

Comparing video-based versions of Halsted's 'See One, Do One' and Peyton's '4-step Approach' for teaching surgical skills: a randomized controlled trial

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Research article

Keywords: Undergraduate medical skills training, medical education, Peyton's 4-step Approach, Halsted's See One Do One, Cranio-maxillo-facial surgery

Posted Date: January 15th, 2020

DOI: <https://doi.org/10.21203/rs.2.20706/v1>

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Version of Record: A version of this preprint was published on June 17th, 2020. See the published version at <https://doi.org/10.1186/s12909-020-02105-5>.

Abstract

Background: Teaching complex motor skills at a high level remains a challenge in medical education. Established methods often involve large amounts of teaching time and material. The implementation of standardized videos in those methods might help save resources. In this study, video-based versions of Peyton's '4-step Approach' and Halsted's 'See One, Do One' are compared. We hypothesized that the video-based '4-step Approach' would be more effective in learning procedural skills than the 'See One, Do One Approach'.

Methods: One-hundred-two naïve students were trained to perform a structured facial examination and a Bellocq's tamponade with either Halsted's (n = 57) or Peyton's (n = 45) method within a curricular course. Steps 1 (Halsted) and 1-3 (Peyton) were replaced by standardized teaching videos. The performance was measured directly (T1) and 8 weeks (T2) after the intervention by blinded examiners using validated checklists. An item-analysis was also carried out.

Results: At T1, performance scores significantly differed in favor of the video-based '4-step Approach' ($p < 0.01$) for both skills. No differences were found at T2 ($p < 0.362$). The item-analysis revealed that Peyton's method was significantly more effective in the complex subparts of both skills.

Conclusions: The modified video-based version of Peyton's '4-step Approach' is the preferred method for teaching especially complex motor skills in a large curricular scale. Furthermore, an effective way to utilize Peyton's method in a group setting could be demonstrated. Further studies have to investigate the long-term learning retention of this method in a formative setting.

Background

Despite the ongoing mechanization and the implementation of high technology in nearly all medical fields, clinical skills remain fundamental to every undergraduate student becoming a responsible and independent future doctor and mastering the "clinical art" [1].

However, over the last two decades, many national and international studies have shown that the training of clinical skills in medical and surgical education [2,3] is insufficient. Often young physicians are not adequately prepared to withstand a working environment that is characterized by an increasing economization, leaving less time for learning on the job and supervision through peers and superiors. As a consequence, a sound training of clinical skills must have already taken place at the undergraduate level.

Traditionally, clinical skills training in medicine can be summarized under the adage 'See One, Do One, Teach One', meaning that trainees, after observing a particular procedure once, are expected to be capable of performing that procedure followed by being able to teach another trainee how to conduct that procedure [4]. Against the background of increased awareness for patient safety today, many argue that

this teaching method is passé because students are unable to safely perform a medical procedure after seeing it only once [5–7].

Among other instructional approaches, like mental training [8] or the use of teaching associates [9], the '4-step Approach' outlined by Rodney Peyton (1998) has become increasingly popular in teaching clinical competence and in particular procedural skills. The '4-step Approach' consists of the following steps:

1. Demonstration—The teacher performs the skill in real-time without any explanation
2. Deconstruction—The teacher performs the skill slowly, explaining every single step
3. Comprehension—The student explains whereupon the teacher performs every single step of the procedure
4. Execution—The student explains and simultaneously performs every step of the procedure

Originally developed to teach procedural skills in the operating theatre, today, the '4-step Approach' is used as an instructional approach in basic resuscitation and trauma management [11–13], and has also been shown to be effective in the instruction of basic procedural skills, such as surgical suturing [14,15] or intravenous cannulation [16,17]. Krautter et al. identified Step 3 as the most crucial part of Peyton's '4-step Approach', contributing significantly more to the learning success than the previous steps due to its inherent combination of motor imaginary [18] and skill performance [16]. However, the method is relatively time- and material-consuming and personnel-intensive, and several other studies have shown that simple procedural skills can also be taught with a considerably reduced didactic effort [19,20], which raises the question of how and for which procedural skill, in particular, Peyton's '4-step Approach' should be used.

A possible way to reduce material and personal recourses is to modify the '4-step Approach' by implementing standardized educational videos [21]. Previous studies have demonstrated that replacing steps 1 and 2 through standardized educational videos does not have any negative effects on the learning outcomes compared to other teaching methods [12]. However, it remains unclear how many steps of the '4-step Approach' can be replaced yet remaining effective in practical skills training, and there is no standardized protocol to use this method—that was designed for individual skills training—during small group teaching. For this reason, in this study, we examine a newly modified video-based '4-step Approach' that replaces steps 1 to 3 with standardized educational videos and compared this to a video-enhanced version of Halsted's traditional 'See One, Do One' Approach in short- and long-term practical skills acquisition.

Methods

Study design

This study is a comparative effectiveness research study aimed at detecting the influence of two different instructional approaches on the acquired practical skills during undergraduate surgical training.

Study participants

Study participants were undergraduate medical students at Goethe-University Hospital in Frankfurt in the fourth year of a 6-year program completing their obligatory surgical training. All participants were naïve regarding CMF specific practical skills and knowledge.

Participation was voluntary and took place after written informed consent, which was revocable at any time. Students were blinded towards the used instructional approaches as well as affiliation to any study group. Basic data regarding student age, sex, and duration of the study were collected using a questionnaire.

The study was conducted according to the ethical principles of the Helsinki Declaration (Ethical Principles for Medical Research Involving Human Subjects), and the local ethics committee noted that no further approval was necessary.

Study protocol

The study was carried out within the 'training week of practical clinical skills in surgery' [22], which aims to teach students basic surgical competencies and prepare them for their upcoming surgical rotations. This takes place at the skills lab and consists of 12 teaching units for basic general and surgical skills from all surgical disciplines. The teaching content is based on the learning objectives for practical skills defined in the national competency-based catalog of learning objectives in surgery from the German Society of Surgery [23]. The training has a capacity of 64 students per week, with a maximum of eight students per group and tutor.

On day one, students rotate through four 90-min training units of basic clinical and surgical principles. These training units are taught by peer tutors. From the second to the fifth day, students rotate through eight 210-min training units, of which five are taught by surgical specialists (general surgery, trauma surgery, vascular surgery, thoracic and heart surgery, craniomaxillofacial) and three are taught by peer tutors (punction and injection, taking medical histories, wound management).

Following the first week of practical skills training, students pass through 2 weeks of surgical rotation at the university hospital or associated teaching hospitals with participation on the ward, the ambulance, and in the operating theatre to integrate and apply the acquired surgical knowledge and skills under supervision in daily clinical practice.

Intervention

For the intervention, two fundamental clinical competences from the craniomaxillofacial surgery (CMF) spectrum, namely the performance of a structured facial examination (SFE, video at <https://youtu.be/S-b3klzmLQw>) and the packing of a modified Bellocq tamponade (BT, video at

<https://youtu.be/gtMq4044RIM>) were examined (**Figure 1**). These competencies were chosen since previous studies found medical students to have significant shortcomings in CMF-specific competencies [24–26]. Furthermore, the specialty was shown to be underrepresented in national undergraduate education [27], although consultations in the field are of considerably socioeconomic and numerical importance in the acute and normal care [28,29].

The existing instructional manual for the CMF unit was reworked and adapted for the study purpose for both skills and both instructional approaches. Each manual consists of a detailed schedule and workflow, as well as a step-by-step checklist to ensure a standardized sequence of the training. For further quality assurance and standardization, an instructional video was designed for both skills [30]. All instructors involved received an online-training, where both skills were demonstrated and trained in each of the instructional approaches as well as the correct performance of each instructional approach.

The instructional approaches ‘Video 4-step Approach’ as well as the existing approach ‘See One, Do One’, which was regarded as the control group, were compared.

‘See One, Do One Approach’

This approach is labeled as the main component of clinical-bedside teaching. Students learn by watching an expert explaining and demonstrating a skill. This is followed by the first independent performance of the skill, which is mostly with a patient [4]. As quality assurance and standardization for the demonstration of each skill from the trainers, each skill was videotaped based on the existing manual and checklist. The trainer demonstrated the video and explained the skill in detail, step-by-step. The explanations were predetermined in the manual and trained in the tutor training. Subsequently, students could practice the skill under the supervision and, if needed, receive correction from the tutor. Each student should practice each skill at least once. The training lasted for 60-min.

‘Video 4-step Approach’

For this study, the ‘4-step Approach’ – as described by Walker and Peyton [10] – was modified. For Step 1, the video was demonstrated without any comments. For Step 2, the trainer demonstrated the video and explained the skill step-by-step in detail. The explanations were predetermined in the manual and trained in the online-tutorial. For Step 3, the video was paused after each step, and students were chosen one-by-one by the trainer to explain the next instructional step of the video, which was then video-played. Step 4 was performed, as described by R. Peyton. Subsequently, students could practice the skills under the supervision and, if needed, receive correction from the tutor. Each student was advised to practice each skill at least once. The training lasted for 60-min.

Assignment of the students to instructional approaches of the skills

The assignment of students to one of the eight learning groups per training week with a maximum of six students per group who pass through the teaching units together occurred prior to the training week, independent of the authors and independent of study participation by the deanery. The allocation of the learning group in the study to the two instructional approaches was performed alternately.

Outcome measures

To assess the acquired competence in both skills of the study, the OSCE-format (one station for each skill) was used during the training week directly after the intervention (T1) and 5–13 (SD = 3.16) weeks later (T2), as part of the curricular and summative surgical OSCE (10 stations in total). A trinary scoring scale was used (0 points for not done, 1 point for done but incorrect, and 2 points for done and correct) for each checklist, which was based on the checklist used in the tutor manual. A time-frame of 5-min to complete each OSCE station was given. Subsequently, students received short feedback regarding their performance and suggestions for improvement at T1. During their training week, students were video-recorded (Camera System: Panasonic HC-X929) for later performance measurement and to validate the used Checklists by two independent, blinded examiners. During their surgical OSCE, due to examination regulations, the performance was not video-recorded and measured by only one examiner for each skill using the same now validated checklists. All examiners were blinded towards the students' instructional approach and affiliation of the learning group. They received training before the OSCE to gain experience in the use of the checklist.

Data analysis

Microsoft Excel 2016 (Microsoft Office 2007, © Microsoft Corporation, Redmond, USA) for Mac and SPSS Statistics version 19 (IBM, Armonk, USA) were used for the statistical analysis and graphical display of data.

To test for significant differences in learning success between the 'Video 4-step Approach' and 'See One, Do One Approach', the Mann-Whitney-U-Test for non-parametric data was used. To test for performance differences within the respective groups at different times, the Friedman test for repeated measures was used. Furthermore, effect sizes were calculated using Cohen's *d*, which is defined as the difference between two means divided by a standard deviation for the data, resulting in a unitless value that helps to interpret the effect size of observed results and hence the statistical power of a study. For most types of effect sizes, a larger absolute value indicates a stronger effect. Furthermore, it can be used as an additional control test since prior studies have shown that significant test results alone are not sufficient to interpret data and draw conclusions [31].

Additionally, each item of the checklists that were used to measure student performance was categorized into four (extraoral examination, neurological examination, midface examination, intraoral examination) or three (material preparation, insertion of the tamponade, fixation of the tamponade) subgroups.

Averages from those subgroups were checked for significant differences using the Mann-Whitney-U-Test for non-parametric data.

Sample size estimation

Based on prior examination results from the years before the intervention, we estimated an average student performance of 70% with a standard deviation of 10% in the OSCE. A sample size of 88 was calculated based on the following parameters: mean '4-step Approach' = 33, mean 'See One, Do One' = 30, SD = 10, alpha = 80%, beta = 20%.

Results

Study participants

One-hundred-two (f = 62; m = 40) out of 176 students agreed to participate in the study. Fifty-seven students (m = 18, w = 39) belonged to the 'See One, Do One' group while 45 students (m = 22, w = 23) were trained using the video-based '4-step Approach'. Due to incomplete video footage in the performance of a Bellocq's tamponade, two students that were trained with the video-based '4-step Approach' and one student that belonged to the 'See One, Do One' group had to be excluded from the study. Ninety-five students (f = 56; m = 39) participated in the curricular OSCE 5–13 weeks after the intervention. Seven students did not participate in this OSCE due to illness or other reasons.

Both teaching interventions were carried out in a curricular setting in the given timeframe without any complications.

Structured facial examination

At T1, students that were trained with the video-based '4-step Approach' showed highly significantly better results in the performance of a structured facial examination ($p < 0.001$) than students that were trained with the 'See One, Do One' approach (**Table 1**). At T2, no significant difference could be found between both groups ($p < 0.616$, $d = 0.153$). Most (81.1%) of those in the video-based '4-step Approach' group showed very good retention of the acquired knowledge, while the 'See One, Do One' group was able to significantly increase its performance by at least 6.4 % compared to the first measure.

The item-based analysis revealed significant differences in favor of the video-based '4-step Approach' in all three subgroups ('neurological examination', 'examination of the midface' and 'intraoral examination') at T1 (**Table 2**). At T2, no significant differences could be found between the groups. The correlation (0.585) between both examiners at T1 was satisfactory.

Bellocq's tamponade

At T1, students that were trained with the video-based '4-step Approach' showed highly significantly better results in the performance of a modified Bellocq's tamponade ($p < 0.001$) than students that were trained with the 'See One, Do One' approach. At T2, no significant difference could be found ($p < 0.362$, $d = 0.149$). Both groups were able to significantly increase their performance from T1 to T2 (**Table 3**).

The item-based analysis revealed significant differences in favor of the video-based '4-step Approach' in the subgroups 'material preparation' and 'insertion of the tamponade', but no significant differences in the subgroup 'fixation of the tamponade' at T1. At T2, no significant differences could be found for any subgroup (**Table 4**). With 0.104, the correlation between both examiners at T1 was rather weak.

Discussion

The correct performance of a structured facial examination, as well as the insertion of a Bellocq's tamponade, present two fundamental surgical skills that, because of the high frequency of craniofacial trauma, are of great importance for physicians [28,29]. The aim of this study was to prospectively investigate the teaching efficacy of two teaching methods: a video-based '4-step Approach' (study group) and the traditional 'See One, Do One Approach' (control group) in the short- and long-term acquisition of the above mentioned basic surgical skills. Another aim of this study was to investigate the curricular (*in vivo*) feasibility of the video-based '4-step Approach'.

Overall, our results revealed significant performance differences between both groups in the short-term examination (T1) in favor of the study group. Furthermore, the re-examination 5–13 weeks later (T2) revealed a very good long-term learning retention of the acquired practical skills for the study group. Students of the control group, however, were able to significantly improve their level of competence to the level of the study group in the long-term comparison. The implementation of the video-based '4-step Approach' in a curricular setting was completely feasible within the given timeframe of the 'training week of practical clinical skills in surgery' [22].

We believe a reason for that is Step 3 of the '4-step Approach' namely, the verbalization and subsequent instruction of a complex motor skill, led to a more profound cognitive processing and hence, to a better skills performance of the study group compared to the control group. This presumption is also supported by a previous study by Krautter et al., who identified Step 3 as the most crucial part of Peyton's original '4-step Approach' [16]. These authors assumed that the reason for this is that it combines motor imagery [32] and skills performance and is hence superior to skills observation-only, like in the 'See One, Do One Approach'.

Interestingly, the control group was able to significantly improve its performance in the long-term examination at T2 while the study group managed to maintain a high-performance level even though other studies found a clear benefit for Peyton's '4-step Approach' compared to other teaching formats in the long-term comparison [17]. Hermann-Werner et al. compared the use of a 'best practice-model' containing structured individual feedback and Peyton's '4-step Approach' to the traditional 'See One, Do One Approach' for teaching the insertion of a nasogastric tube and i.v. cannulation. These authors found

Peyton's '4-step Approach' to be superior both in the short- and long-term comparison. However, their study was conducted in a non-curricular '*in vitro*' setting within a skills-laboratory [17]. In the present study, the performance assessment at T2 as part of a curricular and formative surgical OSCE approach might have been influenced by the desire of all participating students to perform well. This could have led to the significant performance improvement of the control group when measured in the long-term. This phenomenon is also known as "assessment drives learning" and has been described in detail by Raupach et al., who found that summative examinations to be 'more powerful drivers of student learning than the instructional format' itself [33].

When looking closer at the results of this study, it is noticeable that the performance differences and effect sizes between the study- and the control group were greater for the performance of an SFE compared to the insertion of a Bellocq's tamponade. This difference can be explained with the higher level of difficulty of the SFE compared to the Bellocq's tamponade (Supplements 1 and 2) since previous studies found a clear benefit of Peyton's '4-step Approach' for very challenging motor skills, such as laparoscopic suturing and knot tying [15] or the replacement of a complex wound dressing or performing a simple interrupted suture [21]. For relatively easy to learn motor skills like performing external chest compressions or the placement of a laryngeal tube, no significant advantages could be found for Peyton's '4-step Approach' in previous studies (Orde 2010; Münster 2016). The results of the item-based analysis support the assumption that the '4-step Approach' is particularly useful for more complex motor skills since significant differences were found only for the more complex sub-parts of the SFE (neurological and midface examination) and the insertion of Bellocq's tamponade (material preparation and catheter insertion).

Peyton's '4-step Approach' is an effective teaching method but can be time and personnel consuming since all steps have to be repeated various times by a qualified tutor. Moreover, it has been shown that trainers tend to teach practical skills with their own individual stamp [12]. Especially in a curricular setting with a high number of students and frequently changing trainers, the use of videos enables a higher standardization of the demonstration of the skills. The implementation of standardized instructional videos into Peyton's '4-step Approach' has been investigated in previous studies [11,21,35]. Schwerdtfeger et al. compared Peyton's traditional '4-step Approach' with a video-based '4-step Approach' that replaced Steps 1 and 2 with instructional videos to teach acute clinical care of trauma patients to 313 medical students. These authors found no differences between the tested interventions [12]. Sopka et al. conducted a very similar study and compared the traditional '4-step Approach' with a media-supported '4-step Approach' that replaced the Steps 1 and 2 with a standardized self-produced podcast to teach external chest compressions to 220 medical students. These authors also found no significant differences between both interventions [11]. Although both of these cited studies present a high number of participants and hence, a good explanatory power, they did not compare the video-based '4-step Approach' to a the often used 'See One, Do One Approach' and did not investigate multiple skills with different levels of difficulty. Rossettini et al. compared Peyton's '4-step Approach' to the 'See One, Do One Approach' in the training of manual therapy [36]. These authors found Peyton's '4-step Approach' to be

more effective in the short-, medium-, and long-term. However, with 39 participants, their study lacked explanatory power and did not investigate the use of a video-based '4-step Approach'.

Limitations

One shortcoming of our study is that there was no objective assessment before the intervention determining the previous experience of the individual participants. Another limitation is the performance assessment at T2 as part of a curricular and summative surgical OSCE, which might have influenced our results. A purely formative assessment would have been desirable but was not possible due to the curricular implementation of the study.

Conclusion

To our knowledge, this study is the first that compared a video-based '4-step Approach' that replaced the Steps 1 to 3 with standardized instructional videos and the often-used 'See One, Do One Approach' in the mediation of multiple surgical skills with different levels of difficulty and within in a curricular setting.

We were able to show that the video-based '4-step Approach' is significantly more effective than the 'See One, Do One Approach' in the mediation of a structured facial examination and the insertion of a Bellocq's tamponade in the short-term, and that this holds for the more complex parts of both skills. Furthermore, we could demonstrate that the curricular implementation of the video-based '4-step Approach' was possible within a larger scale and the given time frame.

List Of Abbreviations

1. OSCE – Objective Structured Clinical Examination
2. SFE – Structured Facial Examination
3. CMF – Cranio-Maxillo-Facial

Declarations

Consort guidelines

This study adheres to the CONSORT guidelines.

Ethics approval and consent to participate

The study was approved by the Ethical Commission of the University Hospital Frankfurt (Goethe University) and it was stated that no further approval was required. The study was conducted according to the Declaration of Helsinki. All participants of the study gave their written consent for participation, which they could withdraw at any time.

Consent for publication

Not applicable since no individual person's data was included in the manuscript.

Availability of data and material

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

All authors declare that they have no financial or non-financial competing interests that might create a conflict of interest with the information presented in this article. One of the authors (MR) is also a member of BMC Medical Education's editorial board.

Funding

This study was not funded.

Authors' contributions

All Authors (LS, BS, CS, RS, MR and JS) had a relevant contribution to the manuscript and have read and approved the final manuscript. LS was responsible for study conception and design. BS performed the data collection and statistical analysis. All authors read, edited and approved the final manuscript.

Acknowledgements

The authors would like to thank all students that participated in the study.

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Tables

	Examiner 1 (T1)	Examiner 2 (T1)	T2
4SA	81.1 %	82.5 %	81.2 %
SODO	69.3 %	72.4 %	78.8 %
p-Value	p < .001	p < .001	p < .616
Cohen's d	1.073	1.255	0.149

Table 1: Examination results of the video-based ‘4-step Approach’ group (4SA) and the ‘See One, Do One’ (SODO) group at T1 and T2 for performing a structured facial examination.

		Extraoral Examination	Neurological Examination	Midface Examination	Intraoral Examination
4SA	Examiner 1 (T1)	32.2%	89.1%	87.0%	63.9%
	Examiner 2 (T1)	35.6%	94.2%	86.3%	67.2%
	T2	75.0%	91.0%	77.9%	81.3%
SODO	Examiner 1 (T1)	24.6%	81.6%	71.6%	57.9%
	Examiner 2 (T1)	24.6%	92.0%	73.8%	53.8%
	T2	68.3%	92.5%	74.6%	78.4%
p-Values	Examiner 1 (T1)	p < .435	p < .008	p < .001	p < .138
	Examiner 2 (T1)	p < .332	p < .107	p < .001	p < .001
	T2	p < .267	p < .968	p < .477	p < .764

Table 2: Item-based analysis of the examination results between the video-based ‘4-step Approach’ group (4SA) and the ‘See One, Do One’ (SODO) group at T1 and T2. Significant differences in favour of the video-based ‘4-step Approach’ group could be found in the subgroups ‘neurological examination’, ‘midface examination’ and ‘intraoral examination’.

	Rater 1 (T1)	Rater 2 (T1)	T2
4SA	81.3%	83.7%	87.9%
SODO	75.5%	77.6%	86.2%
P-Value	p < .001	p < .001	p < .362
Cohen’s d	0.906	0.855	0.149

Table 3: Examination results of the video-based ‘4-step Approach’ group (4SA) and the ‘See One, Do One’ (SODO) group at T1 and T2 for the insertion of a modified Bellocq’s tamponade.

		Material preparation	Catheter Insertion	Tamponade Fixation
4SA	Examiner 1 (T1)	83.3%	96.6%	58.3%
	Examiner 2 (T1)	94.3%	98.3%	53.4%
	T2	88.1%	98.2%	73.8%
SODO	Examiner 1 (T1)	71.5%	91.8%	57.6%
	Examiner 2 (T1)	75.2%	94.5%	57.3%
	T2	93.0%	93.5%	69.7%
p -value	Examiner 1 (T1)	p < .003	p < .011	p < .756
	Examiner 2 (T1)	p < .001	p < .033	p < .631
	T2	p < .596	p < .057	p < .322

Table 4: Item-based analysis of the examination results between the video-based ‘4-step Approach’ group (4SA) and the ‘See One, Do One’ (SODO) group at T1 and T2. Significant differences in favor of the video-based ‘4-step Approach’ group could be found in the subgroups ‘material preparation’ and ‘catheter insertion’. No differences were found at T2.

Figures

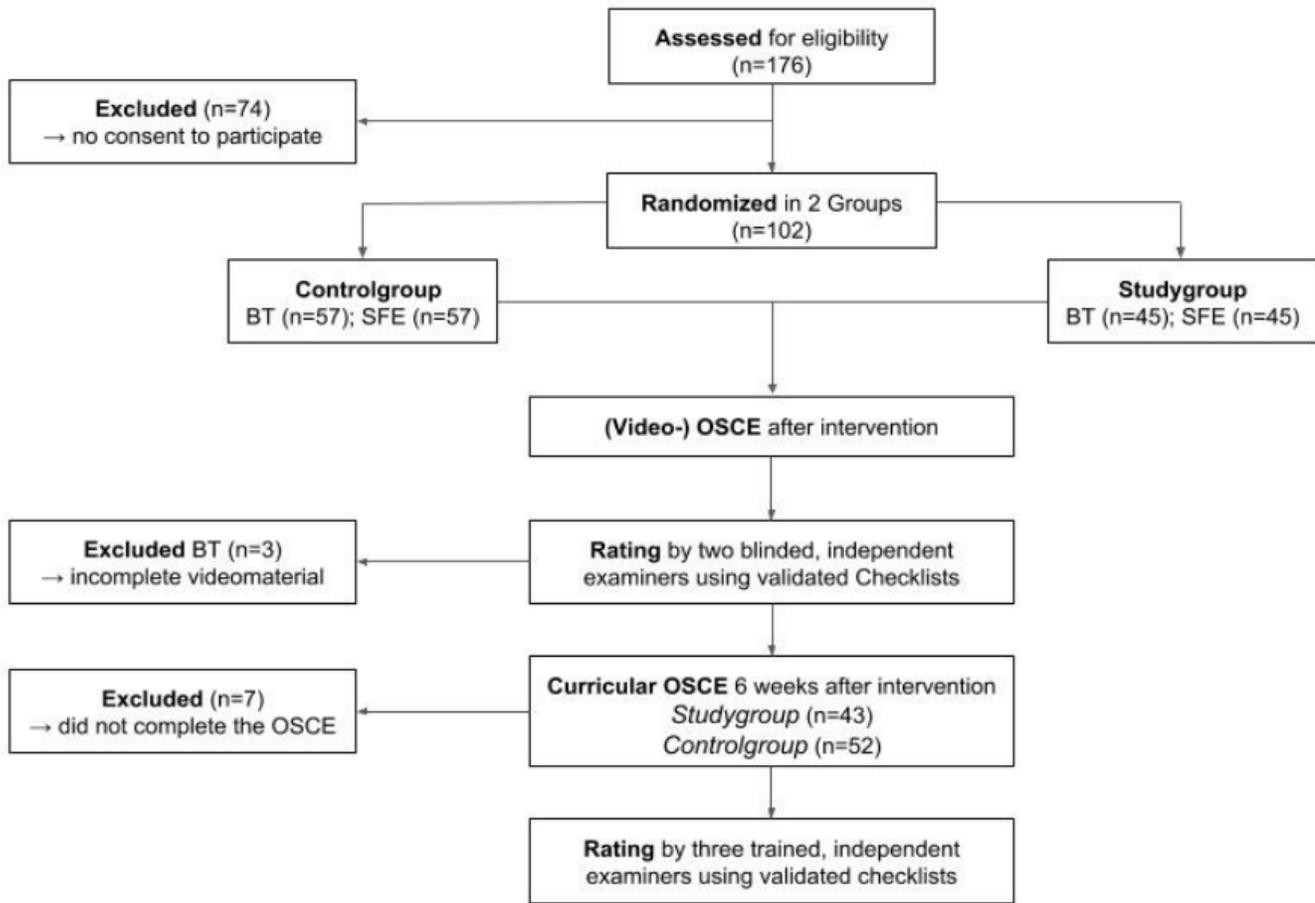


Figure 1

Study design and execution

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