Peer Assisted Learning: A Pedagogical Alternative of Teaching Skills to Medical Students

Aprendizagem Assistida por Pares: Uma Alternativa Pedagógica no Ensino de Competências a Estudantes de Medicina

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ABSTRACT

Introduction: Technical skills training is fundamental for clinical practice although poorly emphasised in undergraduate medical curricula. In these circumstances, Peer Assisted Learning methodology has emerged as a valid alternative to overcome this insufficiency. The purpose of this study is to evaluate the impact on students of a Peer Assisted Learning program in basic surgical skills, regarding technical competences and knowledge improvement.

Material and Methods: A total of 104 randomly selected third year medical students participated in a workshop delivered by fifth year students. From that total, 34 students were assessed before and after the workshop, using the Objective Structured Assessment of Technical Skills instrument, that consists of a global rating scale and a procedure-specific checklist. Sixth year students (control group) were also assessed in their performance without participating in the workshop. Before workshop *versus* after workshop Objective Structured Assessment of Technical Skills results were compared using Wilcoxon and McNemar tests. After workshop *versus* control group Objective Structured Assessment of Technical Skills results were compared using Mann-Whitney, qui-squared test and Fisher's exact test.

Results: For the global rating scale, students obtained an after the workshop score (29.5) that was significantly higher than the before the workshop score (15.5; *p*-value < 0.001), but no significant differences were found between after the workshop and control group scores (*p*-value = 0.167). For the procedure-specific checklist, 3rd year students had a substantial positive evolution in all parameters and obtained higher rates of correct achievements compared to the control group.

Discussion: The final outcomes demonstrated a significant qualitative and quantitative improvement of knowledge and technical skills, which is in accordance with other literature.

Conclusion: This Peer Assisted Learning program revealed promising results concerning improvement of surgical skills in medical students, with little staff faculty contribution and extension to a much broader number of students.

Keywords: Education, Medical, Undergraduate; General Surgery / education; Peer Group; Students, Medical

RESUMO

Introdução: O treino de competências técnicas é fundamental para a prática clínica, mas pouco explorado no currículo médico pré-graduado. Neste contexto, o método de aprendizagem assistida por pares tem surgido como uma alternativa válida para contrariar esta insuficiência formativa. Neste estudo pretende-se avaliar o impacto, nos estudantes, de um programa de aprendizagem assistida por pares em técnicas cirúrgicas básicas, relativamente a competências técnicas e conhecimentos adquiridos.

Material e Métodos: Foram selecionados aleatoriamente 104 estudantes do terceiro ano de Medicina para participarem numa formação, lecionada por estudantes do quinto ano. Um total de 34 estudantes foram avaliados antes e após formação, através do instrumento *Objective Structured Assessment of Technical Skills*, composto por uma escala global de avaliação e uma lista de verificação específica de procedimentos. Estudantes do sexto ano (grupo de controlo) foram também submetidos a uma avaliação, sem formação. Os resultados do *Objective Structured Assessment of Technical Skills* obtidos pelos estudantes antes da formação *versus* após a formação foram comparados através dos testes de Wilcoxon e McNemar. Para comparar os resultados do *Objective Structured Assessment of Technical Skills* obtidos pelos estudantes após formação *versus* grupo de controlo foram utilizados os testes de Mann-Whitney, qui-quadrado e teste exato de Fisher.

Resultados: Na escala global de avaliação, os estudantes obtiveram uma pontuação após a formação (29,5) significativamente superior à obtida antes da formação (15,5; *p-value* < 0,001), não tendo sido encontradas diferenças significativas entre após a formação e grupo de controlo (*p-value* = 0,167). Na lista de verificação específica de procedimentos, os estudantes obtiveram uma evolução significativamente positiva em todos os parâmetros, sendo que estudantes após a formação obtiveram, maioritariamente, uma percentagem de realizações corretas bastante superior ao grupo de controlo.

Discussão: Os resultados obtidos demonstraram uma melhoria qualitativa e quantitativa significativa do conhecimento e competências técnicas dos estudantes, o que se encontra em consonância com a literatura encontrada.

Conclusão: Este programa de aprendizagem assistida por pares revelou-se promissor para a melhoria das competências técnicas cirúrgicas dos estudantes de medicina, com utilização de escassos recursos da faculdade e extensão a um número mais alargado de

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estudantes.
Palavras-chave: Cirurgia Geral/educação; Educação Médica Pré-graduada; Estudantes de Medicina; Grupo de Pares

INTRODUCTION

The structural reforms that have been introduced in medical education underlying a greater concern with the holistic approach to patients have led to a lower emphasis on technical skills (TS) in undergraduate medical curricula.[1-3] A suboptimal TS training in medical schools has been suggested by some studies, leading students to seek extracurricular training[1,3,4] while junior doctors have described this as one of the areas in which they consider themselves less competent (median of 2.8 in a five-point Likert scale).[3] TS training is crucial to ensure autonomous and skilled practice of the profession.[1,2,5-8]

As regards surgery, (i) aseptic technique, (ii) handling of surgical instruments, (iii) suturing techniques and their removal have been described in European documents as some of the core competences.[7-9] A Portuguese nationwide study on suturing techniques[3] has found that Portuguese new graduates had a self-perception of low competence (median of 2.6 in a five-point Likert scale).[3]

Transmitting practical contents requires demanding educational schemes with high student/tutor ratios[10] and extended availability of teaching staff.[11] However, these requirements are limitations that are frequently found in medical schools. Peer-assisted learning (PAL) has emerged as an alternative training method to fill this training gap.[4,11,12]

PAL is a teaching method in which people from similar groups, not teachers, help each other to learn and learn to teach.[13] Its use in medical education was started in the 1970s in the United States of America[14] and is considered as a valid method to promote teaching in small groups, with sustainable use of resources and reaching a larger population.[13,15,16] It has been incorporated into the medical curricula in different universities worldwide, in several areas and with positive outcomes for trainees/trainers as for the medical curriculum.[12-20] It is a proven method in teaching of human anatomy[12] with similar promising results in physical examination training.[12] Recently, there has been an increase in its application to TS training, namely regarding basic surgical skills (BSS), in medical schools in the United Kingdom such as Keele, Exeter and Cardiff, as well as in São Paulo, Brazil.[4,11,21,22] The outcomes have shown a significant improvement in the skills of students in BSS, in a sustainable and inexpensive manner.[4,11,21,22]

Some of the documented advantages of PAL include (i) cognitive and social congruence,[23] (ii) supportive learning environment, (iii) enhancement of student teaching knowledge, (iv) increasing motivation, leadership training and confidence, (v) increasing involvement in learning and development process and (vi) preparation for the future role as educator.[12,13,15,16]

The main objective of this work was to evaluate the outcome of a PAL program in BSS as regards the improvement of knowledge and TS in medical students. This was part of the Near-Peer Teaching modality, which consists of training from the initial levels of a course carried out by students from more advanced levels of the same study program, with a difference of one or more years.[15] In order to achieve the main objective, three specific objectives were considered: (i) perception assessment of trainee students as regards the PAL program; (ii) comparison of the level of knowledge and TS pre and post-PAL program and (iii) comparison of the level of knowledge and TS post-PAL program *vs.* the level of knowledge and TS of final-year students.

MATERIAL AND METHODS

A pilot PAL program based on guide no. 30 of the Association for Medical Education in Europe was held by the Medical Education Office (*Gabinete de Educação Médica* - GEM) of the Faculty of Medicine of the University of Coimbra (FMUC) and the *Núcleo de Estudantes de Medicina da Associação Académica de Coimbra* (NEM/AAC) in the 2015/2016 academic year.[15] This program consisted of a training session on BSS aimed at third-year students, led by fifth-year students of the Integrated Master's Degree in Medicine (MIM). Third-year students' knowledge of BSS was assessed by an examiner before (AnF) and following the training session (ApF). In addition, the BSS knowledge of a group of sixth-year MIM students (control group (CG)) was assessed in order to compare it with the ApF knowledge of the third-year students who attended the session.

Participants

Three different types of participants (trainers, trainees and controls) were involved in the PAL program.

Twelve students enrolled in the fifth year of the MIM of the FMUC in the 2015/2016 academic year were included in the trainer group. The fifth-year students were considered, as it is an advanced year of medical training but with greater time availability when compared to the sixth-year students. These were recruited from a pool of volunteers, as suggested by Wadoodi and Crosby.[24] The participants received a 16-hour training, proportionally divided into (i) a pedagogical component under the responsibility of the GEM and (ii) a technical component under the responsibility of two experienced general surgery registrars (from the third and fourth years of the six-year internship) at the *Centro Hospitalar e Universitário de Coimbra, EPE*. The content of this

technical component was based on the general subjects of the course of the Royal College of Surgeons of England - Surgical Skills for Students.[25] Trainers were informed on the session's objectives and contents, while the implementation of the session and methodologies were entirely their responsibility.

Third-year MIM undergraduate students of the same academic year were included in the trainee group, as it is the last pre-clinical year in which teaching of practical procedures, namely suturing, is already planned. These were selected from a NEM/AAC list with 258 students. Having attended a similar extracurricular training and/or holding a university degree in a related area were considered as exclusion criteria, which has reduced the group to 224 trainees, sorted alphabetically by name and each of them was assigned an integer number between 1 and 224; a group of 130 students, approximately 58% of the study population, were then randomly selected (sample size calculation is described in the Sample Size section) using an available online random number generator.[26] These students were sent an invitation to participate and a brief description of the PAL program, through their class representatives and in writing; 104 students agreed to participate.

Those who agreed to participate attended the BSS training session. However, due to logistical time-related limitations and the examiner's availability, it would not be possible to assess such a large number of students before and after the session and it was established that the knowledge assessment would only be applied to a subset of these students. They were then sorted alphabetically by name and each was given a whole number between 1 and 104, in sequence. Forty students were then randomly selected [evaluation group (EG)], using the same random number generator. A measurement instrument, the Objective Structured Assessment of Technical Skills (OSATS),[27-30] was applied to these students before and after the training session in order to assess their knowledge on BSS.

Sixth-year students having completed the surgical internship were included in the CG and the same exclusion criteria that were applied to third-year students were applied to them. A pool of volunteers was also created for the selection of these students and a group of 20 students was obtained. The CG members did not attend a training session; they were only assessed regarding their knowledge on BSS, using the OSATS.

Anonymity was ensured and a verbal informed consent was obtained from all participants. The study was submitted and approved by the Faculty of Medicine of the University of Coimbra, according to the rules established for final works of the Integrated Master's Degree in Medicine, so it was not submitted to the Ethics Committee.

Training session

In total, five training sessions were carried out, covering eight students each and with a three-hour duration, delivered by two student trainers, with a 1:4 trainer-trainee ratio, as suggested by Dubrowski and MacRae.[31] Each session included a theoretical exposition and a practical component using a pig suture model. The content covered in the training session was based on the recommended objectives of undergraduate training: aseptic technique (surgical hand washing, use of personal protection, use of sterile gloves, and disinfection of surgical and non-surgical wounds), principles of wound closure, suture threads, surgical instruments and their handling, simple suturing technique, suture removal time and suture and staple removal technique.

Performance evaluation

Each participant in the EG underwent a 10-minute practical test on BSS using a pig model and was assisted by an examiner (a fifth-year registrar). The performance was assessed by the examiner, based on the OSATS instrument,[27-30] validated for surgical registrars[27] and translated into Portuguese and applied to medical students by Denadai *et al.*[29], consisting of two components: a detailed global rating scale (GRS) for surgical procedures and an operation-specific checklist (OSC).

The GRS allows the assessment of global qualitative aspects of the BSS performance and consists of eight items, measured by five-point Likert scales: respect for tissue (RT), time and motion (TM), instrument handling (IH), suture technique (ST), flow of operation (FO), knowledge of specific procedure (KSP), quality of final product (QFP) and overall performance (OP). Total score ranges from eight to 40 points but by definition, an examinee is considered competent in the technique with a score of at least 24 points.[28]

The OSC is less examiner dependent and indicates whether each of the following parameters was performed correctly: sterile technique (ST), cleans wound outward x2 (CWOx2), appropriate suture choice (ASC), needle driver (ND), perpendicular penetration and exit (PPE), bite no closer than 0.5 cm (BNC), knot technique with needle holder (KTNH), 'surgeon's knot' technique (SNT), leaves 0.5cm after cutting suture (LACS) and suture removal (SR).

Trainees underwent no extracurricular preparation of any kind for the AnF assessment, so they presented for examination with the knowledge they had acquired during the first three years of the course at the time of the AnF assessment. In addition, they were unfamiliar with the content of the practical test and the structure of the assessment. All were considered to be in equivalent conditions as they attended the same academic and curricular year and within the same institution. The ApF assessment had a similar structure, even though with a different content in order

to take advantage of the element of surprise. Three weeks elapsed between the first assessment and the training session, due to reasons related to the availability of those involved. The second evaluation took place one month after the training session, so that not only the immediate impact, but also the knowledge retention (or TS) was assessed.[32]

No verbal feedback was given during the evaluations. The examiners did not have access to any information that could identify the students and different assessment sheets were used at both moments.

Self-perception questionnaire

At the end of the session, trainees were asked to complete a satisfaction questionnaire (Appendix 1: https://www.actamedicaportuguesa.com/revista/index.php/amp/article/view/12125/Apendice_01.pdf). This questionnaire was aimed to assess the students' perception of the training session, namely its impact on their confidence, motivation, knowledge and TS, in addition to some qualitative parameters of the session, namely: trainers' skills/knowledge, working group size, learning environment, teaching method and teaching resources used. Close-ended questions were mostly used, in five-point Likert scales (1 - "strongly disagree"; 5 - "strongly agree") or dichotomous yes/no.

Since the authors did not find in literature any validated questionnaire that met their objectives, a questionnaire was developed and pretested with a 10-people convenience sample.

Sample Size

A total of 130 participants from the 224-participant study population were selected. This sample size was determined for proportions, considering: confidence level = 95%, sample proportion = 50% (conservative scenario) and sample error = 5.6%. However, only 104 agreed to participate, corresponding to an approximately 7.1% sampling error. For the study of the effect of the training session, 40 students were randomly selected from these 104, without prior calculation of the sample size. The justification for this size was due only to logistical limitations of the study's operationalisation. In order to bypass this limitation, magnitudes of effect are presented in the analysis of the session effects.

Statistical methods

Data analysis was performed using Microsoft Excel 2016 and SPSS v.25 softwares.

Nominal qualitative variables were described by their absolute (n) and relative (%) frequencies. Ordinal qualitative and non-normal quantitative variables were described by the median (Med) and interquartile range [Q1; Q3], in which Q1 represents the first quartile and Q3 represents the third quartile. The normality of quantitative variables was checked by observing the histograms.

Wilcoxon's test has been used to compare two paired distributions in the case of ordinal or non-normal quantitative variables and McNemar's test in the case of dichotomous variables.

Mann-Whitney test was used to compare two independent distributions of non-normal quantitative variables.

Chi-square test or Fisher's exact test (whenever chi-square did not meet the requirements) were used to verify the independence of dichotomous variables.

Magnitudes of effect (ME) were determined in each test: Wilcoxon - ratio of the standardised statistic test to the square root of the number of observations; McNemar - p - 0.5, where p is the maximum between b/(b+c) and c/(b+c), where b and c correspond to the discordant cells in a double-entry table; Mann-Whitney - ratio of the standardised statistic test to the square root of the total number of individuals; Chi-square/Fisher's exact test- Phi coefficient. ME of 0.1 are small, 0.3 are medium and above 0.5 are large.

p-values ≤ 0.05 were considered as significant.

RESULTS

A total of 104 third-year MIM undergraduate students who have agreed to participate in the PAL program have attended the BSS.

The study design is shown in Fig. 1.

Self-perception questionnaire

An assessment questionnaire was completed by 89 of the 104 participants (see Appendix 1: https://www.actamedicaportuguesa.com/revista/index.php/amp/article/view/12125/Apendice_01.pdf), including 54 respondents (60.7%) aged 19-21, 32 (36%) aged 22-24 and 3 (3.4%) aged 25 or older. As regards any previous contact with the suture technique, 51 (57.3%) described as having had it within some curricular unit (51 86.3%) [attended 1-3 hours of training, six (11.8%) 4-9 hours and only one (2%) over 9 hours]. As regards any previous contact with asepsis and wound cleansing notions, 59 (66.3%) have described no previous training, while 27 (90%) of those who have given affirmative responses had 1-3 hours of training and the remaining three (10%) 4-9 hours. A total of 64 (71.9%) respondents have described that they were in disagreement with having received sufficient training in suturing technique and 61 (68.5%) disagreed that they have received sufficient training in notions of asepsis and wound cleansing.

The answers to the questions on impact and quality of the session are shown in Table 1. A positive impact has been described by most respondents: on TS (84; 94.4%); knowledge (82; 92.1%), confidence (82; 92.1%) and motivation (81; 91%) in performing the techniques (Table 1). As regards quality, most respondents have assessed the

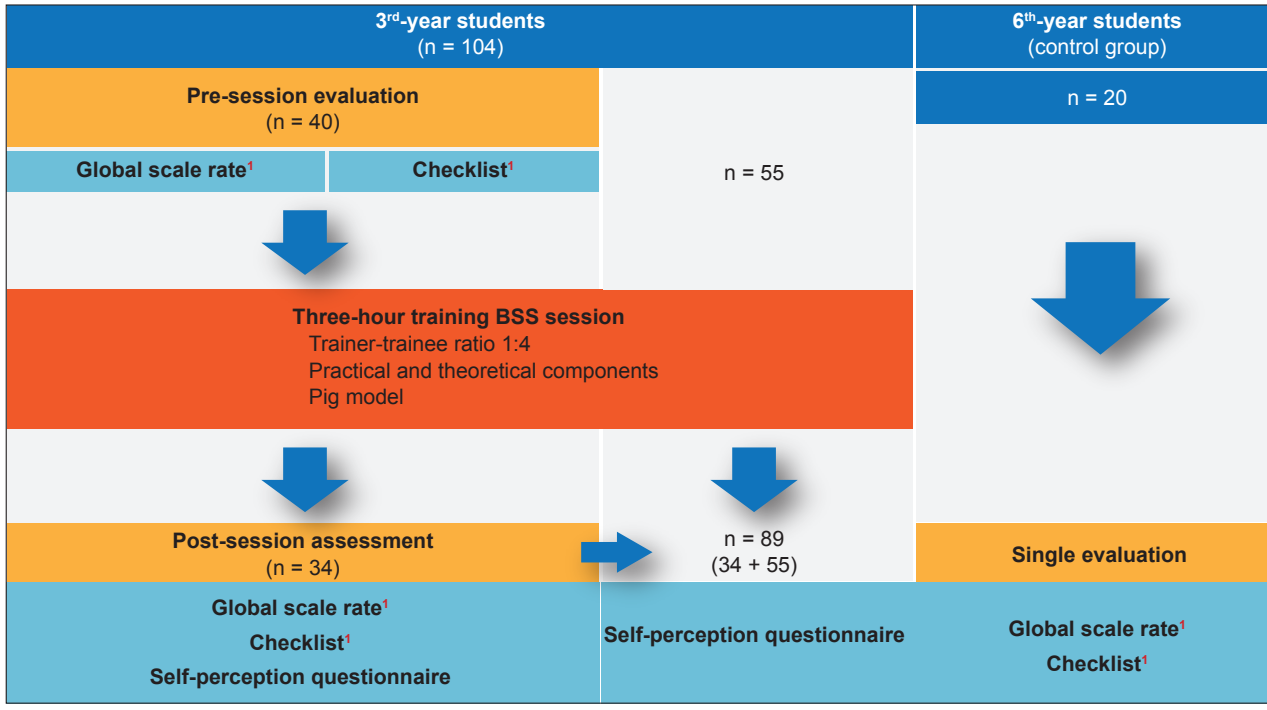

Figure 1 – Study design
1: Components of the OSATS (Objective Structured Assessment of Technical Skills) instrument, validated for surgical techniques
PAL: peer-assisted learning; BSS: basic surgical skills; MIM: Integrated Master's degree in Medicine

quality associated with each parameter as high/very high.

All respondents have described that they would participate in a further session taught by more experienced students while 84 (94.4%) have described that they would consider the possibility of participating as trainers in a further PAL program.

Performance evaluation

A total of 40 students were included into the EG and all were presented for the first assessment. However, only 34 students were presented for the second assessment, as exclusion criteria were met by six students. Thus, the results shown in Table 2 refer to the 34 participants in both assessments (AnF and ApF) [23 (67.6%) female].

Table 1 – Evaluation of the training session (89 third-year MIM undergraduate students)

	1	2	3	4	5	Med [Q_1;Q_3]
Impact of the training session						
Sinto que o workshop foi útil para desenvolver a minha competência técnica nas áreas abordadas.	0 (0%)	0 (0%)	5 (5.6%)	37 (41.6%)	47 (52.8%)	5 [4; 5]
Sinto que o workshop foi útil para desenvolver o meu conhecimento teórico nas áreas abordadas.	0 (0%)	0 (0%)	7 (7.9%)	43 (48.3%)	39 (43.8%)	4 [4; 5]
Após o workshop senti-me mais confiante para executar as tarefas que me foram solicitadas.	0 (0%)	1 (1.1%)	6 (6.7%)	52 (58.4%)	30 (33.7%)	4 [4; 5]
Sinto que, após o workshop, fiquei mais motivado para aprender mais sobre técnicas cirúrgicas/sutura.	0 (0%)	0 (0%)	8 (9%)	42 (47.2%)	39 (43.8%)	4 [4; 5]
Sinto que fui ensinado num ambiente descontraído que potenciou a minha aprendizagem.	0 (0%)	0 (0%)	4 (4.5%)	26 (29.2%)	59 (66.3%)	5 [4; 5]
Quality of the training session						
Competence/knowledge of the trainers.	0 (0%)	0 (0%)	3 (3.4%)	47 (52.8%)	39 (43.8%)	4 [4; 5]
Working group size.	0 (0%)	2 (2.2%)	4 (4.5%)	33 (37.1%)	50 (56.2%)	5 [4; 5]
Learning environment.	0 (0%)	0 (0%)	0 (0%)	30 (33.7%)	59 (66.3%)	5 [4; 5]
Teaching methodology.	0 (0%)	0 (0%)	4 (4.5%)	36 (40.4%)	49 (55.1%)	5 [4; 5]
Educational resources.	1 (1.1%)	0 (0%)	11 (12.4%)	39 (43.8%)	38 (42.7%)	4 [4; 5]

mpact of the training session. 1: I totally disagree; 5: I totally agree. Quality of the training session. 1: Very low; 2: Low; 3: Medium; 4: High; 5: Very high..

A 15.5 median total AnF score and a 29.5 median total ApF score were obtained with the GRS (Table 2), with a statistically significant 14-point increase (*p*-value < 0.001) reflected into a large ME value (0.62). In fact, there was a statistically significant increase in the median values in all the items of the GRS, with large ME values shown in all items. The AnF assessment has shown that only one participant scored 24 points, i.e., only one (2.9%) student was considered competent[29] in simple suture technique; 30 (88.2%) participants scored > 24 points in the ApF assessment, showing an increase in the number of students considered as competent.

A statistically significant positive progression in student performance has been found for all parameters with the OSC assessment (Table 2). The ApF assessment has shown that CWOx2 and KTNH parameters were correctly performed by all the students, while the AnF assessment has shown that these techniques had been correctly performed by nine (26.5%) and 17 (50%) participants, respectively. Even though significantly higher percentages of ApF scores have been obtained in all parameters, those showing a greater progression included ST - difference = 28 (82.4%); ME = 0.5; *p*-value < 0.001; CWOx2 - difference = 25 (73.5%); ME = 0.5; *p*-value < 0.001; PPE - difference = 24 (70.6%); ME = 0.5; *p*-value < 0.001; SNT - difference = 24 (70.6%); ME = 0.46; *p*-value < 0.001 and KTNH - difference = 17 (50%); ME = 0.5; *p*-value < 0.001, while those with the lowest progression included ND - difference = 16 (47.1%); ME = 0.36; *p*-value = 0.001; ASC - difference = 14 (41.2%); ME = 0.35; *p*-value = 0.003; LACS - difference = 13 (38.2%); ME = 0,34; *p*-value = 0,004; BNC - difference = 11 (32,4%); ME = 0,24; *p*-value = 0,035 and SR - difference = 10 (29,4%); ME = 0,31; *p*-value = 0,021. The SR parameter showed the lowest ApF scores, with 18 (52.9%) students showing correct scores.

Comparison of performance with the CG

The CG included 20 sixth-grade students. The results obtained by this group were compared with the ApF scores obtained by the EG (Table 3).

Statistically significant differences (*p*-value = 0.018) between EG and CG ApF scores were only found as regards the RT item, with a higher median ApF EG score (4 *vs.* 3), reflected into a medium ME value (0.32). As regards the GRS assessment of the remaining items, no significant differences were found in both groups. The same happened for the scale's total score, i.e., even though a higher median total EG ApF score has been found (29.5 *vs.* 28.5), the

Table 2 – Pre and post-training session assessment (34 third-year MIM undergraduate students)

	Pre-sessionn = 34	Post-session n = 34	*p*-value	Magnitude of the effect
GRS, Med [Q_1;Q_3]				
Respect for tissue	2 [1.75; 2]	4 [3; 4]	< 0.001[a.*]	0.60
Time and motion	2 [1; 2]	3 [3; 4]	< 0.001[a.*]	0.59
Instrument handling	2 [1; 2]	3 [3; 4]	< 0.001[a.*]	0.59
Suture technique	2 [1; 2]	4 [3; 4]	< 0.001[a.*]	0.60
Flow of operation	2 [1; 2.25]	4 [3; 4]	< 0.001[a.*]	0.60
Knowledge of specific procedure	2 [1; 3]	4 [3; 4]	< 0.001[a.*]	0.59
Quality of final product	2 [1; 3]	4 [3; 4]	< 0.001[a.*]	0.60
Overall performance	2 [1; 3]	4 [3; 4]	< 0.001[a.*]	0.60
Total score	**15.5 [9; 19]**	**29.5 [26; 32]**	< 0.001[a.*]	0.62
Operation-specific checklist, n (%)				
Sterile technique	1 (2.9%)	29 (85.3%)	< 0.001[b.*]	0.5
Cleans wound outward x2	9 (26.5%)	34 (100%)	< 0.001[b.*]	0.5
Appropriate suture choice	7 (20.6%)	21 (61.8%)	0.003[b.*]	0.35
Needle driver	13 (38.2)	29 (85.3)	0.001[b.*]	0.36
Perpendicular penetration and exit	9 (26.5%)	33 (97.1%)	< 0.001[b.*]	0.50
Bite no closer than 0.5 cm	16 (47.1%)	27 (79.4%)	0.035[b.*]	0.24
Knot technique with needle holder	17 (50%)	34 (100%)	< 0.001[b.*]	0.50
"Surgeon's knot" technique	8 (23.5%)	32 (94.1%)	< 0.001[b.*]	0.46
Leaves 0.5 cm after cutting suture	9 (26.5%)	22 (64.7%)	0.004[b.*]	0.34
Suture removal	8 (23.5%)	18 (52.9%)	0.021[b.*]	0.31

a: Wilcoxon test; b: McNemar test.
*: significant at 5%

Table 3 – Evaluation group (post-session - ApF) *vs.* control group

	Evaluation group n = 34	Control group n = 20	*p*-value	Magnitude of the effect
GRS, Med [Q_1;Q_3]				
Respect for tissue	4 [3; 4]	3 [1.25; 4]	0.018[a.*]	0.32
Time and motion	3 [3; 4]	3 [1; 4]	0.207[a]	0.17
Instrument handling	3 [3; 4]	3 [1.25; 4]	0.169[a]	0.19
Suture technique	4 [3; 4]	3 [1; 4]	0.188[a]	0.18
Flow of operation	4 [3; 4]	4 [1; 4]	0.070[a]	0.25
Knowledge of specific procedure	4 [3; 4]	4 [2.25; 4]	0.135[a]	0.20
Quality of final product	4 [3; 4]	4 [1; 4]	0.483[a]	0.10
Overall performance	4 [3; 4]	4 [2; 4]	0.127[a]	0.21
Total score	**29.5 [26; 32]**	**28.5 [10.5; 31.8]**	0.167[a]	0.19
Operation-specific checklist, n (%)				
Sterile technique	29 (85.3%)	14 (70%)	0.294[b]	0.18
Cleans wound outward x2	34 (100%)	16 (80%)	0.015[b.*]	0.37
Appropriate suture choice	21 (61.8%)	3 (15%)	0.001[c.*]	0.45
Needle driver	29 (85.3%)	11 (55%)	0.014[c.*]	0.33
Perpendicular penetration and exit	33 (97.1%)	14 (70%)	0.008[b.*]	0.39
Bite no closer than 0.5 cm	27 (79.4%)	12 (60%)	0.124[c]	0.21
Knot technique with needle holder	34 (100%)	13 (65%)	< 0.001[b.*]	0.50
"Surgeon's knot" technique	32 (94.1%)	13 (65%)	0.009[b.*]	0.38
Leaves 0.5 cm after cutting suture	22 (64.7%)	6 (30%)	0.014[c.*]	0.34
Suture removal	18 (52.9%)	2 (10%)	0.002[c.*]	0.43

a: Mann-Whitney test; b: Fisher's exact test; c: chi-square test.
*: significant at 5%

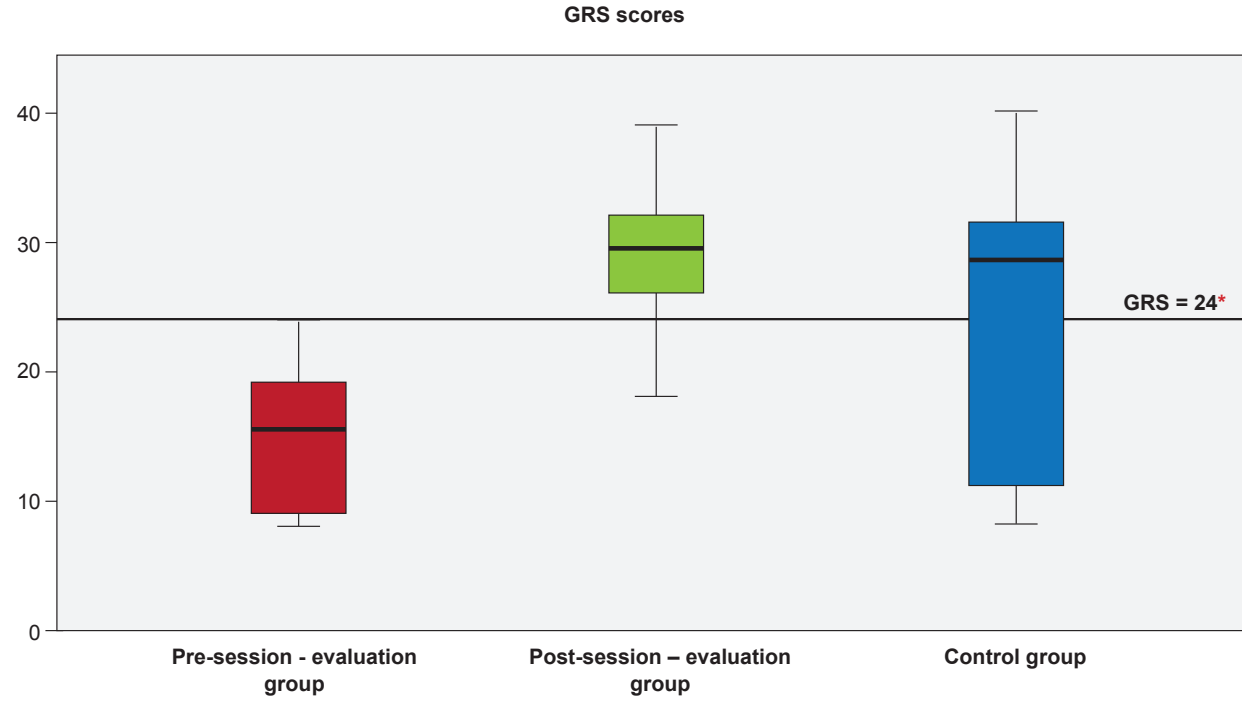

Figure 2 – Total scores in global rating scale (GRS) for the evaluation group in both assessments (pre and post-training session) and for the control group (a single moment of assessment)
*: Score from which every trainee is considered as competent in the technique.[28]

distributions of both groups were not considered as significantly different (*p*-value = 0.167), showing a low ME value (0.19). Total scores of GRS for the EG at both assessments (AnF and ApF) as well as for the CG (a single assessment) are shown in Fig. 2. It is worth mentioning a < 24-point AnF EG score that was obtained, a score from which any participant was considered competent in suturing technique. It should also be noted that a higher dispersion has been found in the CG when compared to the ApF EG, as total score of GRS ranged 8-40 in the CG, while it ranged 18-39 in the ApF EG.

As regards the OSC assessment, ST (*p*-value = 0.294) and BNC (*p*-value = 0.124) were the only parameters for which no statistically significant differences were found, showing low ME values (0.18 and 0.21, respectively). A much higher ratio of correct performance has been found in the EG when compared to the CG, mainly in ASC (61.8% *vs.* 15%; ME = 0.45); SR (52.9% *vs.* 10%; ME = 0.43); KTNH (100% *vs.* 65%; ME = 0.50); LACS (64.7% *vs.* 30%; ME = 0.34) and ND (85.3% *vs.* 55%; ME = 0.33). The use of the OSC in both groups is shown in Fig. 3, showing that more students in the EG obtained better ApF scores when compared to the CG.

DISCUSSION

In line with other studies,[4,11,12] the PAL program has contributed to significant qualitative and quantitative improvement in knowledge and TS, covering more students and using fewer faculty resources. The evaluation obtained by the GRS showed a significantly positive progression in AnF and ApF scores, while an increase in the number of students who correctly performed the parameters of the list has been found with the OSC. It has been shown in another study[34] that a single TS training session within the undergraduate curriculum could promote an improvement of these skills and motivation in students. This was also found in this study.

Techniques in medicine are everyday actions of clinical skills, supported by a strong component of scientific knowledge. As the development of proficiency in a technique is a cumulative and progressive process[33] teaching should start during undergraduate training.[1,3] PAL methodology for teaching BSS allows a more profitable use of resources and reaching a larger number of students, preparing them with teaching skills and promoting their competence and confidence.[4,11,16,17]

Few studies have evaluated PAL in BSS[4,11,23,34,35] and even fewer have used the OSATS instrument.[11]

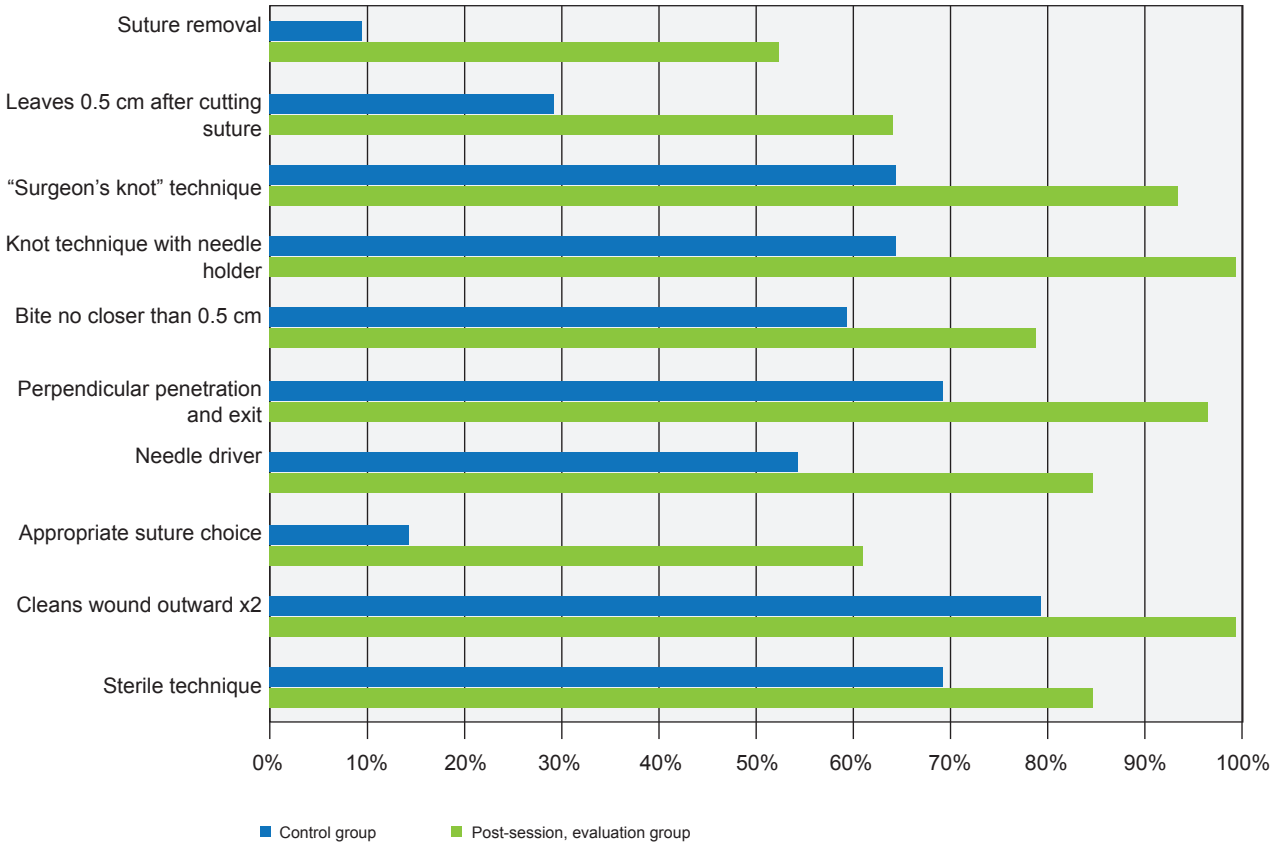

Figure 3 – Students in the evaluation group (post-session) and in the control group that have correctly performed all the procedures in the checklist

The results obtained in this study were in line with literature,[11] even though higher median ApF scores were obtained in this study with the GRS. This result may be explained by the fact that, in this study, these were students attending the end of their third year who were submitted to the AnF assessment with higher GRS scores, since differences between AnF and ApF scores were similar in both studies. As regards the OSC, success rates above 70% after training (ApF) were obtained for all parameters except the following: ASC, LACS and SR. In addition, successful ApF scores in COWx2 were obtained by all the students. These results could be explained by the fact that these are simple techniques, with little cognitive complexity and therefore can easily be taught by trained students.

When EG ApF total scores in GRS were compared to those obtained in CG, no statistically significant differences were found between both groups. However, there is a greater dispersion of results in CG students, which may mean that training is not uniform and consistent, depending on the opportunities provided by the clinical setting, as reported by Davis *et al.*[1] This result refers to final-year students (with all course units completed) and is in line with the study by Grilo *et al.*,[3] in which recent graduates have described practical procedures including suturing as one of the areas in which they feel less competent.

Regarding students' perception of the curriculum and the training session, a negative degree of academic exposure to BSS has been described by respondents, in line with other studies.[1,3,4] More than 80 respondents (> 90%) agreed that the training session had contributed to develop their knowledge and TS in BSS. This perception is in line with the progression of the ApF performance and is in line with another similar study,[4] as well as with the idea that PAL could in fact contribute to an improvement of technical skills in BSS.[4,11] In addition, more than 80 respondents (> 90%) described that the training session had increased their level of confidence and motivation in performing the techniques, showing higher scores than a previous similar study.[4] These data are in line with what is described in literature, namely the studies by Hill,[12] Topping,[13] Ten Cate[16] and Bennet.[35]

A median score over 4 (1-5 Likert scale) has been found in all the parameters regarding session quality, showing the students' satisfaction with the quality of the training, in line with the study by Preece *et al.*[4] Almost all students (96%) have described that they were taught in a relaxed environment that enhanced their learning. This relaxed environment, which was described by different studies as one of the main characteristics and added value of PAL, associated with greater cognitive and social congruence,[12,13,16,23,36] promotes higher levels of learning when compared to traditional teaching.[34] In fact, it is known that anxiety levels increase with poorly relaxed environments, which can be detrimental to the acquisition of knowledge and query handling.[36]

The EG sample that was used by this study was randomly selected, with well-defined inclusion and exclusion criteria, in contrast to other similar studies.[4,11,12] However, the results obtained are in line with those of other studies.[4,12] The use of the OSATS as an assessment tool is worth mentioning, as it is considered a gold standard for the objective assessment of surgical technical skills.[38] We chose to have the assessments carried out by a single examiner in order to avoid some degree of examiner bias. The use of a structured assessment method, with well-defined and pre-established assessment parameters, validated in other contexts, also aimed to mitigate some subjective biases.

In this study, a short retention time assessment has been used (one month), leaving some doubt as to whether the results would remain the same with a longer time gap. This should be assessed in further research. Other limitations include the fact that no analysis of representativeness was carried out and, although a satisfactory sample size and magnitude of effect values were obtained, it would be interesting to extend the study to the remaining Portuguese medical schools. In order to obtain greater data validity, the use of an already validated questionnaire would have been advantageous. However, no such questionnaire has been found in literature by the authors.

This study showed that a well-organised PAL program carried out by students in the final years can represent an asset for teaching skills, without any prejudice to the students, according with the conclusions of a large-scale retrospective study.[19] The relaxed atmosphere, the accountability of older students for one of the functions of being a doctor, their own training and that of their peers (transmission of experience), the development of team spirit and solidarity among colleagues are values developed in a program such as this one.[16,20,36] As described by Furmedge *et al.*,[17] many of these students may already be performing these functions within their own interest groups and would simply benefit from an academic support that would ensure[22] accurate knowledge, aligned with the curricular objectives of the faculty. It is clear that the involvement of students in the construction of their curricula and learning has a significant correlation with the levels of satisfaction and this cannot and should not be underestimated.[17,16] This is shown by the fact that all students have described that they would participate in further PAL sessions as trainees and more than 80 respondents (> 90%) even described that they would consider participating as trainers. This is in line with a similar study.[35]

The trend shown by these results was the reason for the development of an optional curricular unit at the FMUC called Peer Assisted Teaching, started in the 2017/2018

academic year, with an enthusiastic support by students and with its first assessment expected after three academic years. This curricular unit is composed of three practical strands (basic clinical actions, BSS and basic life support) and a pedagogical one and is aimed at fifth-year students who will teach their younger colleagues.

CONCLUSION

This peer-assisted learning program was promising in the improvement of the surgical technical skills of medical students, using scarce faculty resources and extending to a wider number of students.

The results found in this study explain the need for further research in a longitudinal manner, as well as to assess the transfer of learning into clinical practice. It may be interesting to extend the study to other skills and knowledge domains.

HUMAN AND ANIMAL PROTECTION

The authors declare that the followed procedures were according to regulations established by the Ethics and Clinical Research Committee and according to the Helsinki Declaration of the World Medical Association.

DATA CONFIDENTIALITY

The authors declare that they have followed the protocols of their work centre on the publication of patient data.

CONFLICTS OF INTEREST

The authors declare that there were no conflicts of interest in writing this manuscript.

FINANCIAL SUPPORT

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