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ORIGINAL ARTICLE

Does the WHO Surgical Safety Checklist Need Modification for Orthopaedic Surgery Practices? A Cross-Sectional Survey Among Indian Orthopaedic Surgeons

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Abstract

Background It is well known that the implementation of the WHO surgical safety checklist (SSC) leads to improved operating room team coordination and reduced perioperative complication and mortality rates. Although it is proven to be beneficial worldwide, its awareness and usage need to be evaluated in a diverse country like India. As orthopaedic surgeries involve implants and tourniquet usage, it is important to evaluate the applicability of WHO SSC specifically to orthopaedic surgeries, and whether any modifications are needed.

Materials and Methods A web-based cross-sectional survey was conducted among Indian Orthopaedic Surgeons with a predefined questionnaire regarding awareness, usage and suggestions to modify the existing WHO SSC (2009) for orthopaedic surgeries.

Results 513 responses were included for final analysis. 90.3% of surgeons were aware of the surgical safety checklist; however, only 55.8% used it routinely in their practice. The awareness of SSC availability was 1.85 times more among younger surgeons (< 20 years of experience) than among those with > 20 years of experience. 17% of surgeons thought the usage of SSC was time-consuming and 52.4% of participants felt a need to modify the existing WHO SSC (2009) for orthopaedic surgeries. 34.5% recommended the inclusion of the patient blood group in the "Sign-in" section, 62.77% proposed the inclusion of details about the tourniquet, whereas only 6.63% suggested adding about surgical implant readiness in the "Time-out" section and 72.7% suggested including a check to make sure the tourniquet was deflated, removed and also recording of the total usage time during the "Sign-out" section.

Conclusion Despite high (90%) awareness among Indian Orthopaedic surgeons, they have limited usage of the WHO SSC in their practice. Identifying barriers and considering modifications for orthopaedic surgeries, like details about tourniquet usage during the "Time-out" section and a check to ensure it was removed during the "Sign-out" section, will improve patient safety and outcomes.

Keywords WHO · Surgical safety checklist · Orthopaedic surgery · Sign-in · Tourniquet

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Introduction

Since the launch of the "safe surgery saves life" programme by World Health Organisation (WHO) in 2007, there has been increased awareness and adherence to safe surgical practices globally. This initiation led to the development of the WHO surgical safety checklist (SSC), which got published in January 2009 [1]. This checklist aimed to improve coordination among surgeons, anaesthetists and nurses. This results in improved compliance with the standard of practice care leading to a significant reduction in complication (30%) and mortality rates [2]. Although it has proven beneficial, in a country as diverse as India, awareness and usage of this checklist need to be evaluated.

WHO SSC has three components, namely "Sign-in" before the induction of anaesthesia, "Time-out" before skin incision and "Sign-out" before the patient leaves the operating room with adherence to follow all three components being recommended. During the "Sign-in" component, the surgeon's presence is not mandatory and can be done by the anaesthetist and nurse alone. This checklist is a common standard for all surgical procedures in any operating room. However, there is a rider mentioned in the WHO SSC, "This checklist is not intended to be comprehensive. Additions and modifications to fit local practice are encouraged" [3].

Orthopaedic surgeries differ from other surgical departments like General Surgery, Gynaecology, Neurosurgery, Otorhinolaryngology, and Ophthalmology. Specifically, tourniquet use is routine to have a bloodless field and has significant potential for complications. Even though the latest pneumatic tourniquet systems have many safeguards [4], its addition to the WHO SSC will help reduce associated complications with tourniquet usage. Most orthopaedic surgeries are implant oriented; thus, supplementing the existing questionnaire "Are there any equipment issues or concerns?" in the "Time-out" component, with notings like "readiness of surgical implant," may be beneficial to reduce intraoperative hassles.

We conducted a questionnaire-based cross-sectional survey to obtain opinions from Indian orthopaedic surgeons, focusing specifically on the awareness and usage of the WHO SSC and whether there was any need for modifications for orthopaedic surgeries. Opinions were sought for additions/ changes in the WHO SSC in any of three or all the sections.

Materials and Methods

A web-based survey was conducted among Indian Orthopaedic surgeons using a questionnaire that was developed with google forms (Google LLC, California). The departmental review board approval was obtained for this study (Reference no. DRB/Ortho/2023/19). All the authors actively participated in formulating, evaluating, and verifying the questionnaire. The questionnaire contained multiple questions concerning the experience of the participants, demographic characteristics, subspecialty expertise, awareness, and usage of surgical safety checklists, whether there is any need for modification in the existing WHO SSC for orthopaedic surgeries and suggestions for modifications in all three parts (Sign-in, Time-out and Sign-out) separately. Various trial runs were conducted internally among our institute's residents and consultants (30 participants) to check the questions' understandability and reduce the ambiguity in the options provided. However, these details were wholly erased before collecting actual data.

The participants were Indian Orthopaedic surgeons who were members of IOA (Indian Orthopaedic Association) or surgeons known to be actively involved in orthopaedic surgeries (only authors have their personal information). A questionnaire link (https://forms.gle/m7GQWPiud7uajzqx8) was circulated through popular social media platforms (WhatsApp, Facebook Corp., CA, USA) from January 29, 2023 (Fig. 1). The aims of the study and its objectives were informed to the participants filling out the questionnaire. Informed consent was obtained from every participant, the confidentiality of the participant's information was ensured, and their responses were kept anonymous. The data was collected over two weeks, with three reminders sent out in between to complete the survey. Further, data collection ceased one week post the third reminder. All collected data were then exported to Microsoft Excel sheets.

Statistical Analysis

Descriptive statistics were reported as mean (SD) for continuous variables and frequencies (percentage) for categorical variables. Chi-square was used to find the association between categorical variables. The odds ratio was computed to find the strength of the association between risk factors and outcomes. Data were statistically evaluated with IBM SPSS Statistics for Windows, Version 26.0., IBM Corp., Chicago, IL.

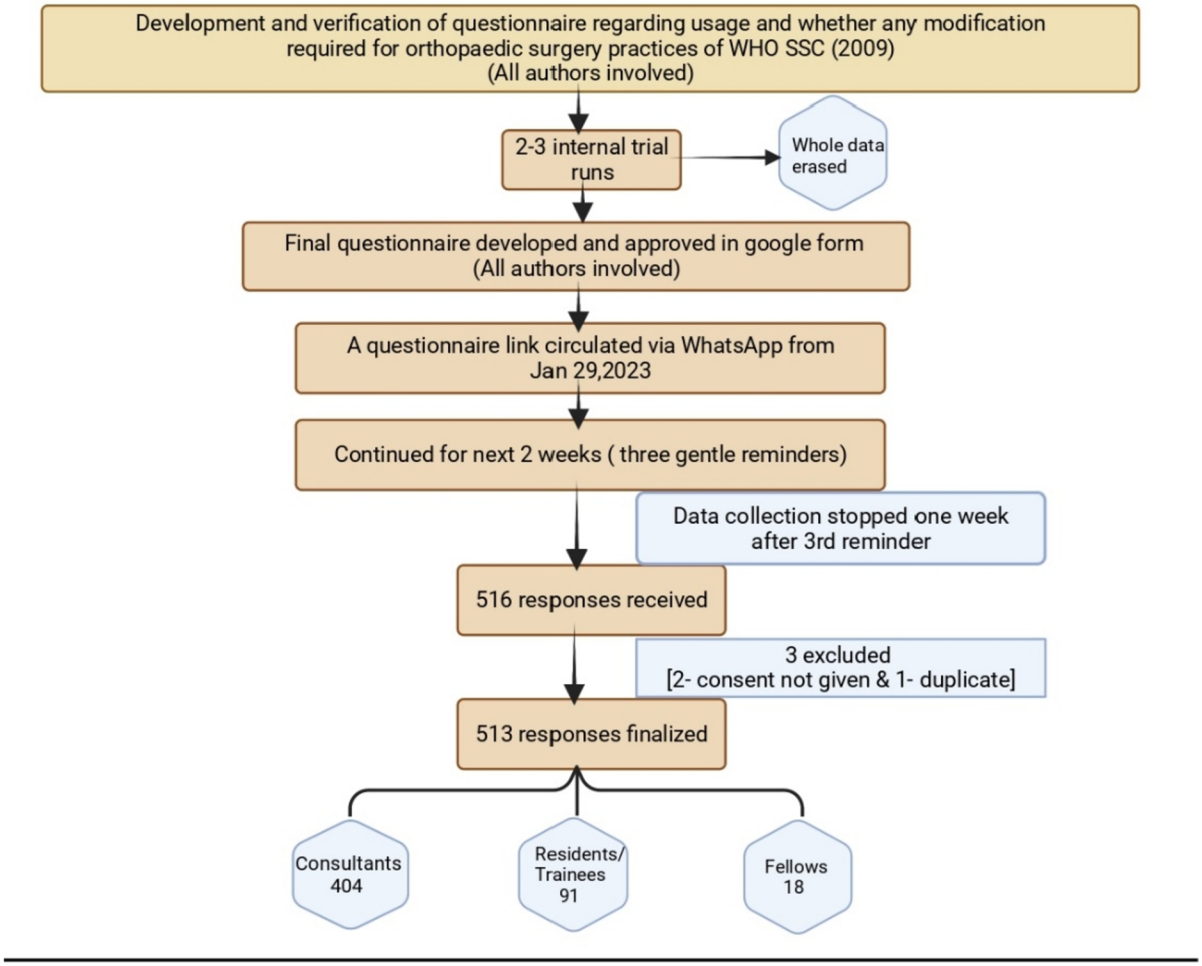


Fig. 1 Flow diagram showing methodology and data collection process

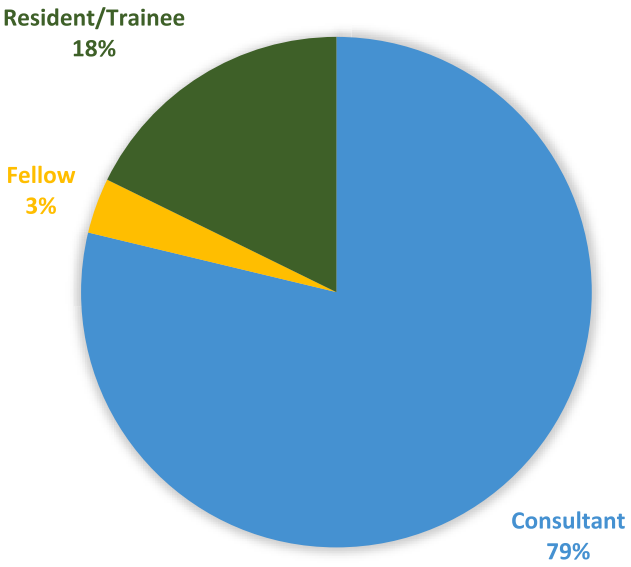


Fig. 2 Distribution of surgeon—seniority levels

Results

A total of 516 responses were collected through the Google response sheet. However, two persons declined to give their consent and one case was found to be a duplicate. Consequently, 513 cases were included in the final analysis.

Among 513 participants in the final analysis, 78.8% were consultants, 3.5% were fellows and 17.7% were residents (Fig. 2). 11.5% of total participants had an experience of less than 2 years, 16.6% had 2–5 years of experience, 15.2% had 6–10 years of experience, 27.3% had 11–20 years of experience and 29.4% had more than 20 years of experience. 12.9% of participants practiced in rural areas, and 87.1% were in urban areas. 46.5% of surgeons worked in a teaching institute (medical college), 25.3% in a private clinic, 20.8% in a corporate multispecialty hospital, 4.7% in a government non-teaching hospital and 2.7% in a trust hospital. 85.6% of the participants were doing trauma surgeries, followed by 54.9% also doing arthroplasty cases, 41.3% were doing arthroscopy and sports medicine, 21.4% were doing the spine, 15% were

Table 1 Distribution of demographic data among the study participants ($n=513$)

Variables	Frequency (n)	Percentage (%)
Level of training in orthopaedics		
Consultant	404	78.8
Fellow	18	3.5
Resident/trainee	91	17.7
Experience		
< 2 years	59	11.5
2–5 years	85	16.6
6–10 years	78	15.2
11–20 years	140	27.3
> 20 years	151	29.4
Region of practice		
Rural	66	12.9
Urban	447	87.1
Place of work		
	107	20.8
Corporate multispecialty hospital Government non-teaching hospital	24	4.7
Private clinic	130	25.3
Teaching institute (medical college)	238	46.5
Trust hospital	14	2.7
Surgical expertise		
Arthroplasty	282	54.9
Arthroscopy and sports medicine	212	41.3
Deformity corrections	70	13.6
Spine	110	21.4
Paediatric orthopaedics	77	15.0
Musculoskeletal oncology	21	4.09
Hand and microsurgery	43	8.38
Trauma	439	85.6

doing paediatric orthopaedics, 13.6% were doing deformity corrections, 8.38% were doing hand and microsurgery and 4.09% were practicing musculoskeletal oncology (Table 1).

Regarding obtaining consent before surgical procedures in their practice, 54.8% used to get general written consent for all surgeries, 43.85% used to get informed consent for a specific surgery and only 1.56% used to get video consent. About 90.3% of participants were aware of the surgical checklist availability, but only 55.8% used the WHO SSC in their practice routinely. 17% thought using the WHO SSC was time-consuming. 52.4% of participants felt there was a need to modify the existing WHO SSC (2009) for orthopaedic surgeries.

Out of three sections (Sign-in, Time-out and Sign-out) in the WHO SSC (2009), 53.2% follow all three sections, 8.4% follow only the "Sign-in" part, 11.9% follow only the "Time-out" section and 0.8% follow only "Sign-out" part. In about 50% of time, nurses initiate the 'Sign-in' part of the WHO SSC, followed by surgeons (15.8%) and anaesthetists (15.4%) (Table 2).

Regarding suggestions for modifications in WHO SSC, under the "Sign-in" section, 50.87% of the surgeons suggested including the patient's blood group and reservation of any blood products (Fig. 3). Under the section "Time-out," 62.8% of the surgeons suggested adding questions regarding tourniquet usage during surgery (Fig. 4). Under the section "Sign-out," the majority of the surgeons (72.7%) suggested the inclusion of the question "Whether the tourniquet was deflated and the cuff removed, also the total tourniquet usage time, if used" (Fig. 5). Over all suggested modifications illustrated in radar plot (Fig. 6).

Using checklists in various settings, such as medical colleges, corporate hospitals and private clinics, did not demonstrate any statistically significant difference ($p > 0.05$) between them. Similarly, the results of using checklists in both urban and rural settings showed no statistically significant differences ($p > 0.05$).

The awareness of SSC availability is 1.85 times more among surgeons with less than 20 years of experience than among surgeons with more than 20 years of experience. Younger surgeons (< 20 years of experience) use it 1.6 times more than surgeons with more than 20 years of experience. However, younger surgeons felt using WHO SSC is more time-consuming than senior surgeons with > 20 years of experience (Odds ratio (OR): 1.81) (Table 3).

Discussion

The implementation of the WHO SSC (2009) was aimed at reducing complication rates and patient mortality following surgeries. A growing body of research has indicated that the effective implementation of this checklist has indeed achieved its intended goal while simultaneously enhancing communication within the team [5–7]. The success of the checklist has led Braham et al. to propose an adaption of the same for use in medical procedures; upon implementation of which, a significant reduction in procedural complications was observed [8]. In the present study, a total of 513 responses were included for the final analysis, representing a diverse demographic of orthopaedic surgeons at different levels of training, work experience, location, and expertise. Our study showed a high awareness (90.3%) of the surgical checklist among orthopaedic surgeons; however, only 55.8% used it in their routine practice, highlighting the potential gap in implementing the checklist. It was found that surgeons with less than 20 years of experience were more (1.85 times) aware of the checklist than surgeons with more than 20 years of experience, suggesting an emphasis on continued medical education in senior surgeons to embrace newer advances for the safety and outcome of the patients. The previous studies

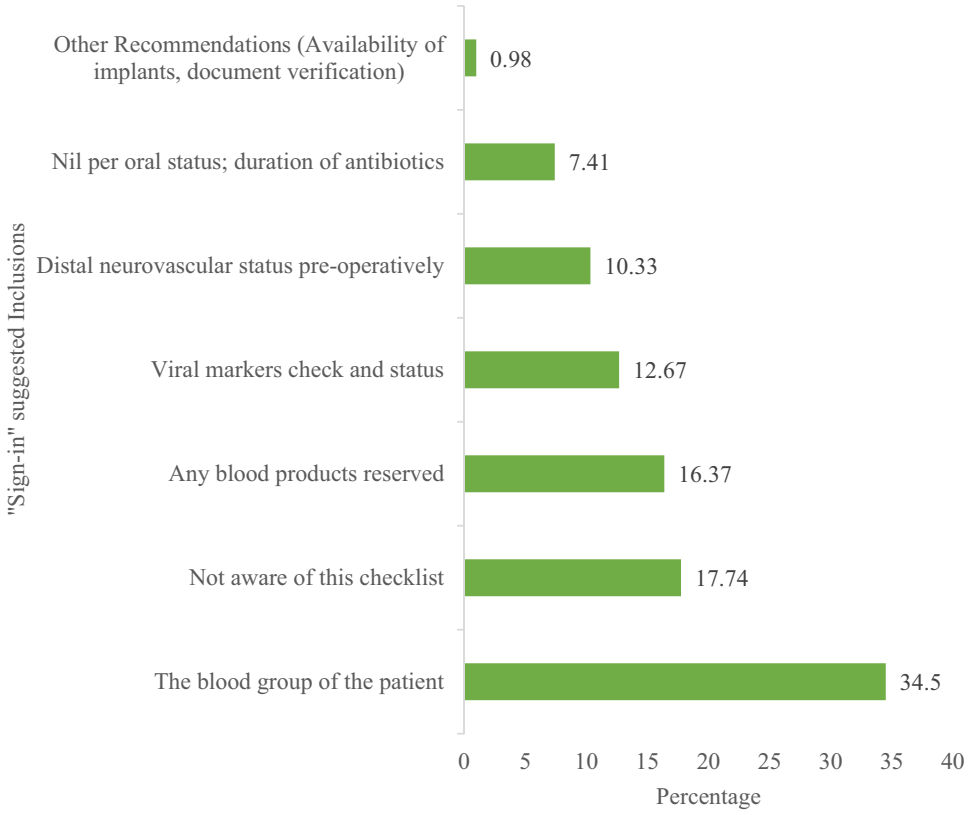
Table 2 Distribution of various questions asked related to the surgical safety checklist (SSC) among the study participants ($n=513$)

Variables	Frequency (n)	Percentage (%)
Type of consent obtained for surgery in their practice		
General written consent to all surgery	280	54.58
Informed consent to the specific surgery	225	43.85
Video consent	8	1.56
Awareness of surgical checklist availability		
Yes	463	90.3
No	50	9.7
Usage of WHO surgical safety checklist in practice		
Yes	287	55.8
Sometimes	103	20.0
No	123	24.1
Are you using WHO surgical safety checklist as it is?		
Yes	291	56.6
With some modifications	99	19.3
No	123	24.1
Whether usage of the WHO surgical safety checklist is time-consuming?		
Yes	87	17.0
No	302	58.9
Not sure	124	24.2
Is there any need for a separate, modified WHO surgical safety checklist (2009) for orthopaedic surgeries?		
Yes	269	52.4
No	125	24.4
I am not aware of it	119	23.2
Out of three sections (Sign-in, Time-out, Sign-out) in the WHO safety checklist 2009, which of the following does your team follows		
All three sections	273	53.2
Only Sign-in	43	8.4
Only Sign-out	4	0.8
Only Time-out	61	11.9
Any other combination	23	4.5
I am not aware of it	109	21.2
Who routinely initiates the 'Sign in' part of the WHO surgical safety checklist in your practice?		
Anaesthetist	79	15.4
Nurse	257	50.1
Surgeon/surgical resident	81	15.8
Not done/not aware of it	96	18.7

in the literature also mentioned that, although the checklist is proven to improve patient outcomes, certain barriers like lack of leadership, the impression that it is time-consuming or over burdens the paramedical staff, and lower applicability in emergency situations impede them from being utilised in everyday practices [9, 10].

Interestingly, 17% of participants in our study perceived the checklist usage to be time-consuming, further contributing to its underutilization and this was more among younger surgeons (less than 20 years of experience). In line with these observations, Tan et al. reported that 49.4% of the study participants disagreed that utilising the checklist was time-consuming [10].

Tang et al. suggested that implementing surgical checklists, when effective, can potentially improve patient outcomes [11]. Similarly, a randomised control trial by Haugen et al. determined that implementing the WHO surgical checklist improved complication rates and reduced hospital stay length [12]. Numerous other studies have also demonstrated improved patient outcomes using SSC and the need for further research, training, and adaptations to increase compliance [6, 9, 10, 13–17]. However, many barriers to the universal acceptance of the WHO SSC (2009) were found, namely hierarchy issues among operating room personnel, increased workload for paramedical staff, and the perception that the checklists have limited application in emergencies



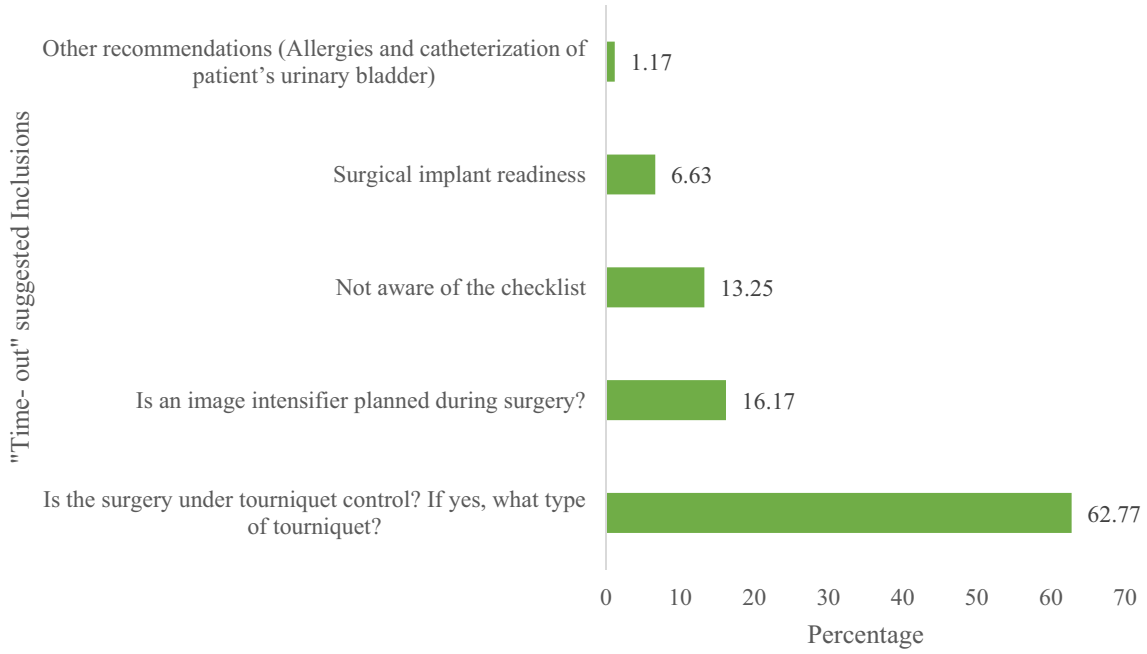


Fig. 3 Suggested modifications in "Sign-in" section of 2009 WHO SSC for orthopaedic surgeries

Fig. 4 Suggested modifications in "Time-out" section of 2009 WHO SSC for orthopaedic surgeries

[9, 10]. All of them point to the fact that the socio-cultural norms and organisational hierarchy are impeding factors, requiring changes to increase the adoption of the checklist to improve patient outcomes. To ensure better utilisation, the time at which the checklist is used can be optimised, as found by a longitudinal study by Tully et al., which states that compliance improved in orthopaedic surgeries when the "Sign-out" checklist was done immediately after wound

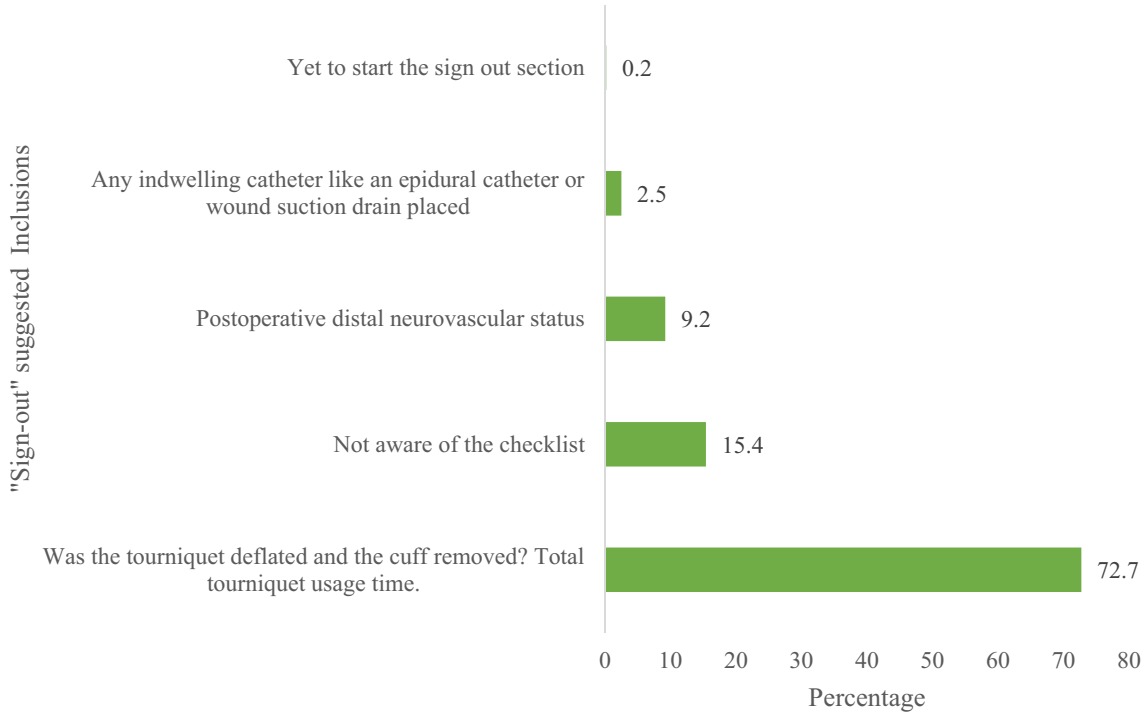


Fig. 5 Suggested modifications in "Sign-out" section of 2009 WHO SSC for orthopaedic surgeries

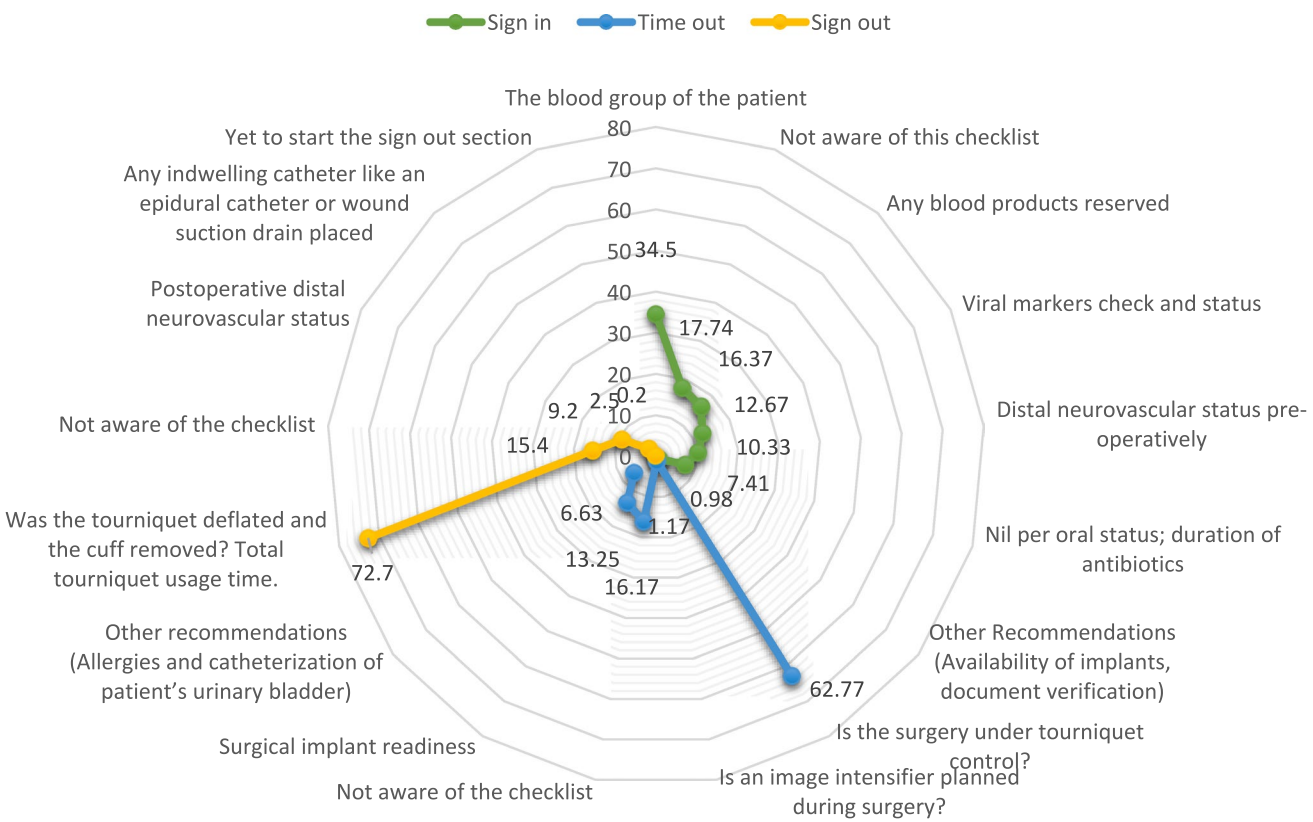


Fig. 6 Radar plot showing overall suggested modifications of 2009 WHO SSC for orthopaedic surgeries

Table 3 Association of various questions asked among participants with years of experience ($n=513$)

Variables	< 20 years ($n=362$)	> 20 years ($n=151$)	Chi-Square (*df*), *p*	Odds ratio (OR)	95% Confidence Interval*
Level of training in orthopaedics					
Consultant	253 (69.9)	151 (100)	57.74		
Fellow	18 (5)	0 (0)	(2)		
Resident/trainee	91 (25.1)	0 (0)	< 0.001	–	–
Region of practice					
Rural	49 (13.5)	17 (11.3)	0.493 (1)	1.23	0.68–2.22
Urban	313 (86.5)	134 (88.7)	0.48	1	
Place of work					
Corporate multispecialty hospital	65 (17.9)	42 (27.8)		1.16	0.37–3.58
Govt Non-teaching hospital	15 (4.14)	9 (5.96)	47.71	1.25	0.32–4.78
Private clinic	71 (19.61)	59 (39.07)	(4)	0.90	0.29–2.74
Teaching institute (medical college)	203 (56.07)	35 (23.18)	< 0.001	4.35	1.42–13.31*
Trust hospital	8 (2.21)	6 (3.97)		1	–
Type of consent					
General written consent to all surgery	200 (55.25)	80 (52.98)	13.19 (2)	17.50	2.11–144.53*
Informed consent to the specific surgery	161 (44.48)	64 (42.38)	0.001	17.69	2.12–146.01*
Video consent	1 (0.27)	7 (4.64)		1	–
Awareness of surgical checklist availability					
Yes	333 (92)	130 (86.1)	4.21 (1)	1.85	1.02–3.37*
No	29 (8)	21 (13.9)	0.04	1	–
Usage of the WHO surgical safety checklist in your practice					
Yes	206 (56.9)	81 (53.6)	1.76 (2)	1.32	0.83–2.07
Sometimes	75 (20.7)	28 (18.5)	0.42	1.39	0.78–2.46
No	81 (22.4)	42 (27.8)		1	–
Are you using WHO surgical safety checklist as it is?					
Yes	222 (61.3)	69 (45.7)	12.53 (2)	1.6	1.02–2.53*
With some modifications	54 (14.9)	39 (25.8)	0.002	0.69	0.39–1.20
No	86 (23.8)	43 (28.5)		1	–
Whether usage of the WHO surgical safety checklist is time-consuming?					
Yes	64 (17.7)	23 (15.2)	8.004	1.81	1.05–3.31*
No	223 (61.6)	79 (52.3)	(2)	1.84	1.18–2.87*
Not sure	75 (20.7)	49 (32.5)	0.02	1	–
Any need for a separate modified existing WHO surgical safety checklist (2009) for orthopaedic surgeries					
Yes	192 (53)	77 (51)	2.937 (2)	1.36	0.86–2.15
No	93 (25.7)	32 (21.2)	0.23	1.58	0.91–0.75
I am not aware of it	77 (21.3)	42 (27.8)		1	
Out of three sections (Sign-in, Time-out, Sign-out) in the WHO safety checklist 2009, which of the following does your team follows					
All three sections	190 (52.5)	83 (55)		1.13	0.71–1.82
Any other combination	19 (5.2)	4 (2.6)		2.34	0.74–7.39
Only Sign-in	29 (8)	14 (9.3)	6.22 (5)	1.02	0.48–2.17
Only Sign-out	2 (0.6)	2 (1.3)	0.29	0.49	0.06–3.64
Only Time-out	49 (13.5)	12 (7.9)		2.01	0.95–4.25
I am not aware of it	73 (20.2)	36 (23.8)		1	–
Who routinely initiates the 'Sign in' part of the WHO surgical safety checklist?					
Anaesthetist	56 (15.5)	23 (15.2)		1	0.52–1.93
Nurse	185 (51.1)	72 (47.7)	1.28 (3)	1.06	0.63–1.78
Surgeon/surgical resident	53 (14.6)	28 (12.5)	0.73	0.78	0.42–1.47
Not done/not aware of it	68 (16.8)	28 (12.5)		1	–

*Statistically significant

closure and before undraping the patient [18]. A Knowledge, Attitude and Practice (KAP) study on the use of the SSC in Brazilian surgeons by Filho et al. found that the awareness about the checklist among the surgeons was very low, and the rate of complications and errors was high [19]. However, the article by Sewell et al. found that education programmes among orthopaedic surgeons improved the adoption of the SSC [20].

The WHO SSC (2009) has been adopted by various departments, such as paediatric surgery department of Boston's Children's Hospital and Otorhinolaryngology, to better adapt to their surgical practices [21, 22]. Our study found that 52.4% of Indian participants believe there is a need to modify the WHO SSC (2009) and adapt it to the current trends in orthopaedics. Additionally, 53.2% of the participants also voted for changes in all three sections of the checklist which includes the "Sign-in," "Time-out" and "Sign-out" components. This finding is consistent with the review article by Sleimann et al., who found that though the WHO SSC is highly effective and reduces complications and death, it needs to be modified to include it in the field of orthopaedics [23].

Participants in our study were asked to provide suggestions for modifications to the checklist, and 34.5% recommended including the blood group of the patient in the "Sign-in" section, 62.77% proposed the inclusion of details about the tourniquet in the "Time-out" section and 72.7% suggested to include a check to make sure the tourniquet was deflated and recording of the time of usage in the "Sign-out" section. These suggestions would help make meaningful modifications to the checklist, potentially increasing the adoption of the same. Similar recommendations were reported by the study by Thomasson et al., which suggests that the current SSC does not account for orthopaedic equipment failures and that a modification to the checklist that includes a multi-disciplinary team to improve patient outcomes is in order in the context of orthopaedic surgeries [24]. Conversely, a study by Solsky et al. indicated that certain modifications they studied included items that did not enhance communication and omitted items from the WHO's Anticipated Critical Events section [25]. Therefore, it is imperative that the modification to the checklist needs to be carefully considered to ensure they effectively improve patient safety and team dynamics.

The improvement of the World Health Organisation (WHO) Surgical Safety Checklist in orthopaedic surgery hinges on several key factors. Educational programmes play a critical role in enhancing checklist use, leading to reduced complications and mortality, and positively influencing staff perceptions [20]. Addressing resistance and barriers to change requires a comprehensive understanding of routine tasks, emphasising the entire patient journey, including pre- and post-operative stages [26]. Compliance and attitudes towards the checklist are vital; practices like delaying surgical instruments until after the surgical time-out can ensure team focus and adherence [27]. Systematic analysis across surgical specialties shows that patient outcomes improve with high compliance, necessitating continuous feedback and monitoring to maintain effectiveness in changing clinical environments [28]. Adapting the checklist to local practices, such as incorporating nursing assertiveness and surgeon-led teamwork, as seen in a study in China, is crucial for enhancing efficacy [10]. Thus, optimising the WHO surgical safety checklist in orthopaedic surgery involves educational initiatives, overcoming resistance, strict adherence, continual evaluation and local customisation.

Limitations

The study design, being a survey, may have recall/responder bias and the evidence level is not the greatest. We circulated questionnaire links via WhatsApp, and the response rate was not the highest as in any other survey study design. There can be a non-responder bias, or those in busy practice might not find time to register their response. The number of participants in this survey is a small subset of the big organisation, IOA. Still, we have received responses from different regions of the country showing broad representation.

Conclusion

Our study emphasises that despite high (90%) awareness among Indian Orthopaedic surgeons, they have limited usage of the WHO SSC in their practice. Identifying barriers and considering modifications for orthopaedic surgeries, like details about tourniquet usage during the "Time-out" section and a check to ensure it was removed during the "Sign-out" section, will improve patient safety and outcomes.

Future Directions

Future research following this phase I study will focus on developing and validating an orthopaedic-specific surgical safety checklist, as well as the evaluation of its effectiveness in improving patient outcomes and reducing surgical complications. Additionally, exploring strategies to overcome barriers to checklist implementation and training programmes for surgical teams could further enhance the adoption and effectiveness of checklists in orthopaedic practice.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s43465-024-01096-5.

Declarations

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval This article does not contain any studies with human or animal subjects performed by the any of the authors.

Informed Consent For this type of study, informed consent is not required.

References

1. Haynes, A. B., Weiser, T. G., Berry, W. R., Lipsitz, S. R., Breizat, A.-H.S., Dellinger, E. P., et al. (2009). A surgical safety checklist to reduce morbidity and mortality in a global population. *The New England Journal of Medicine, 360*(5), 491–499. https://doi.org/10.1056/NEJMsa0810119
2. van Schoten, S. M., Kop, V., de Blok, C., Spreeuwenberg, P., Groenewegen, P. P., & Wagner, C. (2014). Compliance with a time-out procedure intended to prevent wrong surgery in hospitals: Results of a national patient safety programme in the Netherlands. *British Medical Journal Open, 4*(7), e005075. https://doi.org/10.1136/bmjopen-2014-005075
3. WHO Guidelines for Safe Surgery 2009: Safe Surgery Saves Lives. (2009). Geneva: World Health Organization.
4. Noordin, S., McEwen, J. A., Kragh, J. F., Eisen, A., & Masri, B. A. (2009). Surgical tourniquets in orthopaedics. *The Journal of Bone and Joint Surgery American Volume, 91*(12), 2958–2967. https://doi.org/10.2106/JBJS.I.00634
5. Lyons, V. E., & Popejoy, L. L. (2014). Meta-analysis of surgical safety checklist effects on teamwork, communication, morbidity, mortality, and safety. *Western Journal of Nursing Research, 36*(2), 245–261. https://doi.org/10.1177/0193945913505782
6. Haynes, A. B., Weiser, T. G., Berry, W. R., Lipsitz, S. R., Breizat, A.-H.S., Dellinger, E. P., et al. (2009). A surgical safety checklist to reduce morbidity and mortality in a global population. *New England Journal of Medicine, 360*(5), 491–499. https://doi.org/10.1056/NEJMsa0810119
7. Fudickar, A., Hörle, K., Wiltfang, J., & Bein, B. (2012). The effect of the WHO surgical safety checklist on complication rate and communication. *Deutsches Ärzteblatt International, 109*(42), 695–701. https://doi.org/10.3238/arztebl.2012.0695
8. Braham, D. L., Richardson, A. L., & Malik, I. S. (2014). Application of the WHO surgical safety checklist outside the operating theatre: Medicine can learn from surgery. *Clinical Medicine, 14*(5), 468–474. https://doi.org/10.7861/clinmedicine.14-5-468
9. Jain, D., Sharma, R., & Reddy, S. (2018). WHO safe surgery checklist: Barriers to universal acceptance. *Journal of Anaesthesiology Clinical Pharmacology, 34*(1), 7. https://doi.org/10.4103/joacp.JOACP_307_16
10. Tan, J., Ngwayi, J. R. M., Ding, Z., Zhou, Y., Li, M., Chen, Y., et al. (2021). Attitudes and compliance with the WHO surgical safety checklist: A survey among surgeons and operating room staff in 138 hospitals in China. *Patient Safety in Surgery, 15*(1), 3. https://doi.org/10.1186/s13037-020-00276-0
11. Tang, R., Ranmuthugala, G., & Cunningham, F. (2014). Surgical safety checklists: A review. *ANZ Journal of Surgery, 84*(3), 148–154. https://doi.org/10.1111/ans.12168
12. Haugen, A. S., Søfteland, E., Almeland, S. K., Sevdalis, N., Vonen, B., Eide, G. E., et al. (2015). Effect of the World Health Organization checklist on patient outcomes: A stepped wedge cluster randomized controlled trial. *Annals of Surgery, 261*(5), 821–828. https://doi.org/10.1097/SLA.0000000000000716
13. de Vries, E. N., Prins, H. A., Crolla, R. M. P. H., den Outer, A. J., van Andel, G., van Helden, S. H., et al. (2010). Effect of a comprehensive surgical safety system on patient outcomes. *The New England Journal of Medicine, 363*(20), 1928–1937. https://doi.org/10.1056/NEJMsa0911535
14. Delisle, M., Pradarelli, J. C., Panda, N., Koritsanszky, L., Sonnay, Y., Lipsitz, S., et al. (2020). Variation in global uptake of the Surgical Safety Checklist. *British Journal of Surgery, 107*(2), e151–e160. https://doi.org/10.1002/bjs.11321
15. Borchard, A., Schwappach, D. L. B., Barbir, A., & Bezzola, P. (2012). A systematic review of the effectiveness, compliance, and critical factors for implementation of safety checklists in surgery. *Annals of Surgery, 256*(6), 925–933. https://doi.org/10.1097/SLA.0b013e3182682f27
16. Alnaib, M., Samaraee, A. A., & Bhattacharya, V. (2012). The WHO Surgical Safety Checklist: A review. *Journal of Perioperative Practice, 22*(9), 289–292. https://doi.org/10.1177/175045891202200903
17. Papaconstantinou, H. T., Jo, C., Reznik, S. I., Smythe, W. R., & Wehbe-Janek, H. (2013). Implementation of a Surgical Safety Checklist: Impact on surgical team perspectives. *Ochsner Journal, 13*(3), 299–309.
18. Tully, P. A., Ng, B., McGagh, D., Meehan, N., Khachane, A., Higgs, J., et al. (2021). Improving the WHO Surgical Safety Checklist sign-out. *BJS Open, 5*(3), zrab028. https://doi.org/10.1093/bjsopen/zrab028
19. Motta Filho, Gd. R., Neves da Silva, Ld. F., Ferracini, A. M., & Bähr, G. L. (2013). The WHO Surgical Safety Checklist: Knowledge and use by Brazilian orthopedists. *Revista Brasileira de Ortopedia (English Edition), 48*(6), 554–562. https://doi.org/10.1016/j.rboe.2013.12.010
20. Sewell, M., Adebibe, M., Jayakumar, P., Jowett, C., Kong, K., Vemulapalli, K., et al. (2011). Use of the WHO surgical safety checklist in trauma and orthopaedic patients. *International Orthopaedics, 35*(6), 897–901. https://doi.org/10.1007/s00264-010-1112-7
21. Norton, E. K., & Rangel, S. J. (2010). Implementing a Pediatric Surgical Safety Checklist in the OR and beyond. *AORN Journal, 92*(1), 61–71. https://doi.org/10.1016/j.aorn.2009.11.069
22. Dabholkar, Y., Velankar, H., Suryanarayan, S., Dabholkar, T. Y., Saberwal, A. A., & Verma, B. (2018). Evaluation and customization of WHO Safety Checklist for Patient Safety in otorhinolaryngology. *Indian Journal of Otolaryngology and Head & Neck Surgery, 70*(1), 149–155. https://doi.org/10.1007/s12070-018-1253-3
23. Sleiman, B., Sayeed, Z., Padela, M. T., Padela, A. F., Bobba, V., Yassir, W., et al. (2019). Review article: Current literature on surgical checklists and handoff tools and application for orthopaedic surgery. *Journal of Orthopaedics, 16*(1), 86–90. https://doi.org/10.1016/j.jor.2018.12.006
24. Thomasson, B. G., Fuller, D., Mansour, J., Marburger, R., & Pukenas, E. (2016). Efficacy of surgical safety checklist: Assessing orthopaedic surgical implant readiness. *Healthcare, 4*(4), 307–311. https://doi.org/10.1016/j.hjdsi.2016.01.005
25. Solsky, I., Berry, W., Edmondson, L., Lagoo, J., Baugh, J., Blair, A., et al. (2020). World Health Organization Surgical Safety Checklist modification: Do changes emphasize communication and teamwork? *Journal of Surgical Research, 246*, 614–622. https://doi.org/10.1016/j.jss.2018.09.035
26. Barimani, B., Ahangar, P., Nandra, R., & Porter, K. (2020). The WHO Surgical Safety Checklist: A review of outcomes and implementation Strategies. *Perioperative Care and Operating Room Management, 21*, 100117. https://doi.org/10.1016/j.pcorm.2020.100117

27. Ragusa, P. S., Bitterman, A., Auerbach, B., & Healy, W. A. (2016). Effectiveness of Surgical Safety Checklists in improving patient safety. *Orthopedics, 39*(2), e307-310. https://doi.org/10.3928/01477447-20160301-02
28. Patel, J., Ahmed, K., Guru, K. A., Khan, F., Marsh, H., Shamim, K. M., et al. (2014). An overview of the use and implementation of checklists in surgical specialities—A systematic review. *International Journal of Surgery (London, England), 12*(12), 1317–1323. https://doi.org/10.1016/j.ijsu.2014.10.031

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