban	10 (25)	10 (18.2)	8 (20.5)	2 (10.5)	
Dabigatran	1 (2.5)	2 (3.6)	2 (5.1)	1 (5.3)	
Rivaroxaban	28 (70)	35 (63.6)	23 (59)	13 (68.4)	
<b>For how long the patient must use this drug at home?</b>					
1 week	0 (0)	2 (2.5)	1 (1.6)	1 (2.5)	0.253
10 days	10 (17.5)	28 (34.6)	22 (34.4)	8 (20)	
2 weeks	21 (36.8)	27 (33.3)	17 (26.6)	18 (45)	
3 weeks	9 (15.8)	12 (14.8)	10 (15.6)	9 (22.5)	
4 weeks	16 (28.1)	11 (13.6)	13 (20.3)	4 (10)	
> 4 weeks	1 (1.8)	1 (1.2)	1 (1.6)	0 (0)	
<b>The options you stated above indicate your current practice. Would you prefer another conduct if you could use other resources/drugs?</b>					
No, I am free to work as I prefer	42 (73.7)	68 (84)	58 (90.6)	35 (87.5)	0.061
Yes, but the administration route prevents its home use	1 (1.8)	5 (6.2)	2 (3.1)	2 (5)	
Yes, but the cost would prevent its use by my patients	14 (24.6)	8 (9.9)	4 (6.3)	3 (7.5)	
<b>Do you prescribe mechanical thromboprophylaxis after total knee replacement?</b>					
No	14 (24.6)	31 (38.3)	18 (28.1)	9 (22.5)	0.204
Yes	43 (75.4)	50 (61.7)	46 (71.9)	31 (77.5)	
<b>Graduated compression stockings</b>					
No	6 (14)	13 (26)	3 (6.5)	9 (28.1)	0.022
Yes	37 (86)	37 (74)	43 (93.5)	23 (71.9)	
<b>Continuous passive motion (CPM) device</b>					
No	42 (97.7)	41 (82)	38 (82.6)	25 (78.1)	0.023
Yes	1 (2.3)	9 (18)	8 (17.4)	7 (21.9)	
<b>Fixed pneumatic compression device</b>					
No	33 (76.7)	35 (70)	42 (91.3)	22 (68.8)	0.030
Yes	10 (23.3)	15 (30)	4 (8.7)	10 (31.3)	
<b>Portable pneumatic compression device</b>					
No	43 (100)	49 (98)	44 (95.7)	27 (84.4)	0.014
Yes	0 (0)	1 (2)	2 (4.3)	5 (15.6)	
<b>How do you use the device?</b>					
On the operated lower extremity alone	5 (11.6)	6 (12)	5 (10.9)	4 (12.5)	0.997
On both lower extremities	38 (88.4)	44 (88)	41 (89.1)	28 (87.5)	
<b>When do you start the mechanical thromboprophylaxis?</b>					
Before surgery	3 (7)	4 (8)	3 (6.5)	1 (3.1)	0.647
During surgery	4 (9.3)	7 (14)	3 (6.5)	4 (12.5)	
Immediately after the end of surgery	28 (65.1)	24 (48)	31 (67.4)	22 (68.8)	
A couple of hours after the end of surgery	8 (18.6)	15 (30)	9 (19.6)	5 (15.6)	
<b>The options you stated above indicate your current practice. Would you prefer another conduct if you could use other resources/drugs?</b>					
No, I am free to work as I prefer	26 (60.5)	30 (60)	35 (76.1)	30 (93.8)	0.070



**Table 3** (Continued)

Variable	R4 completion				p-value
	Up to 10 years	11 to 20 years	21 to 30 years	> 30 years	
Yes, but they are not available at the hospital(s) I work	6 (14)	7 (14)	3 (6.5)	1 (3.1)	
Yes, but they are not financed by health insurance providers	3 (7)	5 (10)	4 (8.7)	1 (3.1)	
Yes, but the device is not available where I work	1 (2.3)	1 (2)	1 (2.2)	0 (0)	
Yes, but the cost would prevent its use by my patients	7 (16.3)	7 (14)	3 (6.5)	0 (0)	
<b>Do you stratify your thromboprophylaxis method for knee replacement or do you use the same routine regimen for all patients?</b>					
I stratify it	6 (10.5)	33 (40.7)	27 (42.2)	16 (39)	< 0.001
I use the same method for all patients	51 (89.5)	48 (59.3)	37 (57.8)	25 (61)	
<b>Do you follow any guideline regarding a thromboprophylaxis method?</b>					
No	21 (36.8)	33 (40.7)	25 (39.1)	9 (22)	0.538
Yes, 2011 American Academy of Orthopaedic Surgeons (AAOS)	10 (17.5)	12 (14.8)	7 (10.9)	9 (22)	
Yes, 2012 American College of Chest Physicians (ACCP)	1 (1.8)	3 (3.7)	3 (4.7)	3 (7.3)	
Yes, the guidelines from the hospital I work	24 (42.1)	30 (37)	28 (43.8)	20 (48.8)	
Yes, 2019 National Institute for Health and Care Excellence (NICE)	1 (1.8)	3 (3.7)	1 (1.6)	0 (0)	

Likelihood-ratio test.

**Table 4** Thromboprophylaxis techniques preferences and procedures from Brazilian knee surgeons for total knee replacement according to the Brazilian region in which they work

Variable	Brazilian Region					p-value
	North	Northeast	Southeast	South	Central-West	
<b>Which thromboprophylaxis type(s) do you use for total knee replacement?</b>						
Pharmacological alone	8 (29.6)	10 (22.7)	35 (26.7)	2 (8.3)	2 (11.8)	0.440
Mechanical alone	0 (0)	0 (0)	1 (0.8)	0 (0)	0 (0)	
Pharmacological + mechanical	19 (70.4)	34 (77.3)	95 (72.5)	22 (91.7)	15 (88.2)	
<b>When do you start the pharmacological thromboprophylaxis?</b>						
Before surgery	4 (14.8)	3 (6.8)	7 (5.4)	1 (4.2)	0 (0)	0.278
After surgery	23 (85.2)	41 (93.2)	123 (94.6)	23 (95.8)	17 (100)	
<b>Which drug do you use after surgery?</b>						
Acetylsalicylic acid	0 (0)	0 (0)	4 (3.1)	1 (4.2)	0 (0)	0.192
Apixaban	0 (0)	0 (0)	3 (2.3)	0 (0)	0 (0)	
Dabigatran	2 (7.4)	0 (0)	2 (1.5)	0 (0)	0 (0)	
Enoxaparin	25 (92.6)	42 (95.5)	107 (82.3)	20 (83.3)	17 (100)	
Rivaroxaban	0 (0)	2 (4.5)	13 (10)	3 (12.5)	0 (0)	
Another drug	0 (0)	0 (0)	1 (0.8)	0 (0)	0 (0)	
<b>How long after surgery is the first dose administered?</b>						
Up to 2 hours	1 (3.7)	2 (4.5)	6 (4.6)	5 (20.8)	2 (11.8)	0.006
3 to 6 hours	10 (37)	22 (50)	33 (25.4)	10 (41.7)	11 (64.7)	
7 to 11 hours	2 (7.4)	7 (15.9)	20 (15.4)	4 (16.7)	1 (5.9)	

(Continued)

**Table 4** (Continued)

Variable	Brazilian Region					p-value
	North	Northeast	Southeast	South	Central-West	
12 hours	11 (40.7)	12 (27.3)	57 (43.8)	4 (16.7)	2 (11.8)	
≥ 24 hours	3 (11.1)	1 (2.3)	14 (10.8)	1 (4.2)	1 (5.9)	
<b>What is the frequency of administration of this drug during hospitalization?</b>						
Every 12 hours	0 (0)	0 (0)	7 (5.4)	1 (4.2)	0 (0)	0.114
Once a day	27 (100)	44 (100)	123 (94.6)	23 (95.8)	17 (100)	
<b>For how long the patient must take this drug during hospitalization?</b>						
1 day	1 (3.7)	0 (0)	2 (1.5)	0 (0)	0 (0)	0.898
2 days	3 (11.1)	5 (11.4)	16 (12.3)	3 (12.5)	2 (11.8)	
3 days	0 (0)	1 (2.3)	7 (5.4)	1 (4.2)	1 (5.9)	
Only while the patient cannot walk. When walking is resumed, I terminate the drug	1 (3.7)	0 (0)	1 (0.8)	0 (0)	0 (0)	
During the whole hospitalization period	22 (81.5)	38 (86.4)	104 (80)	20 (83.3)	14 (82.4)	
<b>The options you stated above indicate your current practice. Would you prefer another conduct if you could use other resources/drugs?</b>						
No, I am free to work as I prefer	15 (55.6)	35 (79.5)	104 (80)	22 (91.7)	13 (76.5)	0.078
Yes, but they are not available at the hospital(s) I work	5 (18.5)	5 (11.4)	15 (11.5)	0 (0)	2 (11.8)	
Yes, but they are not financed by health insurance providers	7 (25.9)	4 (9.1)	11 (8.5)	2 (8.3)	2 (11.8)	
<b>Do you prescribe the same drug used during hospitalization for home treatment after discharge?</b>						
No	14 (51.9)	22 (50)	84 (64.6)	20 (83.3)	13 (76.5)	0.028
Yes	13 (48.1)	22 (50)	46 (35.4)	4 (16.7)	4 (23.5)	
<b>Which new drug do you prescribe for home use?</b>						
Acetylsalicylic acid	1 (7.1)	0 (0)	12 (14.3)	3 (15)	2 (15.4)	0.007
Apixaban	3 (21.4)	3 (13.6)	18 (21.4)	0 (0)	6 (46.2)	
Dabigatran	1 (7.1)	3 (13.6)	1 (1.2)	1 (5)	0 (0)	
Rivaroxaban	9 (64.3)	16 (72.7)	53 (63.1)	16 (80)	5 (38.5)	
<b>For how long the patient must use this drug at home?</b>						
1 week	3 (11.1)	0 (0)	1 (0.8)	0 (0)	0 (0)	0.173
10 days	8 (29.6)	17 (38.6)	30 (23.1)	7 (29.2)	6 (35.3)	
2 weeks	7 (25.9)	10 (22.7)	55 (42.3)	7 (29.2)	4 (23.5)	
3 weeks	4 (14.8)	8 (18.2)	20 (15.4)	3 (12.5)	5 (29.4)	
4 weeks	4 (14.8)	9 (20.5)	22 (16.9)	7 (29.2)	2 (11.8)	
> 4 weeks	1 (3.7)	0 (0)	2 (1.5)	0 (0)	0 (0)	
<b>The options you stated above indicate your current practice. Would you prefer another conduct if you could use other resources/drugs?</b>						
No, I am free to work as I prefer	20 (74.1)	37 (84.1)	109 (83.8)	22 (91.7)	15 (88.2)	0.099
Yes, but the administration route prevents its home use	0 (0)	2 (4.5)	5 (3.8)	1 (4.2)	2 (11.8)	
Yes, but the cost would prevent its use by my patients	7 (25.9)	5 (11.4)	16 (12.3)	1 (4.2)	0 (0)	
<b>Do you prescribe mechanical thromboprophylaxis after total knee replacement?</b>						
No	11 (40.7)	11 (25)	44 (33.8)	2 (8.3)	4 (23.5)	0.042
Yes	16 (59.3)	33 (75)	86 (66.2)	22 (91.7)	13 (76.5)	
<b>Graduated compression stockings</b>						
No	4 (25)	7 (21.2)	13 (14.9)	6 (27.3)	1 (7.7)	0.467
Yes	12 (75)	26 (78.8)	74 (85.1)	16 (72.7)	12 (92.3)	
<b>Continuous passive motion (CPM) device</b>						
No	10 (62.5)	24 (72.7)	80 (92)	21 (95.5)	11 (84.6)	0.006

**Table 4** (Continued)

Variable	Brazilian Region					p-value
	North	Northeast	Southeast	South	Central-West	
Yes	6 (37.5)	9 (27.3)	7 (8)	1 (4.5)	2 (15.4)	
<b>Fixed pneumatic compression device</b>						
No	16 (100)	30 (90.9)	62 (71.3)	14 (63.6)	10 (76.9)	0.003
Yes	0 (0)	3 (9.1)	25 (28.7)	8 (36.4)	3 (23.1)	
<b>Portable pneumatic compression device</b>						
No	14 (87.5)	32 (97)	84 (96.6)	20 (90.9)	13 (100)	0.394
Yes	2 (12.5)	1 (3)	3 (3.4)	2 (9.1)	0 (0)	
<b>How do you use the device?</b>						
On the operated lower extremity alone	4 (25)	6 (18.2)	7 (8)	2 (9.1)	1 (7.7)	0.292
On both lower extremities	12 (75)	27 (81.8)	80 (92)	20 (90.9)	12 (92.3)	
<b>When do you start the mechanical thromboprophylaxis?</b>						
Before surgery	3 (18.8)	0 (0)	6 (6.9)	2 (9.1)	0 (0)	0.013
During surgery	2 (12.5)	2 (6.1)	14 (16.1)	0 (0)	0 (0)	
Immediately after the end of surgery	8 (50)	20 (60.6)	49 (56.3)	16 (72.7)	12 (92.3)	
A couple of hours after the end of surgery	3 (18.8)	11 (33.3)	18 (20.7)	4 (18.2)	1 (7.7)	
<b>The options you stated above indicate your current practice. Would you prefer another conduct if you could use other resources/drugs?</b>						
No, I am free to work as I prefer	9 (56.3)	25 (75.8)	61 (70.1)	17 (77.3)	9 (69.2)	0.412
Yes, but they are not available at the hospital(s) I work	2 (12.5)	4 (12.1)	9 (10.3)	1 (4.5)	1 (7.7)	
Yes, but they are not financed by health insurance providers	2 (12.5)	1 (3)	4 (4.6)	4 (18.2)	2 (15.4)	
Yes, but the device is not available where I work	0 (0)	1 (3)	2 (2.3)	0 (0)	0 (0)	
Yes, but the cost would prevent its use by my patients	3 (18.8)	2 (6.1)	11 (12.6)	0 (0)	1 (7.7)	
<b>Do you stratify your thromboprophylaxis method for knee replacement or do you use the same routine regimen for all patients?</b>						
I stratify it	4 (14.8)	14 (31.8)	47 (35.9)	10 (41.7)	7 (41.2)	0.173
I use the same method for all patients	23 (85.2)	30 (68.2)	84 (64.1)	14 (58.3)	10 (58.8)	
<b>Do you follow any guideline regarding a thromboprophylaxis method?</b>						
No	11 (40.7)	17 (38.6)	43 (32.8)	8 (33.3)	9 (52.9)	0.397
Yes, 2011 American Academy of Orthopaedic Surgeons (AAOS)	6 (22.2)	9 (20.5)	18 (13.7)	2 (8.3)	3 (17.6)	
Yes, 2012 American College of Chest Physicians (ACCP)	0 (0)	1 (2.3)	6 (4.6)	2 (8.3)	1 (5.9)	
Yes, the guidelines from the hospital I work	10 (37)	17 (38.6)	59 (45)	12 (50)	4 (23.5)	
Yes, 2019 National Institute for Health and Care Excellence (NICE)	0 (0)	0 (0)	5 (3.8)	0 (0)	0 (0)	

Likelihood-ratio test.

than the 2% observed in our research. None of the orthopedists who claimed to operate predominantly on SUS patients prescribes aspirin. Perhaps, the fear of possible medical and legal implications, mentioned by some in the optional final comments section, explains the low use, although several studies support it;<sup>14-18</sup> in addition, aspirin is accepted as pharmacological prophylaxis by the main guidelines in the world.<sup>1,2,9</sup>

Early mobility is the most simple and cheap form of mechanical prophylaxis against thrombus formation.<sup>19</sup> Studies relating thromboembolism with walking after TKA reveal a significantly lower incidence of thromboembolic

complications in patients walking within 24 hours in comparison with those starting to walk on the 2<sup>nd</sup> day.<sup>20,21</sup> Improved anesthetic techniques, especially with the advent of ultrasound-guided adductor canal block, facilitate early walk.<sup>22,23</sup> In total, 55% of the participants mentioned spinal anesthesia associated with this block, but even so, only 38% of them claimed that their patients resume walking within 24 hours postoperatively.

The main mechanical method used by the participants was the graduated compression stocking (GCM), cited by 82%. The literature, however, does not seem to agree on its effectiveness.<sup>3,4,24,25</sup>

**Table 5** Thromboprophylaxis techniques preferences and procedures from Brazilian knee surgeons for total knee replacement according to their surgical volume

Variable	Arthroplasties performed per month			p-value
	0 to 4	5 to 8	≥ 9	
<b>Which thromboprophylaxis type(s) do you use for total knee replacement?</b>				
Pharmacological alone	32 (22.9)	17 (23.3)	8 (26.7)	0.863
Mechanical alone	1 (0.7)	0 (0)	0 (0)	
Pharmacological + mechanical	107 (76.4)	56 (76.7)	22 (73.3)	
<b>When do you start the pharmacological thromboprophylaxis?</b>				
Before surgery	9 (6.5)	3 (4.1)	3 (10)	0.530
After surgery	130 (93.5)	70 (95.9)	27 (90)	
<b>Which drug do you use after surgery?</b>				
Acetylsalicylic acid	2 (1.4)	2 (2.7)	1 (3.3)	0.783
Apixaban	1 (0.7)	2 (2.7)	0 (0)	
Dabigatran	2 (1.4)	1 (1.4)	1 (3.3)	
Enoxaparin	123 (88.5)	63 (86.3)	25 (83.3)	
Rivaroxaban	11 (7.9)	4 (5.5)	3 (10)	
Another drug	0 (0)	1 (1.4)	0 (0)	
<b>How long after surgery is the first dose administered?</b>				
Up to 2 hours	10 (7.2)	4 (5.5)	2 (6.7)	0.119
3 to 6 hours	39 (28.1)	32 (43.8)	15 (50)	
7 to 11 hours	17 (12.2)	12 (16.4)	5 (16.7)	
12 hours	59 (42.4)	21 (28.8)	6 (20)	
≥ 24 hours	14 (10.1)	4 (5.5)	2 (6.7)	
<b>What is the frequency of administration of this drug during hospitalization?</b>				
Every 12 hours	4 (2.9)	3 (4.1)	1 (3.3)	0.896
Once a day	135 (97.1)	70 (95.9)	29 (96.7)	
<b>For how long the patient must take this drug during hospitalization?</b>				
1 day	1 (0.7)	1 (1.4)	1 (3.3)	0.623
2 days	15 (10.8)	10 (13.7)	4 (13.3)	
3 days	5 (3.6)	5 (6.8)	0 (0)	
Only while the patient cannot walk. When walking is resumed, I terminate the drug	1 (0.7)	1 (1.4)	0 (0)	
During the whole hospitalization period	117 (84.2)	56 (76.7)	25 (83.3)	
<b>The options you stated above indicate your current practice. Would you prefer another conduct if you could use other resources/drugs?</b>				
No, I am free to work as I prefer	104 (74.8)	61 (83.6)	24 (80)	0.286
Yes, but they are not available at the hospital(s) I work	15 (10.8)	8 (11)	4 (13.3)	
Yes, but they are not financed by health insurance providers	20 (14.4)	4 (5.5)	2 (6.7)	
<b>Do you prescribe the same drug used during hospitalization for home treatment after discharge?</b>				
No	94 (67.6)	43 (58.9)	16 (53.3)	0.225
Yes	45 (32.4)	30 (41.1)	14 (46.7)	
<b>Which new drug do you prescribe for home use?</b>				

Table 5 (Continued)

Variable	Arthroplasties performed per month			p-value
	0 to 4	5 to 8	≥ 9	
Acetylsalicylic acid	10 (10.6)	7 (16.3)	1 (6.3)	0.333
Apixaban	20 (21.3)	9 (20.9)	1 (6.3)	
Dabigatran	2 (2.1)	2 (4.7)	2 (12.5)	
Rivaroxaban	62 (66)	25 (58.1)	12 (75)	
<b>For how long the patient must use this drug at home?</b>				
1 week	2 (1.4)	2 (2.7)	0 (0)	0.094
10 days	36 (25.9)	22 (30.1)	10 (33.3)	
2 weeks	40 (28.8)	31 (42.5)	12 (40)	
3 weeks	30 (21.6)	8 (11)	2 (6.7)	
4 weeks	30 (21.6)	8 (11)	6 (20)	
> 4 weeks	1 (0.7)	2 (2.7)	0 (0)	
<b>The options you stated above indicate your current practice. Would you prefer another conduct if you could use other resources/drugs?</b>				
No, I am free to work as I prefer	114 (82)	63 (86.3)	26 (86.7)	0.648
Yes, but the administration route prevents its home use	5 (3.6)	3 (4.1)	2 (6.7)	
Yes, but the cost would prevent its use by my patients	20 (14.4)	7 (9.6)	2 (6.7)	
<b>Do you prescribe mechanical thromboprophylaxis after total knee replacement?</b>				
No	41 (29.5)	19 (26)	12 (40)	0.381
Yes	98 (70.5)	54 (74)	18 (60)	
<b>Graduated compression stockings</b>				
No	18 (18.2)	9 (16.7)	4 (22.2)	0.873
Yes	81 (81.8)	45 (83.3)	14 (77.8)	
<b>Continuous passive motion (CPM) device</b>				
No	84 (84.8)	46 (85.2)	16 (88.9)	0.898
Yes	15 (15.2)	8 (14.8)	2 (11.1)	
<b>Fixed pneumatic compression device</b>				
No	74 (74.7)	45 (83.3)	13 (72.2)	0.404
Yes	25 (25.3)	9 (16.7)	5 (27.8)	
<b>Portable pneumatic compression device</b>				
No	97 (98)	50 (92.6)	16 (88.9)	0.137
Yes	2 (2)	4 (7.4)	2 (11.1)	
<b>How do you use the device?</b>				
On the operated lower extremity alone	12 (12.1)	5 (9.3)	3 (16.7)	0.692
On both lower extremities	87 (87.9)	49 (90.7)	15 (83.3)	
<b>When do you start the mechanical thromboprophylaxis?</b>				
Before surgery	8 (8.1)	3 (5.6)	0 (0)	0.705
During surgery	9 (9.1)	7 (13)	2 (11.1)	
Immediately after the end of surgery	59 (59.6)	34 (63)	12 (66.7)	
A couple of hours after the end of surgery	23 (23.2)	10 (18.5)	4 (22.2)	

(Continued)

**Table 5** (Continued)

Variable	Arthroplasties performed per month			p-value
	0 to 4	5 to 8	≥ 9	
<b>The options you stated above indicate your current practice. Would you prefer another conduct if you could use other resources/drugs?</b>				
No, I am free to work as I prefer	69 (69.7)	36 (66.7)	16 (88.9)	0.528
Yes, but they are not available at the hospital(s) I work	8 (8.1)	8 (14.8)	1 (5.6)	
Yes, but they are not financed by health insurance providers	9 (9.1)	4 (7.4)	0 (0)	
Yes, but the device is not available where I work	2 (2)	1 (1.9)	0 (0)	
Yes, but the cost would prevent its use by my patients	11 (11.1)	5 (9.3)	1 (5.6)	
<b>Do you stratify your thromboprophylaxis method for knee replacement or do you use the same routine regimen for all patients?</b>				
I stratify it	44 (31.4)	29 (39.7)	9 (30)	0.434
I use the same method for all patients	96 (68.6)	44 (60.3)	21 (70)	
<b>Do you follow any guideline regarding a thromboprophylaxis method?</b>				
No	53 (37.9)	27 (37)	8 (26.7)	0.401
Yes, 2011 American Academy of Orthopaedic Surgeons (AAOS)	17 (12.1)	15 (20.5)	6 (20)	
Yes, 2012 American College of Chest Physicians (ACCP)	4 (2.9)	3 (4.1)	3 (10)	
Yes, the guidelines from the hospital I work	62 (44.3)	27 (37)	13 (43.3)	
Yes, 2019 National Institute for Health and Care Excellence (NICE)	4 (2.9)	1 (1.4)	0 (0)	

Likelihood-ratio test.

**Table 6** Thromboprophylaxis techniques preferences and procedures from Brazilian knee surgeons for total knee replacement according to the origin of the patient

Variable	Which are your main knee replacement patients?			p-value
	Private Insurance	Brazilian Universal Healthcare System (SUS)	Same volume SUS/ Private Insurance	
<b>Which thromboprophylaxis type(s) do you use for total knee replacement?</b>				
Pharmacological alone	37 (22.3)	10 (30.3)	10 (22.7)	0.793
Mechanical alone	1 (0.6)	0 (0)	0 (0)	
Pharmacological + mechanical	128 (77.1)	23 (69.7)	34 (77.3)	
<b>When do you start the pharmacological thromboprophylaxis?</b>				
Before surgery	9 (5.5)	1 (3)	5 (11.4)	0.286
After surgery	156 (94.5)	32 (97)	39 (88.6)	
<b>Which drug do you use after surgery?</b>				
Acetylsalicylic acid	1 (0.6)	1 (3)	3 (6.8)	0.072
Apixaban	1 (0.6)	0 (0)	2 (4.5)	
Dabigatran	1 (0.6)	1 (3)	2 (4.5)	
Enoxaparin	150 (90.9)	28 (84.8)	33 (75)	



Table 6 (Continued)

Variable	Which are your main knee replacement patients?			p-value
	Private Insurance	Brazilian Universal Healthcare System (SUS)	Same volume SUS/Private Insurance	
Rivaroxaban	12 (7.3)	3 (9.1)	3 (6.8)	
Another drug	0 (0)	0 (0)	1 (2.3)	
<b>How long after surgery is the first dose administered?</b>				
Up to 2 hours	12 (7.3)	1 (3)	3 (6.8)	0.104
3 to 6 hours	62 (37.6)	11 (33.3)	13 (29.5)	
7 to 11 hours	23 (13.9)	1 (3)	10 (22.7)	
12 hours	53 (32.1)	16 (48.5)	17 (38.6)	
≥ 24 hours	15 (9.1)	4 (12.1)	1 (2.3)	
<b>What is the frequency of administration of this drug during hospitalization?</b>				
Every 12 hours	3 (1.8)	2 (6.1)	3 (6.8)	0.192
Once a day	162 (98.2)	31 (93.9)	41 (93.2)	
<b>For how long the patient must take this drug during hospitalization?</b>				
1 day	3 (1.8)	0 (0)	0 (0)	0.041
2 days	14 (8.5)	7 (21.2)	8 (18.2)	
3 days	9 (5.5)	0 (0)	1 (2.3)	
Only while the patient cannot walk. When walking is resumed, I terminate the drug	0 (0)	1 (3)	1 (2.3)	
During the whole hospitalization period	139 (84.2)	25 (75.8)	34 (77.3)	
<b>The options you stated above indicate your current practice. Would you prefer another conduct if you could use other resources/drugs?</b>				
No, I am free to work as I prefer	130 (78.8)	24 (72.7)	35 (79.5)	0.778
Yes, but they are not available at the hospital(s) I work	17 (10.3)	6 (18.2)	4 (9.1)	
Yes, but they are not financed by health insurance providers	18 (10.9)	3 (9.1)	5 (11.4)	
<b>Do you prescribe the same drug used during hospitalization for home treatment after discharge?</b>				
No	112 (67.9)	18 (54.5)	23 (52.3)	0.090
Yes	53 (32.1)	15 (45.5)	21 (47.7)	
<b>Which new drug do you prescribe for home use?</b>				
Acetylsalicylic acid	13 (11.6)	0 (0)	5 (21.7)	0.109
Apixaban	21 (18.8)	4 (22.2)	5 (21.7)	
Dabigatran	6 (5.4)	0 (0)	0 (0)	
Rivaroxaban	72 (64.3)	14 (77.8)	13 (56.5)	
<b>For how long the patient must use this drug at home?</b>				
1 week	3 (1.8)	0 (0)	1 (2.3)	0.482
10 days	49 (29.7)	8 (24.2)	11 (25)	
2 weeks	50 (30.3)	16 (48.5)	17 (38.6)	
3 weeks	31 (18.8)	2 (6.1)	7 (15.9)	
4 weeks	30 (18.2)	6 (18.2)	8 (18.2)	
> 4 weeks	2 (1.2)	1 (3)	0 (0)	

(Continued)

**Table 6** (Continued)

Variable	Which are your main knee replacement patients?			p-value
	Private Insurance	Brazilian Universal Healthcare System (SUS)	Same volume SUS/ Private Insurance	
<b>The options you stated above indicate your current practice. Would you prefer another conduct if you could use other resources/drugs?</b>				
No, I am free to work as I prefer	142 (86.1)	24 (72.7)	37 (84.1)	0.319
Yes, but the administration route prevents its home use	7 (4.2)	1 (3)	2 (4.5)	
Yes, but the cost would prevent its use by my patients	16 (9.7)	8 (24.2)	5 (11.4)	
<b>Do you prescribe mechanical thromboprophylaxis after total knee replacement?</b>				
No	46 (27.9)	12 (36.4)	14 (31.8)	0.596
Yes	119 (72.1)	21 (63.6)	30 (68.2)	
<b>Graduated compression stockings</b>				
No	22 (18.3)	2 (9.5)	7 (23.3)	0.419
Yes	98 (81.7)	19 (90.5)	23 (76.7)	
<b>Continuous passive motion (CPM) device</b>				
No	99 (82.5)	21 (100)	26 (86.7)	0.024
Yes	21 (17.5)	0 (0)	4 (13.3)	
<b>Fixed pneumatic compression device</b>				
No	90 (75)	17 (81)	25 (83.3)	0.552
Yes	30 (25)	4 (19)	5 (16.7)	
<b>Portable pneumatic compression device</b>				
No	115 (95.8)	20 (95.2)	28 (93.3)	0.857
Yes	5 (4.2)	1 (4.8)	2 (6.7)	
<b>How do you use the device?</b>				
On the operated lower extremity alone	15 (12.5)	3 (14.3)	2 (6.7)	0.590
On both lower extremities	105 (87.5)	18 (85.7)	28 (93.3)	
<b>When do you start the mechanical thromboprophylaxis?</b>				
Before surgery	9 (7.5)	2 (9.5)	0 (0)	0.235
During surgery	10 (8.3)	3 (14.3)	5 (16.7)	
Immediately after the end of surgery	73 (60.8)	11 (52.4)	21 (70)	
A couple of hours after the end of surgery	28 (23.3)	5 (23.8)	4 (13.3)	
<b>The options you stated above indicate your current practice. Would you prefer another conduct if you could use other resources/drugs?</b>				
No, I am free to work as I prefer	92 (76.7)	10 (47.6)	19 (63.3)	0.008
Yes, but they are not available at the hospital(s) I work	10 (8.3)	2 (9.5)	5 (16.7)	
Yes, but they are not financed by health insurance providers	11 (9.2)	1 (4.8)	1 (3.3)	
Yes, but the device is not available where I work	2 (1.7)	1 (4.8)	0 (0)	
Yes, but the cost would prevent its use by my patients	5 (4.2)	7 (33.3)	5 (16.7)	

**Table 6** (Continued)

Variable	Which are your main knee replacement patients?			p-value
	Private Insurance	Brazilian Universal Healthcare System (SUS)	Same volume SUS/Private Insurance	
<b>Do you stratify your thromboprophylaxis method for knee replacement or do you use the same routine regimen for all patients?</b>				
I stratify it	60 (36.1)	7 (21.2)	15 (34.1)	0.231
I use the same method for all patients	106 (63.9)	26 (78.8)	29 (65.9)	
<b>Do you follow any guideline regarding a thromboprophylaxis method?</b>				
No	57 (34.3)	12 (36.4)	19 (43.2)	0.126
Yes, 2011 American Academy of Orthopaedic Surgeons (AAOS)	24 (14.5)	6 (18.2)	8 (18.2)	
Yes, 2012 American College of Chest Physicians (ACCP)	3 (1.8)	3 (9.1)	4 (9.1)	
Yes, the guidelines from the hospital I work	78 (47)	12 (36.4)	12 (27.3)	
Yes, 2019 National Institute for Health and Care Excellence (NICE)	4 (2.4)	0 (0)	1 (2.3)	

Likelihood-ratio test.

The ACCP and the AAOS recommend only intermittent pneumatic compression devices (IPCD) for mechanical prophylaxis.<sup>1,2</sup> The ACCP recommends a portable device (which allows walking) for at least 18 hours a day.<sup>1</sup> However, only 5% of the participants recommended this device, and only 2 of them prescribed its use for > 18 hours per day. Although it is the mechanical thromboprophylaxis device most recommended in the literature, the limited availability of these portable devices in Brazil may partially explain its low use. In Australia, Mirkazemi et al.<sup>8</sup> reported a rate of portable IPCD use of 89.9%. Other guidelines also prefer them over graduated compressive stockings.<sup>3,4</sup> The NICE suggests anti-embolism stockings, but it does not specify which ones.<sup>9</sup> Mechanical prophylaxis was mostly prescribed by participants from the South region, especially fixed compression devices, which do not allow walking.

Approximately 15% of the participants used CPM devices, statistically less among younger orthopedists. A meta-analysis conducted by He et al.<sup>26</sup> revealed that these devices are not effective for TKA thromboprophylaxis.

Our study reflects the controversy observed in the literature on the relationship between tourniquet and thromboembolism in TKA. Among participants, there is no consensus if tourniquets increase the occurrence of VTE (52 versus 48%). However, 70% of them used it, even those considering it thrombogenic. Among those who did not believe that tourniquet increases VTE events, 95% used it. Overall, 82% routinely used a tourniquet, which is lower than the 93% rate observed in Australia.<sup>8</sup>

As for potential post-TKA complications, the participants were more concerned with infections than with thromboembolic phenomena. This is consistent with the study of

Mirkazemi et al.<sup>8</sup> Surgeons may believe that the risk of infection is greater because most thromboembolic events occur after hospital discharge and the incidence of fatal VTE is very low.

In recent years, a trend for thromboprophylaxis individualization has been observed.<sup>8,27,28</sup> In our research, a third of the participants reported this individualization, which is statistically more frequent among orthopedists with > 10 years of knee subspecialization. Further studies are required to confirm this trend.

Although 70% of the respondents said they were free to choose their method, more than half of those working predominantly in the SUS would like to use a different technique, but they do not do so mainly because of the cost. This fact reflects the lower financial availability in this setting. A study from a federal public teaching hospital in Brazil showed an adherence rate to outpatient thromboprophylaxis after TKA and total hip arthroplasty of 73%; however, it did not investigate the cost of the drug.<sup>29</sup>

The fact that 42% of the participants follow the guidelines of their hospitals may explain the wide range of thromboprophylaxis techniques cited here. In addition, 36% of the participants do not follow any guidelines, which is in line with a study by Carvalho Júnior et al.<sup>30</sup> These findings should motivate the development of national guidelines on the subject.

We emphasize that only SBCJ members participated in the present research. However, we know that other orthopedists, not SBCJ members, also perform TKA; including them could alter our findings. On the other hand, although we invited only SBCJ members to participate, we cannot assure that the practices and preferences they reported

reflect an official position of the society; the present research is about individual practices and preferences.

## Conclusions

A wide range of thromboprophylaxis preferences and practices exists for TKA. Most Brazilian surgeons combine pharmacological and mechanical methods, but they do it in several ways. Most knee surgeons either follow their hospital guidelines or none. Mechanical prophylaxis methods and the little use of aspirin are the points most diverging from guidelines and practices from other countries.

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### Conflict of Interests

The authors have no conflict of interests to declare.

## References

- Falck-Ytter Y, Francis CW, Johanson NA, et al. Prevention of VTE in orthopedic surgery patients: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. *Chest* 2012; 141(2, Suppl):e278S–e325S
- Jacobs JJ, Mont MA, Bozic KJ, et al. American Academy of Orthopaedic Surgeons clinical practice guideline on: preventing venous thromboembolic disease in patients undergoing elective hip and knee arthroplasty. *J Bone Joint Surg Am* 2012;94(08):746–747
- Anderson DR, Morgano GP, Bennett C, et al. American Society of Hematology 2019 guidelines for management of venous thromboembolism: prevention of venous thromboembolism in surgical hospitalized patients. *Blood Adv* 2019;3(23):3898–3944
- Samama CM, Afshari A; ESA VTE Guidelines Task Force. European guidelines on perioperative venous thromboembolism prophylaxis. *Eur J Anaesthesiol* 2018;35(02):73–76
- Eysenbach G. Improving the quality of Web surveys: the Checklist for Reporting Results of Internet E-Surveys (CHERRIES). *J Med Internet Res* 2004;6(03):e34
- Almeida RF, Queiroz AA, Belloti JC, Castro Filho JM, Cohen M, Navarro RD. Approach towards total knee arthroplasty in Brazil: cross-sectional study. *Sao Paulo Med J* 2009;127(04):190–197
- Erduran M, Akseki D, Araç S. Surgical practices in total knee arthroplasty in Turkey. *Acta Orthop Traumatol Turc* 2012;46(04):255–261
- Mirkazemi C, Berezniccki LR, Peterson GM. Comparing Australian orthopaedic surgeons' reported use of thromboprophylaxis following arthroplasty in 2012 and 2017. *BMC Musculoskelet Disord* 2019;20(01):57
- Excellence NifHaC. Venous thromboembolism in over 16s: reducing the risk of hospital-acquired deep vein thrombosis or pulmonary embolism. Updated August 2019. Accessed 2021 Aug 08, 2020 <https://www.nice.org.uk/guidance/ng89>
- Liu F, Chu X, Huang J, Tian K, Hua J, Tong P. Administration of enoxaparin 24 h after total knee arthroplasty: safer for bleeding and equally effective for deep venous thrombosis prevention. *Arch Orthop Trauma Surg* 2014;134(05):679–683
- Plante S, Belzile EL, Fréchet D, Lefebvre J. Analysis of contributing factors influencing thromboembolic events after total knee arthroplasty. *Can J Surg* 2017;60(01):30–36
- Runner RP, Gottschalk MB, Staley CA, Pour AE, Roberson JR. Utilization Patterns, Efficacy, and Complications of Venous Thromboembolism Prophylaxis Strategies in Primary Hip and Knee Arthroplasty as Reported by American Board of Orthopedic Surgery Part II Candidates. *J Arthroplasty* 2019;34(04):729–734
- Hunt LP, Ben-Shlomo Y, Whitehouse MR, Porter ML, Blom AW. The Main Cause of Death Following Primary Total Hip and Knee Replacement for Osteoarthritis: A Cohort Study of 26,766 Deaths Following 332,734 Hip Replacements and 29,802 Deaths Following 384,291 Knee Replacements. *J Bone Joint Surg Am* 2017;99(07):565–575
- Prevention of pulmonary embolism and deep vein thrombosis with low dose aspirin: Pulmonary Embolism Prevention (PEP) trial. *Lancet* 2000;355(9212):1295–1302
- Anderson DR, Dunbar M, Murnaghan J, et al. Aspirin or Rivaroxaban for VTE Prophylaxis after Hip or Knee Arthroplasty. *N Engl J Med* 2018;378(08):699–707
- Farey JE, An VVG, Sidhu V, Karunaratne S, Harris IA. Aspirin versus enoxaparin for the initial prevention of venous thromboembolism following elective arthroplasty of the hip or knee: A systematic review and meta-analysis. *Orthop Traumatol Surg Res* 2021; 107(01):102606
- Haykal T, Kheiri B, Zayed Y, et al. Aspirin for venous thromboembolism prophylaxis after hip or knee arthroplasty: An updated meta-analysis of randomized controlled trials. *J Orthop* 2019;16(04):312–319
- Matharu GS, Kunutsor SK, Judge A, Blom AW, Whitehouse MR. Clinical Effectiveness and Safety of Aspirin for Venous Thromboembolism Prophylaxis After Total Hip and Knee Replacement: A Systematic Review and Meta-analysis of Randomized Clinical Trials. *JAMA Intern Med* 2020;180(03):376–384
- Gali JC, Camargo DB. Thromboprophylaxis for Total Knee Arthroplasty. *Rev Bras Ortop* (Sao Paulo) 2019;54(01):1–5
- Chandrasekaran S, Ariaretnam SK, Tsung J, Dickson D. Early mobilization after total knee replacement reduces the incidence of deep venous thrombosis. *ANZ J Surg* 2009;79(7-8):526–529
- Pearse EO, Caldwell BF, Lockwood RJ, Hollard J. Early mobilisation after conventional knee replacement may reduce the risk of postoperative venous thromboembolism. *J Bone Joint Surg Br* 2007;89(03):316–322
- Elkassabany NM, Cai LF, Badiola I, et al. A prospective randomized open-label study of single injection versus continuous adductor canal block for postoperative analgesia after total knee arthroplasty. *Bone Joint J* 2019;101-B(03):340–347
- Li D, Tan Z, Kang P, Shen B, Pei F. Effects of multi-site infiltration analgesia on pain management and early rehabilitation compared with femoral nerve or adductor canal block for patients undergoing total knee arthroplasty: a prospective randomized controlled trial. *Int Orthop* 2017;41(01):75–83
- Shalhoub J, Lawton R, Hudson J, et al; GAPS trial investigators. Graduated compression stockings as adjuvant to pharmacothromboprophylaxis in elective surgical patients (GAPS study): randomised controlled trial. *BMJ* 2020;369:m1309
- Wang D, Bao F, Li Q, Teng Y, Li J. Semiautomatic intermittent pneumatic compression device applied to deep vein thrombosis in major orthopedic surgery. *Biomed Eng Online* 2018;17(01):78
- He ML, Xiao ZM, Lei M, Li TS, Wu H, Liao J. Continuous passive motion for preventing venous thromboembolism after total knee arthroplasty. *Cochrane Database Syst Rev* 2014;(07):CD008207
- Kahn SR, Shivakumar S. What's new in VTE risk and prevention in orthopedic surgery. *Res Pract Thromb Haemost* 2020;4(03):366–376

- 28 Parvizi J, Huang R, Rezapoor M, Bagheri B, Maltenfort MG. Individualized Risk Model for Venous Thromboembolism After Total Joint Arthroplasty. *J Arthroplasty* 2016;31(9, Suppl):180–186
- 29 Viana LMAT, Nogueira IAL, Fontenele AMM, Oliveira LP. Thromboembolism in Arthroplasty: Compliance to Prophylaxis. *Rev Bras Ortop (Sao Paulo)* 2021;56(05):647–655
- 30 Carvalho Júnior LH, Correa MA, Lima MR, Silvestre CB, Almeida VF, Temponi EF. Venous Thromboembolism Prevention Protocol: Experience of 2,000 Cases in Total Knee Arthroplasty. *Rev Bras Ortop (Sao Paulo)* 2020;55(04):426–431