Comparison of different feedback modalities for the training of procedural skills in Oral and Maxillofacial surgery: a blinded, randomized and controlled study

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Abstract

Background: Feedback given to students plays an important role concerning their efficiency in learning practical skills. With the purpose of facilitating this objective, the effectiveness of diverse modalities of given feedback has been investigated. Our hypothesis is that Individualized and Unsupervised Video Feedback can produce a similar learning experience in performing practical skills in Oral and Maxillofacial surgery as with conventional Direct Expert Feedback (Control group).

Methods: This prospective, randomized controlled and blinded study compared Direct Expert Feedback (DEF), Individualized Video Feedback (IVF) and Unsupervised Video Feedback (UVF). Participants were fourth-year dental students from the University Goethe of Frankfurt. Students were assigned to one of the three feedback methods (n = 20) using simple randomization. All participants received a video instruction of an interdental ('Ernst') ligature and a periphery venous catheterization. Subsequently, students were video recorded performing the tasks by themselves (pre-test). Following this, every student received feedback using one of the above mentioned modalities of feedback. Then, the participants performed the same task again while being video recorded (post-test) to measure the acquired competence. Six weeks later, the students participated in an objective structured clinical examination (OSCE), where the long-term knowledge retention was evaluated. All examiners were blinded towards the students' instructional approach and affiliation of the learning group.

Results: For the interdental ligature, significant improvements for each feedback modality from pre-test to post-test were found. The intragroup comparison in the post-test showed no significant differences between the three groups. All groups showed good knowledge retention from post-test to the long-term knowledge retention test. At the placement of a peripheral venous catheter, the IVF and UVF Group showed significant reduction of performance from the post-test to the long-term knowledge retention test.

Conclusion: This study showed that IVF and UVF were acceptable in the acquisition of basic surgical skills in Oral and Maxillofacial surgery and were not quantitatively different from DEF in improving skills.

Background

One of the biggest challenges in both medical and dental training is to provide students with the skills needed for their future work. In daily practice, a wide range of psychosocial to practical-technical skills must be mastered at a very high level.[1] Especially against the background of a continuously growing number of multimorbid patients in the dental practice, the knowledge and capacity to carry out basic medical procedures for emergency treatment will be of great relevance in the future.[2,3] The application of local anesthesia, for example, can cause life-threatening allergic reactions.[4] Knowledge of how to perform the placement of a peripheral venous catheter to apply emergency medication in such scenarios is required to initiate an early emergency treatment. Another frequent complication in the dental practice is the accidental mandibular fracture during the extraction of third molars. Knowledge of how to perform a interdental ligation with wires can help to stabilize the fracture segments and reduce the patient's pain

in these situations.[5] However, previous studies have shown that dental students are insufficiently prepared for practical and theoretical skills in treating dental and medical emergencies.[6] Possible reasons for these findings are that the teaching of these skills is not sufficiently represented in dental curricula. [6] Furthermore, students report receiving little feedback when learning these skills in order to develop a learning effect in the long term.[6,7]

An accepted definition of feedback in medical education is “specific information between a trainee's observed performance and a standard, given with the intent to improve the trainee's performance”. [7] Due to this, feedback plays a crucial role in teaching practical skills and, in many cases, determines the learning success of a trainee.[8] An example for this was published by Schüler et al. (2018): Feedback that was provided in practical clinical courses to dental students fostered the development of technical, management and communication skills significantly more with large effect sizes compared to the same course without feedback (Schüler et al. 2018). Furthermore, Olms et al. were able to demonstrate, that dental students believe individual feedback to be helpful (Olms et al. 2017). According to this, feedback in dental education was found to positively influence dental students’ autonomous motivation (Orsini 2017) and to have a benefit in terms of students’ attitudes toward the course and confidence in diagnosis and treatment planning (Lipp 2016). Even though, medical educators frequently believe they give feedback to medical trainees, trainees report that feedback is rare. [9,10] One possible reason for this is that students often don’t recognize that they get feedback as its not structured and well-planned.[11]

Due to this, the effectiveness of diverse structured modalities of given feedback has been investigated in medical education. Recently, media-supported forms of feedback have been used extensively as an effective modality to enhance feedback.[12] Especially the use of video recordings to provide effective feedback has been evaluated as a valuable resource in medical education. In a previous study by Xeroulis et al., computer-based video feedback significantly improved the learners’ technical skills in suturing and knot tying.[13] In another study by Farquharson et al., similar results were obtained by comparing verbal feedback to verbal feedback coupled with video feedback.[12]

For dental education, however, the use of media-supported forms of feedback has not been investigated sufficiently. Therefore, the aim of the present study is to investigate the effectiveness of various media-supported feedback forms in teaching procedural skills (peripheral venous catheter and interdental wire-ligation) in the discipline of Oral and Maxillofacial surgery (OMS). Our hypothesis is that media-supported video feedback can produce a similar learning outcome in performing practical skills as the conventional and often used direct expert feedback.

Methods

Assignment of the students to instructional approaches of the skills

The assignment of students to one the study arms 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 three instructional approaches was performed alternately.

Study design

All ethical principles for medical research involving human subjects dictated by the 1975 declaration of Helsinki, as revised in 2013, were considered. Concordant with the Ethics Board at the University Medical School, no ethical permission was necessary for conducting the study. The study was prospective, blinded, randomized, and controlled with the following parallel arms (feedback methods):

Control group: Direct expert feedback (DEF) (n = 20)

Intervention group 1: Individualized video feedback (IVF) (n = 20)

Intervention group 2: Unsupervised video feedback (UVF) (n = 20)

Study participants were sixty fourth-year dentistry students from the University Goethe of Frankfurt in the period of 2018-2019 attending a compulsory internship, which includes a five-day rotation through every section of the Department of Oral, Cranio-Maxillofacial and Facial Plastic Surgery, i.e. the operative room, the outpatient clinic or the emergency department. Before starting their rotation, students have to complete a practical skills training. The aim is to give dentistry students a short overview of the most common consultation reasons in OMS and prepare them for the upcoming clinic rotation. It is divided into a theoretical part (240 minutes) in the morning and a practical skills training (240 minutes) in the afternoon in which the study took place. Trained practical skills include performing a structured facial examination, placing a venous catheter and an interdental 'Ernst' ligature. Lessons were held in small groups ranging from four to six students. [14] Sixty students signed an informed consent of participation after receiving explanation of the study process and objectives, from which they could withdraw at any time (**Figure 1**). Evaluation of performance was done using previously validated global rating scales (**Figure 2 and 3**).[15]

The study measured the student's improvement of performance and time used to perform a task directly after an introduction exercise (T0) and a second exercise after receiving feedback (T1). Finally, to measure the long-term learning retention, a final examination (T2) was performed six weeks after the post-test. Examiners were blinded to the study group and received an educational course as calibration and to gain experience using the global rating scale. [15]

Pre-test evaluation

Practical skills training and measurements of pre-test evaluation

In the practical skills training, an emergency situation was simulated in which the students had to insert a periphery venous catheter. In the first exercise, it was evaluated the correct use of gloves, placement of a tourniquet, knowledge of periphery-venous anatomy, preparing a sterile working surface, placing the catheter and fixation of the catheter (Figure 2). The second exercise involved the first aid treatment of a mandibular fracture using an interdental ligature technique ('Ernst' ligature). In this exercise, the correct identification of the fracture line, placement of the ligature, cutting and twisting the endings of the wire and checking the stability of the ligature were evaluated (**Figure 3**). Before taking part in the practical skills training, all students received instructions through a standardized teaching video of each skill. Afterwards, students performed the skills by themselves for 30 minutes. After this, students were video recorded performing each skill as a performance measurement prior to receiving one of the feedback methods investigated in this study. Additionally, time of execution of the practical skills performance was documented.

Feedback Methods

Direct expert feedback (Control group)

In this group, after performing each skill by themselves, every student was video recorded for the later blinded performance assessment while performing the assigned tasks once. Immediately after this, the students practiced each skill again for 30 minutes while receiving a direct feedback regarding their performance by an instructor (T0). Feedback was given using a five-step feedback sheet. These five steps in the feedback protocol assessed what went well, what could be improved, what went badly, what was missing, and what was the take-home message for each student. Immediately after the feedback, the students practiced again for 30 minutes before repeating the exercise while again being video recorded for subsequent assessment (T1).

Individualized video feedback

In this group, after performing each skill by themselves, every student was video recorded for the later blinded performance assessment while performing the assigned tasks once. This initial video was then reviewed by the student and an instructor. Based on the video, feedback was given by the instructor using the same five step-feedback sheet (T0). The feedback sessions were held in a group setting and lasted for 30 minutes. Immediately after the feedback, the students practiced again for 30 minutes before repeating the exercise while again being video recorded for later assessment (T1).

Unsupervised video feedback

In this group, after performing each skill by themselves, every student was video recorded for the later blinded performance assessment while performing the assigned tasks once. Students then reviewed their own performance. As feedback, students received once again the standardized video instructions and were handed out the same five step-feedback sheets (T0). The feedback sessions were held in a group setting and lasted for 30 minutes. Immediately after the feedback, the students practiced again for 30 minutes before repeating the exercise while again being video recorded for later assessment (T1).

Performance measurement

To assess the acquired competence in both skills of the study, standardized checklists were used during the practical skills training week before (T0), directly after the intervention (T1) and 5–13 (SD = 3.16) weeks later (T2), as part of the curricular and summative OMF OSCE (eight stations in total). A trinary scoring scale was used (zero 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 (Figure 2 and 3).[15,16]

During their practical skills training, students were video recorded (Camera System: Panasonic HC-X929, Osaka, Japan) for later performance measurement and to validate the used checklists by two independent, blinded examiners. All examiners were blinded toward 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.

Statistical analysis

Microsoft Office 2016 (Microsoft Office 2007, © Microsoft Corporation, Redmond, USA) for Mac and SPSS Statistics version 19 (IBM, Armonk, USA) were used for the statistical analysis. All the data collected were analyzed using two-way analysis of variance (ANOVA) with a Tukey multiple comparisons test ($\alpha = 0.05$, 95% CI of diff.) of all pairs. Since the sample size was small, Cohen's *d* was used as an additional control test to support the interpretation of the data. Cohen's *d* 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. [17] The results are presented as the mean and standard deviation (SD) and depicted in tables. Statistical significance was considered if $p < 0.05$.

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. With an average student number of 65 per semester, a size of 56 was calculated based on the following parameters: average student performance = 70%, alpha = 80%, beta = 20%.

Results

Fifty-nine students completed the study. There was one drop out in the “Direct expert feedback” group due to personal reasons. Every participant satisfactory performed both practical modules and at all performance measurements. All the results from the pre-test (T0), post-test (T1) and long-term retention test (T2) are shown in Table 1 and 2.

Evaluation of performance - Interdental ligature

The intragroup comparison at T0 showed no significant differences between groups. During the study, all groups improved their performance significantly from T0 to T1 (p <0.001). Additionally, no significant differences between groups were recorded at T1 (p = 0.84). The DEF group showed the biggest effect size regarding the improvement from T0 to T1. Notably, the time needed to execute the exercises significantly improved in the UVF group, but there was not a significant increase in the DEF (p >0.9) and IVF (p >0.9) groups. Within T1, there were no significant differences between the average times of the three groups (p >0.15). Comparing the results from T1 with the T2, none of the groups showed significant differences. The same was observed in the intragroup comparison at T2 where no significant differences (p = 0.33) (Cohen’s d from post-test to OSCE: dDEF=0.09; dIVF=0.17; dUVF=-0.29) were found. The biggest improvement was observed by comparing the results from T0 and T2. At T2, significant increases in the overall average score of all groups compared to T0 (p <0.014) were recorded and the highest effect size according to Cohen’s *d* was found in the DEF group (dDEF=1.15; dIVF=0.77; dUVF=1.14) (**Table 1**).

Evaluation of performance - Periphery venous catheter

The intergroup comparison at T0 showed no significant differences between groups. Furthermore, the intergroup comparison showed no significant differences between the three groups at T1 (p = 0.79). However, the results showed significant performance improvement in all groups from T0 to T1 (p <0.001). The highest effect size according to Cohen’s *d* was found in the DEF group (dDEF=2.75; dIVF=2.22; dUVF=1.34). The time required to execute the exercises also significantly improved in the DEF Group and UVF Group. Within T1, there were no significant differences in time between the individual groups (p = 0.46). However, the evaluation of the time execution from the T1 and T2 showed a reduction of the execution time. Nevertheless, the reduction did not show statistical significance (p = 0.16).

Notably, in the IVF and UVF groups, there was a statistically significant deterioration of the performance (p = 0.047, p = 0.042, respectively) from T1 to the T2. The intragroup comparison at T2 showed no

significant differences between the groups (p = 0.42) (Cohen's d from post-test to OMS-OSCE: dDEF=-1.55; dIVF=-0.95; dUVF=-1.18). The results at T2, however, did not diminish as low as the results at T0. By comparing the results at T0 and at T2, the analyses showed a significant increase in the average of the overall scores in the DEF Group and the IVF Group (p = 0.018; p = 0.012, respectively). Contrary to the DEF and IVF groups, there were no significant improvements between at T1 and at T2 in the UVF group (p >0.9). The highest effect size according to Cohen's d was at the DEF Group (dDEF=1.71; dIVF=1.13; dUVF=0.2) (**Table 2**).

Discussion

The correct placement of a peripheral venous catheter, as well as the performance of a interdental 'Ernst' ligation represent two fundamental OMF skills that, because of the rising number of multimorbid patients in the dental practice, the knowledge and capacity to carry out these basic medical procedures for emergency treatment is of great relevance for the future dentists.[2,3] The aim of this single-blinded study was to prospectively investigate the teaching efficacy of three feedback methods: individualized video feedback (intervention group 1), non-individualized video feedback (Intervention group 2) and the traditional direct expert feedback (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 media-supported feedback methods.

Overall, our results revealed significant performance increases for all feedback forms from the pre-test (T0) to post-test (T1). Furthermore, the re-examination 5–13 weeks later (T2) revealed a good long-term learning retention of the acquired practical skills, especially for the DEF. Also, the direct feedback group showed the strongest effect size in the intergroup comparison between all testing ties. However, the intragroup comparison showed that IVF and USV were not inferior to the traditional direct feedback in the mediation of the above-mentioned skills. The implementation of the media-supported feedback forms in a curricular setting was completely feasible within the given timeframe of the practical skills training week. [18]

In previous studies, only one time of measurement was chosen after the feedback.[19] Neither the direct increase in knowledge nor the long-term increase was registered. In the present study; measurements were registered three times, which led to a better classification and understanding of the learning process. In addition, the time needed to perform the task was also registered. This is of relevance especially in emergency treatments.[12,20]

The study questioned the statement that IVF and UVF lead to a similar improvement of the performance in the learning of procedural skills as with traditional DEF. A previous study aimed to evaluate the effect of IVF and UVF on improvements in suturing skills. The participants were video recorded while suturing and were scored by two experts during the task. After receiving feedback, participants were requested to repeat the task. All feedback forms led to a significant improvement in suturing skills.[21] Similarly to our study, the results of the abovementioned study showed that all the modalities of feedback investigated

were useful regarding improvement of procedural skills in OMS. In our study, a significant performance increase was observed at T1 and T2 six weeks later compared to the T0 for the interdental ligature task. However, with an effect size of 2.75 and 1.54, the DEF group profited more from the training/feedback session than the IVF and UVF group. A rationale could be the presence of the expert during the feedback session. The expert's know-how allows spotting the mistakes more quickly and feedback can be given directly. On the contrary, in the cases of IVF and UVF, the lack of experience of the students impedes them from recognizing the mistakes on their own video-recorded performance. Previous studies have also investigated the use of DEF and the effect on the learning progress. The effect of 'computer-based video instruction', 'summary feedback' and 'direct feedback' were compared on teaching suturing and knot-tying skills to medical students. All participants received an instructional video and were pre-tested directly after. Every participant obtained a training session with one of the feedback forms. After one month, the long-term retention was tested. 'Computer-based video instruction', 'summary feedback' and 'direct feedback' were all three effective on the acquisition of basic surgical skills.[13] Nevertheless, during direct feedback, feedback and performance occur concurrently, which requires multitasking. This could be considered a disadvantage compared to the IVF and UVF groups. In the present study, the group with the lower effect was the UVF group. It can be assumed that, with only the video, the lack of experience of the students and without the expert's tips, the students could not identify mistakes easily. A supplement video with "frequent mistakes / tips and tricks" could enhance this modality of feedback and be used to place focus on specific trigger of errors.

In the present study, the authors decided not to integrate a control group without any feedback. This could be considered as a limitation of the study because one might argue that the improvement of the study groups was due to repetition of the task, rather than to the feedback method used to improve learning. On the other hand, the effectiveness of any type of feedback in comparison to no feedback is already proven in different studies in medical and dental education. [22–24] Due to this, the students included in a control group without feedback would have been disadvantaged. As this is not permitted in the curricular setting ending with a summative assessment in which the present study took place, the authors made a conscious decision not to create this kind of control group.

The control measurements at T0 of all three groups showed similar results concerning practical knowledge in the examined exercises and point to a good comparability between groups at baseline. Furthermore, compared to T0, the results at T2 showed significant improvements in all groups. Here, it has to be considered that a summative examination itself has a positive influence on the performance of the students.[25] Further studies have to focus on the long-term retention in a purely formative setting, which was not possible due to the curricular setting the study took part in. On the other hand, this curricular setting is one of the big advantages the present study has: As a whole semester could be included in the study, we were able to avoid a selection bias and to demonstrate, that the kinds of feedback used are feasible to be integrated in an existing curricular course.

In the present study, the authors were able to demonstrate, that UVF is quantitatively equal in improving basic surgical skills as DEF and IVF. This is even more notable as the UVF needs no presence of the tutor

during the feedback.

Conclusions

This study showed that Individualized Video Feedback and Unsupervised Video Feedback are acceptable approaches in the acquisition of basic surgical skills and were not quantitatively different from Direct Expert Feedback in improving these skills. Individualized Video Feedback and Unsupervised Video Feedback can be considered as an alternative or adjunct to conventional methods on learning procedural skills in Oral- and Maxillofacial Surgery. Functional integrated, Individualized Video Feedback and Unsupervised Video Feedback can serve as a useful adjunct to practical skills training and can increase efficiency of the examiner's time.

Abbreviations

DEF
Direct Expert Feedback
IVF
Individualized Video Feedback
OMS
Oral and Maxillofacial surgery
OSCE
Objective structured clinical examination
UVF
Unsupervised Video Feedback

Declarations

Ethics approval and consent to participate

Concordant with the Ethics Board at the University Medical School, no ethical permission was necessary for conducting the study. All participants signed an informed consent of participation.

Consent for publication

Not applicable.

Availability of data and materials

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

Competing interests

The authors declare that they have no competing interests.

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No funding was obtained for this study.

Authors' contributions

All Authors (LS, CH-V, PH and RS) had a relevant contribution to the manuscript and have read and approved the final manuscript. LS were responsible for study conception and design. All authors wrote, read, edited and approved the final manuscript.

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Tables

Table 1. Evaluation of the placement of the interdental ligature at pre-test, post-test and OSCE.

	pre-test	post-test	OSCE	*p*-value	Effect size (pre to post)	Effect size (post to OSCE)	Effect size (pre to OSCE)
DEF	13.07 +/- 2.60	16.40 +/- 1.55	16.67 +/- 3.58	$p<0.001$	1.54	0.09	1.15
IVF	14.04 +/- 1.52	16.26 +/- 1.76	15.83 +/- 2.92	$p<0.001$	1.35	0.17	0.77
UVF	14.30 +/- 1.69	16.19 +/- 1.50	16.80 +/- 2.46	$p<0.001$	1.12	-0.29	1.14
p-value	$p=0.15$	$p=0.84$	$p=0.33$				

Table 2. Evaluation of the placement of the periphery venous catheter at pre-test, post-test and OSCE.

	pre-test	post-test	OSCE	*p*-value	Effect size (pre to post)	Effect size (post to OSCE)	Effect size (pre to OSCE)
DEF	13.60 +/- 2.67	20.13 +/- 2.03	17.33 +/- 1.54	$p<0.001$	2.75	-1.55	1.71
IVF	14.09 +/- 2.20	18.45 +/- 1.68	16.59 +/- 2.20	$p<0.001$	2.22	-0.95	1.13
UVF	15.90 +/- 2.34	18.80 +/- 1.99	16.35 +/- 2.16	$p=0.018$	1.34	-1.18	0.2
p-value	$p=0.08$	$p=0.79$	$p=0.43$				

Figures

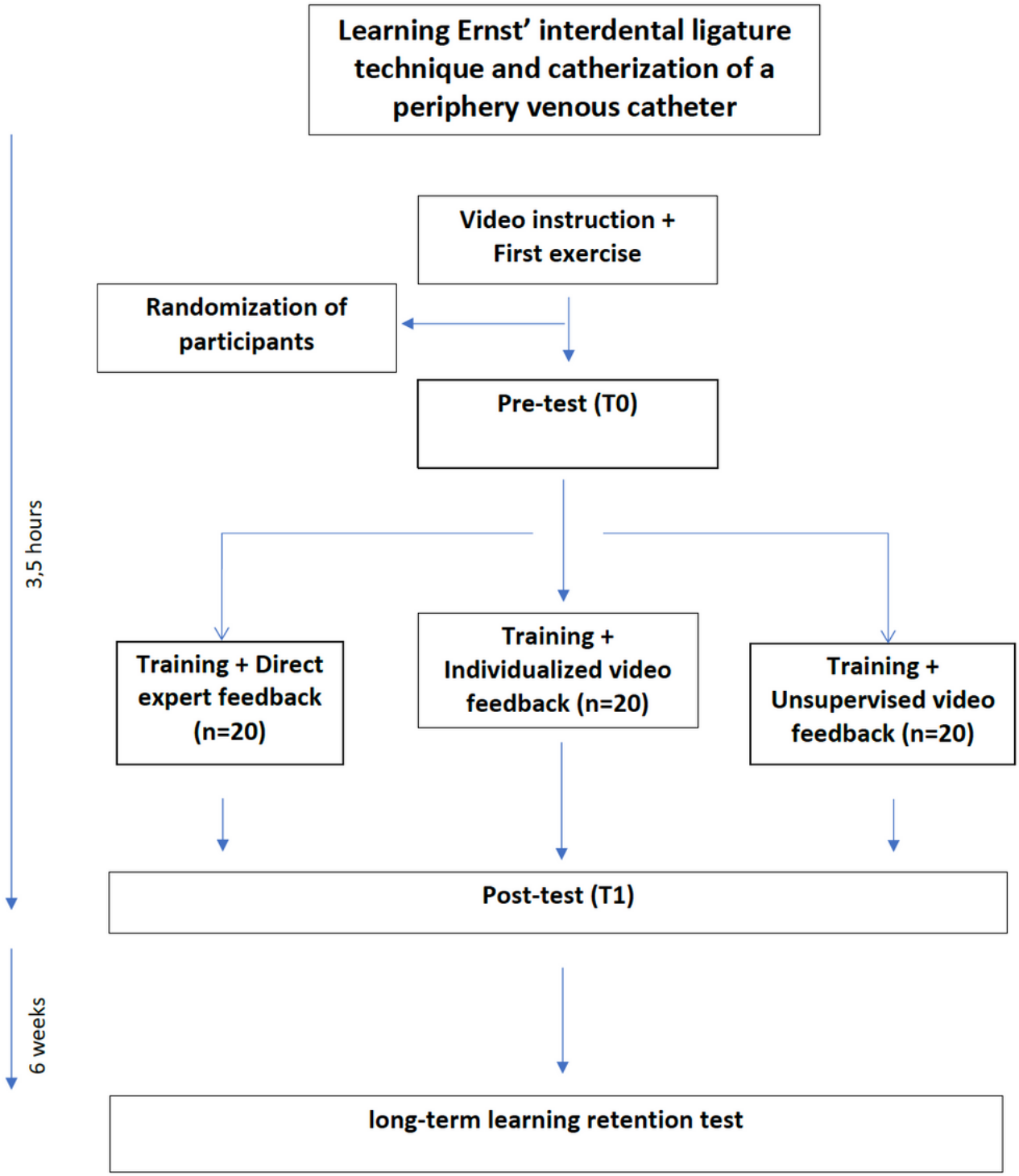

Figure 1

Diagram that represents the participant flow in the study and the timeline

Ernst' Interdental Ligature

Examiner: _____

Student Information

Step	**Not attempted 0**	**Attempted/ incomplete 1**	**Correct/ Complete 2**
Hand disinfection (6-step method)	☐	☐	☐
Putting on gloves	☐	☐	☐
Teeth correctly identified	☐	☐	☐
‚Tongue' traumatized (wire put through the opposite side)	☐	☐	☐
One wire above/below the outer one	☐	☐	☐
Twisted "under pull" (not just sole rotary movement)	☐	☐	☐
Proper placement of the ligature (outer wire becomes "pulled" interdentally)	☐	☐	☐
Wire-ends shortened	☐	☐	☐
Wire-ends bent	☐	☐	☐
Tools used (wire scissors, luniartschek, tweeters)			
Model lifted, no = 2, 1x = 1, multiple times/out of the green area = 0	☐	☐	☐

Figure 2

Global rating scale used for the performance measurement of the Ernst' interdental ligature

Student Information

Periphery venous catheter

Examiner: _____

Step	**Not attempted 0**	**Attempted/ incomplete 1**	**Correct/ complete 2**
Hand disinfection (6-step method)	☐	☐	☐
Putting on gloves	☐	☐	☐
Correctly applying a torniquet	☐	☐	☐
Finding a suitable injection site (palpation of the veins, if problems: tapping, hanging down the arm)	☐	☐	☐
Injection site is sufficiently disinfected	☐	☐	☐
Injection site does not become "non-sterile" again (for example, by repeated palpation of the vein after disinfection)	☐	☐	☐
Quick insertion of the needle and advancement into the vein	☐	☐	☐
The torniquet is released	☐	☐	☐
The peripheral venous catheter is sufficiently fixed	☐	☐	☐
The needle is safely disposed immediately after removal	☐	☐	☐

Figure 3

Global rating scale used for the performance measurement of the periphery venous catheter

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- CONSORT2010ChecklistKopie.pdf