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# Prophylaxis for preventing venous thromboembolism in knee arthroscopy and soft tissue reconstruction: consensus statements from an international panel of experts

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## Abstract

**Purpose** There is a lack of consensus regarding need for Venous Thrombo Embolism (VTE) prophylaxis following arthroscopic knee surgery and open soft tissue knee reconstruction. Clear cut guidelines like ones for trauma surgery and arthroplasty do not exist and the published literature is limited to case reports with a few society guidelines. Given this lack of consensus, we conducted a modified Delphi questionnaire of international experts to provide recommendations on this topic.

**Methods** The consensus statements were generated using an anonymised 3 round modified Delphi questionnaire, sent to an international panel of 38 knee surgeons, with an 80% agreement being set as the limit for consensus. The responses were analysed using descriptive statistics with measures like mode, median and box plots. Feedback was provided to all panelists based on responses from the previous rounds to help generate the consensus.

**Results** Six consensus statements were generated after the three rounds of Delphi. Patient factors, prolonged surgery duration and family history of thrombogenic events emerged as the main points to be taken into consideration for prophylaxis.

**Conclusion** It was established through this study, that there exists a select group of patients undergoing arthroscopic surgery that justify the usage of VTE prophylaxis. The expert responses to most of the questions in different scenarios favoured usage of VTE prophylaxis based on patient factors like advanced age, past history of VTE, smoking, oral contraceptive use etc.

**Level of evidence** Level V.

**Keywords** Knee arthroscopy · Knee soft tissue reconstruction · Venous thromboembolism · Deep venous thrombosis · VTE prophylaxis · Modified Delphi

## Introduction

Knee arthroscopy is one of most common orthopedic procedures performed globally [40]. While clear guidelines exist for prevention of venous thromboembolism (VTE) following arthroplasty and trauma procedures [1], similar guidelines are lacking with regards to VTE prevention following knee arthroscopy [18, 24, 42]. Evidence is limited to society guidelines [32] which are neither universally available nor widely recognized by the majority of treating surgeons. Additionally, available guidelines in many cases provide contradictory recommendations regarding the appropriate use of VTE prophylaxis. [2]. Available literature on thromboembolic complications following knee arthroscopy is primarily case report level data [9, 15, 18, 24, 30, 31, 38]. Recent literature provides higher levels of evidence in the form of randomized controlled trials [4, 20, 41, 43, 44];

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Despite this, no clear recommendations have come out from these publications. Another set of published literature challenged traditionally held beliefs of low incidence of VTE following knee arthroscopy. A high incidence of between 9.9 and 14.9% was reported using interventional modalities like venography and Doppler scan [18, 35], though it was also noted that the incidence of symptomatic VTE remains low. This has contrasted with the traditional view that VTE following knee arthroscopy is too low to receive any prophylactic attention [8, 10, 14, 23, 25, 26, 29, 36, 42].

Given a lack of consensus on the appropriate use and indications of VTE prophylaxis in knee arthroscopy and soft tissue reconstruction, we conducted a modified Delphi questionnaire of international experts to provide recommendations on this topic.

## Materials and methods

### Consensus participants

Forty orthopedic surgeons with experience in knee arthroscopy from across the globe (USA, UK, Australia, Belgium, France, Poland, Malaysia, Thailand, Hong Kong, Indonesia, Japan, New Zealand, UAE, Saudi Arabia and India) were invited to join the initiative. Of the 40 invited, 38 agreed to participate in the study. Out of these 38, 2 panelists dropped out after the first two rounds and hence were excluded from the study. Panelists were selected based on their merit and reputation, given their immense contribution to various aspects of knee arthroscopy. Their contribution in peer reviewed literature and contributions to training and enhancing the science and craft of arthroscopy was considered before approaching each author.

### Delphi technique

Delphi works primarily by allowing the individual panelist to change their opinion by seeing the anonymized responses of other panelists [21]. The biggest advantage of Delphi is the ability to contact a large number of subject experts without topographical restrictions, particularly in the present pandemic, over email and electronic forms. Consensus is statistically quantified using median and interquartile ranges [19]. The 'nominal group technique', the other consensus alternative, consists of a more structured interview with a fewer number of people [11, 13, 18, 21, 27] over two rounds, who meet physically. The panelists are exposed to bias and due to the current pandemic with its travel restrictions, doing a nominal group technique is not feasible [19].

The Delphi panel approach in our study was conducted over three rounds (round 1, extended round 1 and round 2). The fundamental tenets of the Delphi methodology, namely anonymity, controlled feedback and statistical response to key questions were respected [17, 21, 27]. Questions for each round were framed after discussion between the members of the steering committee led by the president and composed of five other senior board members of a recognized knee society who met at regular intervals to develop this initiative. Previously published literature in the field of VTE in knee arthroscopy and open soft tissue reconstruction was used to formulate the list of questions which aimed to cover common clinical scenarios that a knee surgeon performing arthroscopy and open soft tissue reconstruction would be likely to encounter in clinical practice. The first round consisted of 17 questions made on Google Forms (Appendix 1). The first six questions established the basic group demographics and level of experience in knee surgery. The next eight questions were Likert type on a five-point Likert scale (strongly agree-strongly disagree) covering a broad range of facets of VTE prophylaxis in knee arthroscopy. The last three questions quizzed the panel preferences for VTE prophylaxis. Each of these eight Likert questions and the last three questions had the provision for comments, in order to incorporate the rich feedback of panel members for subsequent rounds.

All 17 questions were mandatory to answer, with only the comments for the 11 questions being optional. Osteotomies around the knee were excluded and the questionnaire was limited to scenarios in knee arthroscopy and open soft tissue reconstruction. Consensus levels were set at 80% in concordance with earlier published literature [6, 11, 13, 34]. Forms were sent individually to all panel members to ensure anonymity by email.

All 38 chosen panel members completed the round 1 form. The response of round 1 was analyzed using mode and median, for each of the eight Likert questions and mode only (percentage distribution) for the rest. Box plots were created to show the spread of data (Figs. 1 and 2 showing box plots). All our panelists were provided with simple instructions on how to read and interpret a box plot (Appendix 2). The extended first round consisted of three additional Likert style response questions based upon discussions within the steering group and three questions rephrased from the first round based on panel member feedback, which were agreed upon by the steering committee (Appendix 3). The three Likert questions had possibility for comments. All six questions were compulsory with the comments being optional.

In the last round, an individualized questionnaire, consisting of questions that did not reach a consensus, were sent separately to each of the 36 panel members (Appendix 4), as 36 out of 38 panel members (94.7%) completed the extended first round questionnaire. The two panel members who could not answer the extended first round questionnaire were excluded from the study. Four statements achieved 80% consensus (percentage of panel members answering strongly

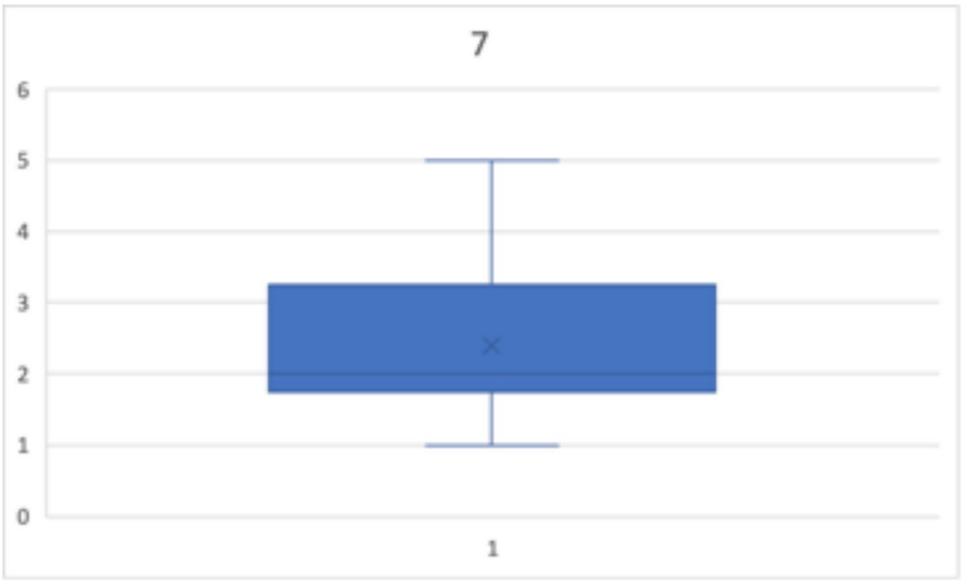


**Fig. 1** Box plot for question on the need for VTE prophylaxis for routine knee arthroscopy like menisectomy, loose body removal etc., showing the middle 50% responses in the blue box with the median (marked by x) skewed towards disagreement (no consensus could be obtained on this statement)

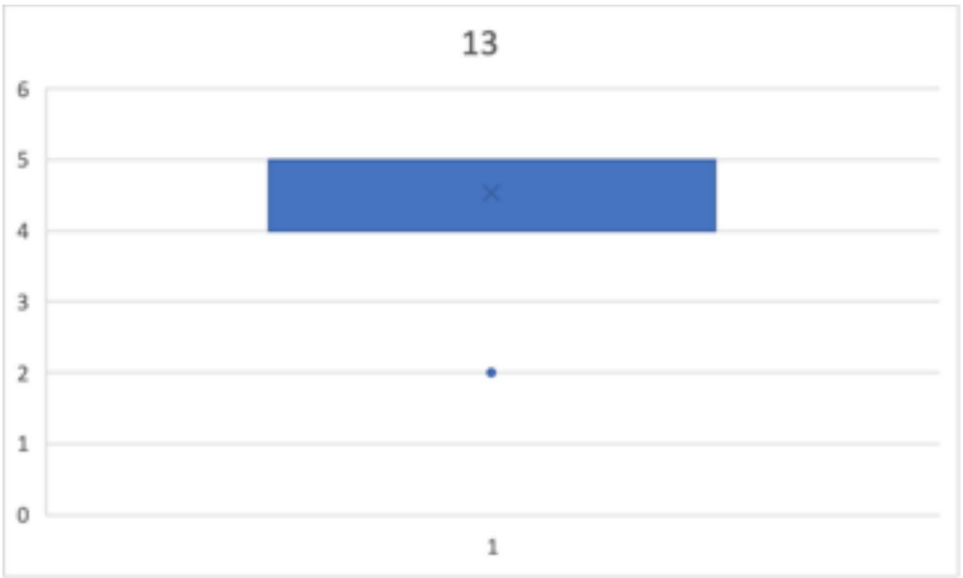


**Fig. 2** Box plot for the question on the need for VTE prophylaxis in the presence of a past history of VTE/ chronic venous insufficiency/ cancer which achieved consensus (the median marked by x is representing agreement) in the first round (note the one outlier represented by a dot)

agree/agree or disagree/strongly disagree depending on the question) after round 1 and extended round 1, and hence, were excluded from round 2.

Round 2 questions were individualized and prepared based on the majority response of the group in the earlier two rounds. For any given question, the set of Likert responses (strongly agree/agree) and (disagree/strongly disagree) that had more than 50% concurrence with the group was chosen as the majority response. The panelists who were not in concurrence for that question were identified based on their responses and were selected in a bid to achieve consensus. There was only one question (on VTE prophylaxis after single ligament reconstruction) that failed to achieve 50% response in either of the two categories (strongly agree/agree) and (disagree/strongly disagree). This question was sent to each of the 36 panel members in round 2. The structure of round 2 involved presenting the panelist with an infographic of panel responses, a short summary of the data and previous responses along with panel comments and a reminder of their initial response. The panel members were asked if they would like to reconsider their initial response based on the group response. In case they did not want to, they were requested to mark the same response that they had marked initially. The responses of this round were added to the previous two rounds' consensus percentages and subjected to statistical analyses.

### Statistical analysis

Descriptive statistics were used to present the characteristics of the respondents, as well as the response rate of the panelists. Categorical responses were converted to numerical values to present medians and measures of spread of responses for interpretation. Microsoft Excel™ was used for calculating medians as per the Tukey method for an even number of responses and the same software was used to generate box plots for graphic visualization of the collective group response. The mode was automatically generated by Google Forms™ for each question.

## Results

### Practice demographics

Asia and Australia (63.2%) was where the majority of the panel members practice, with the remaining 26.3% from North America and 10.5% from Europe including the UK (United Kingdom). The panel is experienced, with the majority (55.3%) performing more than 200 knee arthroscopies a year, and a relatively equal split in percentages of surgeons performing more than 100, 100–150 and 151–200 procedures per year (15.8%, 15.8% and 13.2%, respectively). The same trend is reflected in the number of years of independent practice. 55.3% of the panel members have been in independent practice for more than 20 years with the remaining 34.2% in practice for 10–20 years and the remaining 10.5% for 5–10 years.

### Surgical profile

Simple knee procedures like menisectomy, synovial biopsy, loose body removal, etc. comprised more than 20% practice of 44.7% of panel members, whereas it constituted 10–20% for 31.6% and less than 10% for the remaining 23.7% panel members. A predominantly male patient inflow in their practices was found in 28.9% of the panel, while gender parity was the trend with 68.4% of the panel and a single panel member had a female patient predominant inflow in his practice. 65.8% of panel members reported having experienced VTE in their patients after knee arthroscopy during their practice.

#### Consensus statements after round 1 and extended round 1 (Fig. 3)

- VTE prophylaxis should be based on patient factors (86.8%).
- Previous history of VTE, certain medications like hormones, cancer and chronic venous insufficiency are risk factors, for which prophylaxis should be considered (97.3%).
- Long surgery (> 1.5 h) with increased tourniquet duration as well as long pre/post-op immobilization are risk factors and prophylaxis should be considered (81.5%).
- Family history of VTE is an independent risk factor and prophylaxis should be considered (83.3%).

#### Consensus statements after round 2

- VTE prophylaxis to be given to patients with multi-ligament injured knee/ knee dislocations who are undergoing knee surgery (84.2%).
- VTE prophylaxis should be administered for patients older than 45, smokers or ones whose BMI is more than 30 $kg/m^2$, at the time of undergoing knee arthroscopy (89.4%).

#### Statements that could not reach consensus

- Role of VTE prophylaxis for simple knee procedures like meniscectomy, loose body removal, etc.: 78.9% of the panel members voted against giving prophylaxis, but it fell short of the 80% mark set for consensus.
- Role of VTE prophylaxis in procedures that restrict patient ambulation and weight bearing like meniscal repair or cartilage surgeries: 60.5% of the panel members voted in favor of giving prophylaxis.
- Role of giving VTE prophylaxis when performing surgery at high altitude or if the patient gives a history of past COVID-19 infection: for each of these questions, the panel members voted 69.4% and 66.6% in favor, respectively.
- The most segmented response was noted for the question on the need to give VTE prophylaxis for single ligament reconstructions like ACL reconstruction, PCL reconstruction or MPFL (Medial Patello-Femoral Ligament) reconstruction. Roughly, one-third of the panel voted in agreement and disagreement, with the last one-third maintaining a neutral stance (the exact percentages are 38.8%, 33.3% and 27.7%, respectively).

#### Trends in VTE prophylaxis

With regards to the preferred method of VTE prophylaxis following knee arthroscopy nearly half (47.2%) of the panel members responded to not utilizing any prophylaxis. The majority of the remaining responses favored simple methods like oral Aspirin (27.8%) and DVT (Deep Venous Thrombosis) pumps (13.9%), with only 8.3% preferring to use rivaroxaban (oral direct Thrombin inhibitors) and only a single panelist in favor of low-molecular weight heparin (subcutaneous LMWH) for thromboprophylaxis.

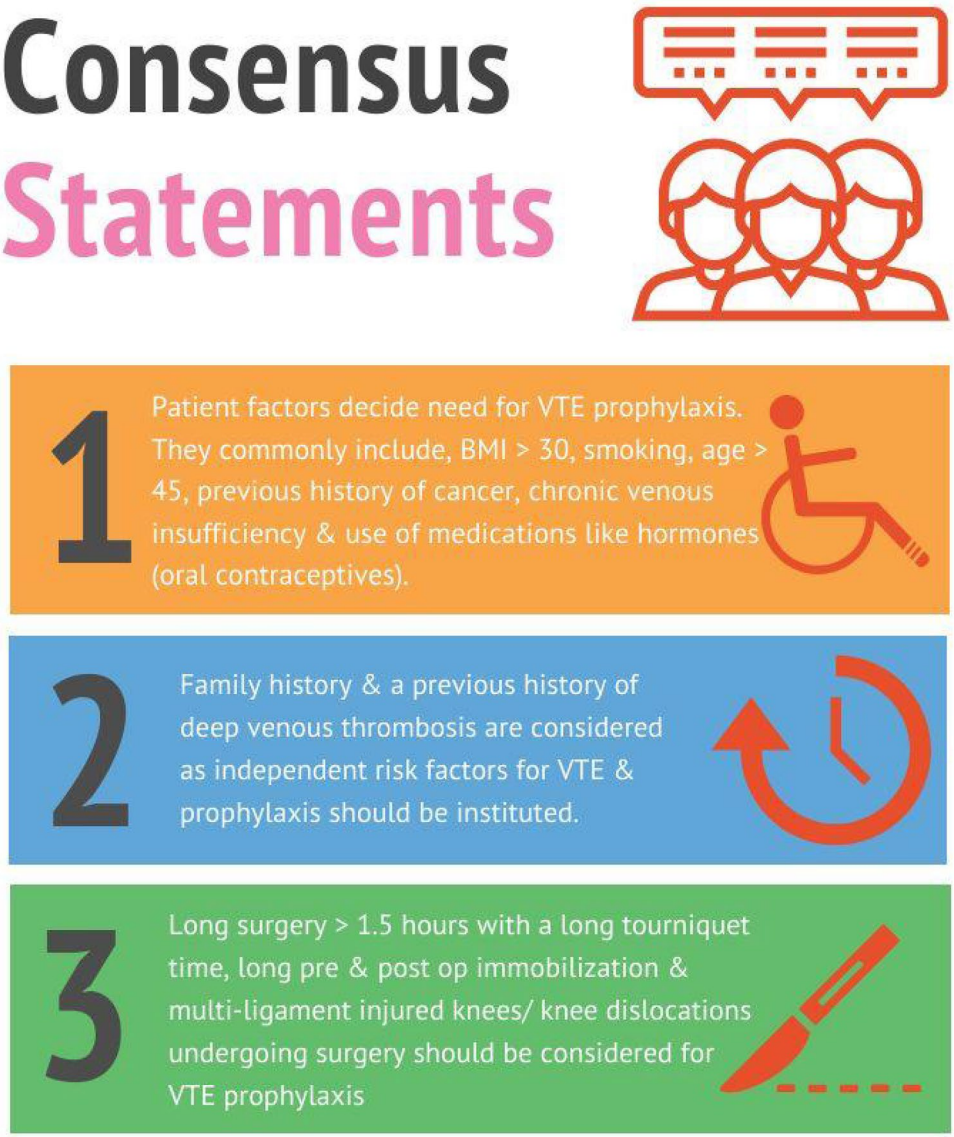


**Fig. 3** Graphic representation of the main consensus statements

The preferred duration of VTE prophylaxis also generated an equally split response with nearly one-third of the panel members (36.1%) excusing themselves saying that they do not administer VTE prophylaxis. Majority of the remaining panelists (27.8%) opted for a 2-week period of thromboprophylaxis. An equal number of panelists (13.9%) opted for 1 month or for the entire duration the patient is kept non-weight bearing. The remaining 8.3% opted to give VTE prophylaxis for the duration of hospital stay of the patient.

The majority (41.7%) of panelists responded as to the reasons for not administering VTE prophylaxis justification, including a lack of high-quality evidence or guidelines (19.4% voted separately for this), low incidence of VTE following knee arthroscopy (33.3% voted separately for this) and concern about bleeding (5.6% voted separately for this).

## Discussion

The most important finding of the present study was that individual patient factors need to be taken into account, while deciding to administer VTE prophylaxis after knee arthroscopy and soft tissue reconstruction. The study was able to achieve its purpose of generating consensus from an international group of experts in knee surgery on some of the common scenarios faced by the treating clinicians during knee arthroscopy and soft tissue reconstruction. The individual factors identified by the panel include, positive family history, previous history of thromboembolic events, chronic venous insufficiency, history of taking medications like hormonal preparations, past history or ongoing history of cancer, age more than 45 years, history of smoking and obesity (BMI more than 30).

Patient factors leading to VTE after knee arthroscopy have been well documented in the literature [23] with a myriad of factors like the lupus anticoagulant [36] and the oral contraceptive pill use [25, 37] associated with VTE. The thrombogenic events associated with the pill were further amplified by smoking and obesity [37]. Age more than 50 was also noted to be an independent risk factor [25, 26, 28]. The Swedish registry in a large database study only found age more than 40 to be a sole risk factor for VTE after knee arthroscopy [22]. A focused family history should be a part of DVT screening as it constitutes a definite risk factor [30]. Apart from these patient factors, certain factors directly or indirectly related to the surgeon or the surgery should also be taken into account. These include, increased surgical duration (lasting more than 90 min), use of tourniquet for the same duration either in parts or throughout (more than 90 min) and a prolonged period of pre- and post-op immobilization.

Increased surgical duration with a prolonged tourniquet time (> 60 min) was identified as an independent risk factor by the Italian intersociety consensus statement on VTE following knee arthroscopy [22]. The same society identified that confinement to bed for more than 3 days before or after the surgery places the patient at a higher risk for VTE [22], a statement endorsed by our panel of experts.

Among the statements that could not reach consensus, the need for routine VTE prophylaxis for simple knee arthroscopic surgeries like menisectomies met with a disagreement, a value just falling short of the consensus. It was the collective opinion of our panel that prophylaxis in this patient group is merited solely upon consideration of patient factors that put them at a risk for thrombogenic events. Surprisingly, the panel did not reach consensus for the role of operating at high altitudes (> 4000 ft.) in causing VTE, despite recent evidence for the same [5], with some studies quoting 3.8 times higher risks at high altitudes [39]. An editorial commentary even advocated the renaming of Virchow's triad (blood flow stasis, endothelial damage and hypercoagulability) into a Virchow's quartet including high altitude as the fourth factor [12].

Consensus could not be achieved for the need for VTE prophylaxis in the backdrop of COVID-19. The expert panel felt that given the uncertainty behind this new disease in the present pandemic, more research is required before making a recommendation in this regard. Consensus also could not be achieved for arguably the commonest knee arthroscopic surgery that is routinely performed, namely ACL reconstruction. There is published evidence that ACL reconstruction is associated with the maximum incidence of VTE following knee arthroscopy, followed closely by meniscal repair [33]. The panel could not reach consensus for meniscal repair as well, but through their comments indicated that VTE for single ligament reconstructions and meniscal repair is merited based solely upon patient factors.

With reference to the agent preferred for VTE prophylaxis, the majority of the panelists indicated their preference for simple agents like low-dose aspirin and mechanical prophylaxis using a DVT pump. Only a small percentage of the panel preferred injectable low-molecular weight heparin (LMWH) or the oral rivaroxaban. LMWH has contrasting published evidence in literature with studies in favor [4, 35] and against [16, 18]. The ERIKA trial has endorsed the safety of rivaroxaban for use in knee arthroscopy with a significant reduction in VTE, but failed to provide recommendations on whom to give this prophylaxis to [3, 4]. The expert panel's preference for aspirin in low doses and concerns about the bleeding complications of LMWH is seconded by the study of Reynolds et al. [33], who also reported a huge cost advantage for Aspirin using 445 as the number needed to treat (NNT) for preventing 1 VTE event. Treatment duration is another area where consensus is lacking both in the opinion of the panelists and the published literature. A time duration of 1 week was suggested by the Italian intersociety consensus group [32], whereas the large database (RIETE) study stressed on the need for further research into treatment duration due to concerns of long-term recurrence in some patients [40].

One limitation of the study lies in the way the panel members are selected. Delphi method does not lend itself to a very structured/ reproducible criteria-based panel selection both in terms of expertise and numbers, though it is broadly recommended that a diverse multidisciplinary panel be selected [7]. The lack of a multidisciplinary panel in the form of cardiologists or hematologists or vascular surgeons may be considered a limiting factor, however, to maintain subject expertise, they were not included in the panel. Additionally, while the consensus statements are not supported by level one evidence, they represent the current best evidence and expert opinion.

The consensus statements generated from this study will help clinicians to open their eyes to VTE prophylaxis following knee arthroscopy. We hope that these guidelines result in clear points of reference just like what exist for knee arthroplasty and trauma.

## Conclusions

This study established the lack of consensus amongst the arthroscopy surgeons regarding the use of VTE prophylaxis with knee arthroscopic procedures. While there was consensus on some of the issues, there was continued non-conformity on others. This study established and reiterated recommendations on tailored guidelines individualizing patient specific care. It was established that there are a select group

of patients undergoing arthroscopic surgery that justify VTE prophylaxis. The majority of surgeons preferred mechanical options and/or administration of oral low-dose Aspirin for varying lengths of time. Based on the responses obtained in this study, we conclude that the need for VTE prophylaxis should be patient and procedure specific. Furthermore, the modalities and duration of less aggressive options are just as effective as oral anticoagulants, with a reduced incidence of side effects.

**Supplementary Information** The online version contains supplementary material available at https://doi.org/10.1007/s00167-022-06973-w.

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**Author contributions** The first author RE prepared all the survey forms and wrote the manuscript which was proofread and approved by the second (MK), third (PS), fourth (AS) & fifth authors (MB), who also helped with selection of the panel members (author numbers 6–41). Author no 41 (AR) gave the idea behind the survey and proofread the manuscript. The statistical methods were facilitated by the second author (MK).

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## Declarations

**Conflict of interest** None.

**Ethical approval** Not required.

**Informed consent** Not required.

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