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New test for systematic skills enhancement and improvement in maxillofacial surgery training: multicentre pilot study

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Abstract

We know of few studies in the international scientific literature that specifically address the evaluation of surgical and clinical progress among physicians undergoing specialist training in maxillofacial surgery. Identifying a reliable tool to accurately assess both theoretical knowledge and surgical skills of trainees is essential. The primary aim of this study therefore was to design a comprehensive assessment tool that is capable of evaluating both the theoretical and practical skills of physicians undergoing specialist training in maxillofacial surgery. The methodology employed aims to ensure fairness and effectiveness in skills development, thereby optimising training activities. To meet this need, an evaluation and self-assessment test was developed for maxillofacial surgery trainees at the Ospedali Riuniti of Ancona. Data collection involved digitally administered evaluations and self-assessment tests focused on maxillofacial traumatology, based on AO trauma surgery references. Data were processed into graphs which revealed a progressive learning trend following an initial adjustment phase, leading to optimal outcomes in both clinical and surgical domains. The evaluation and self-assessment test proved to be a valuable learning tool with which to gauge advancements in clinical and surgical skills among maxillofacial surgery residents.

Keywords: surgical training; resident training; evaluation test; self-evaluation; learning curve; surgical autonomy; clinical learning; surgical learning; maxillofacial surgery

Introduction

To our knowledge few studies in the international scientific literature have evaluated the surgical and theoretical progression of surgical trainees, particularly in the specialty of maxillofacial surgery. This scarcity is especially apparent when considering the evaluation of residents' progress. In

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the last decade we could find only one study on the digital assessment of basic surgical procedures in maxillofacial trainees using a mobile application. However, this study focused solely on practical activities, neglecting the crucial aspect of good surgical planning, which stems from the acquisition of theoretical knowledge and the ability to make appropriate surgical decisions.[1]

It is crucial to identify an assessment tool that can effectively evaluate didactic-theoretical advancement and surgical proficiency of the trainees.[2]

Our study sought to address three key questions regarding the training of resident maxillofacial surgeons: How can training outcomes be enhanced? What strategies are conducive to directing learning effectively? How can residents be empowered in clinical and surgical practice?

The authors aimed to devise an impartial method to enhance the acquisition of skills among maxillofacial surgery trainees. This unique tool is intended to comprehensively evaluate theoretical and practical progress. Through its implementation, specialist training activities can be optimised, emphasising efficiency and targeting the development of skills in areas that require additional exploration. Additionally, individual skill improvement can be prioritised.

Material and methods

A prospective multicentre pilot study was conducted from January 2022 to December 2023 by the Azienda Ospedaliero-Universitaria delle Marche in Ancona. The evaluation tool, designed to assess advancement in maxillofacial traumatology in doctors undergoing specialist training, incorporated an evaluation and self-assessment test (Supplemental File 1). This tool was developed using AO trauma surgery references as a scientific framework.[3]

The study involved seven trainees from the School of Maxillofacial Surgery at the University of Siena who volunteered for the evaluation, along with a single volunteer tutor for each network training school location. Tutors were responsible for assessing both the theoretical and practical performance of the trainees involved.

Throughout the study, 189 traumas were deemed suitable for test evaluation across all the training network locations. These traumas were organised into 27 groups, each containing seven traumas presented in chronological order. Each resident was assigned a trauma from each group, and evaluation and self-assessment tests were conducted for each trauma. To qualify for the test, traumas had to be surgically relevant, referred for treatment, and involve the specialist training doctor as the primary surgeon with assistance from the referral tutor. Traumas requiring urgent attention or those not performed directly by the trainees were excluded.

For each group, the arithmetic mean of the scores obtained by the trainees was calculated. Subsequently, the data were processed into tables and graphs to evaluate trends. Additionally, at the study's conclusion, each trainee provided feedback on the usefulness of the evaluation and self-assessment test to identify critical issues that needed resolution. Feedback was based on three statements: I found the test easy to understand and complete; I found the test useful for measuring my skills; and I found the test useful for improving my skills. Responses were recorded on a Likert scale ranging from strongly disagree to strongly agree (Supplemental File 2). [4]

Evaluation test structure and how to conduct the test

The test was divided into three distinct sections, each assessing a specific theoretical-practical area (Supplemental File 1).

Section 1. Focus: preliminary phase of maxillofacial trauma management

Trainee task: Answer five open-ended questions on surgical fracture identification, classification, and treatment planning. Complete this section independently, relying on theoretical knowledge of traumatology.

Tutor task: Review and score each question from 1 to 5 based on the Likert scale.[4]

Section 2. Focus: surgical behaviour assessment during the planned procedure

Trainee task: Perform the surgical procedure as the first operator, following the previously planned approach.

Tutor task: Observe the trainee during the surgery. Evaluate and score the surgical behaviour from 1 to 5 after the procedure.[4]

Section 3. Focus: final evaluation from initial assessment to postoperative radiological results

Trainee task: Provide a self-assessment score for the final question.

Tutor task: Assess the overall process from initial evaluation to postoperative radiological results. Score each question from 1 to 5.[4]

Rating scale

A simple progressive numerical scale based on Likert theory.[4]

Scores range from 1 (indicating inconsistency in competence) to 5 (indicating maximum competence).

Total possible points range from 14 to 70, based on the sum of the points from each section.

Overall assessment

Scores for each procedure are chronologically arranged and entered into a table to track progress in the learning curve.

Results

The study involved 189 cases managed by the resident-tutor pairs, with each case undergoing a digital evaluation and self-assessment test. The arithmetic mean of the scores obtained by the trainees was computed for each of the 27 groups. The total mean scores are summarised in Table 1. These scores were recorded chronologically to analyse pro-

gression. Graphical representations were generated from the data collected, illustrating the trend of the numerical scores over time. A gradual progression was noted in all sections examined.

Analysis of the obtained data revealed significant improvements across the duration of the study. In the first section, the average percentage score of the initial group was 75%. This progressively increased to 98.9% in the last group, an overall increase of 23.9%. In the second section, the average percentage score began at 63.33% and rose to 94.9% in the final group, marking a 31.6% increase. In the third section, scores started at 76.5% and reached 95% by the end of the study, reflecting an 18.5% increase. Overall, the initial average score of 71.7% rose to 96.3%, an average increase of 24.6%.

The trend depicted in Figure 1 focuses on clinical evaluation and surgical planning. Initially, the scores notably surpassed half the minimum score required, indicating a strong start in understanding and execution. However, an early negative dip was observed in evaluations of the first five traumas, suggesting an adjustment period for the trainees. This was followed by a stabilisation phase characterised by slight oscillations in performance, which reflected a period of acclimatisation as the residents refined their clinical and planning skills. Progress then continued, ultimately reaching a plateau that approached the maximum score. This progression demonstrated a significant improvement over time as trainees became more proficient in integrating clinical knowledge with practical surgical planning.

Table 1
Mean score per section.

Groups (1-189)	Mean score per section			Total
	Section 1	Section 2	Section 3	
1 (1-7)	19	15.833	15.333	50.167
2 (8-14)	22.571	20	17.429	60
3 (15-21)	24.143	23.143	18.143	65.429
4 (22-28)	23	22.571	19.429	65
5 (29-35)	23.286	19.286	16.143	58.714
6 (36-42)	23.429	14.286	12.286	50
7 (43-49)	23.286	17.714	13.857	54.857
8 (50-56)	23.286	18.286	14.286	55.857
9 (57-63)	24	17.857	15.286	57.143
10 (64-70)	23.143	18.286	16.143	57.571
11 (71-77)	22.857	19.429	16.286	58.571
12 (78-84)	23.429	20.857	16.429	60.714
13 (85-91)	23.286	22.571	16.714	62.571
14 (92-98)	22.143	21.571	14.429	58.143
15 (99-105)	23.571	22.571	16	62.143
16 (106-112)	24	23.25	17.125	64.375
17 (113-119)	24.714	22.857	16,429	64
18 (120-126)	24.429	23.571	16.286	64.286
19 (127-133)	24.143	23.286	17	64.429
20 (134-140)	24.571	22.143	17.429	64.143
21 (141-147)	24.429	22.715	17	64.143
22 (148-154)	24.5	22.625	16.875	64
23 (155-161)	24.429	23	17.286	64.714
24 (162-168)	24.429	22.857	16.286	63.571
25 (169-175)	24.714	23.143	16.571	64.429
26 (176-182)	24.429	23.143	17	64.571
27(183-189)	24.714	23.714	19	67.429

The performance trends in the implementation of surgical planning are illustrated in Figure 2, revealing a distinct trajectory compared with the clinical evaluation observed in Figure 1. Initially, scores in this section were lower, indicating a steeper learning curve as trainees began to apply their surgical skills. A notable initial peak suggested brief early success, but this was quickly followed by a rapid decline as challenges and complexities became evident.

However, as the evaluation period progressed, the scores gradually improved. This slow but steady ascent reflected the trainees' increasing proficiency and adjustment to the demands of the surgical skills required. The scores eventually reached a plateau, signifying the stabilisation of skills and knowledge. Notably, the maximum score was achieved after evaluating half the cases, illustrating a significant advancement from initial struggles to proficient performance.

The trajectory of scores in the final evaluation phase is demonstrated in Figure 3, displaying patterns similar to those in Figure 2. Initially, the scores in this section were lower than those in the clinical section, indicating a more challenging start as trainees tackled comprehensive assessments that involved both clinical and surgical aspects. The initial positive peak in the graph suggested early successes, possibly due to the initial application of learned skills. However, this was followed by a gradual decline, reflecting the complexities and integration challenges of the final stages of training. Subsequent progress remained steady, with scores eventually reaching a plateau that signified the stabilisation of skills. Notably, this plateau was reached after half of the cases had been assessed, with trainees achieving the maximum score.

Unlike the previous sections, wider score ranges were observed in the plateau phase, highlighting a greater variability in individual performance during the final evaluation. This variation could be attributed to different levels of mastery of the integrative and comprehensive aspects of the training by each resident.

The cumulative results from all the evaluated sections of the study are presented in Figure 4, showcasing the overarching trends in skills and knowledge development among the trainees. The graph effectively encapsulates progressive improvements across the entire training programme, from clinical evaluation to final assessment.

The data in Figure 4 clearly demonstrate a general upward trend in the trainees' performance, with initial lower scores gradually rising to reach and be sustained at high levels. This visual representation underscores a significant enhancement in both the practical application of surgical techniques and theoretical understanding.

Overall, the results illustrate the robust training methodology employed and the successful acquisition of critical competencies by the trainees, validating the efficacy of the assessment tools used.

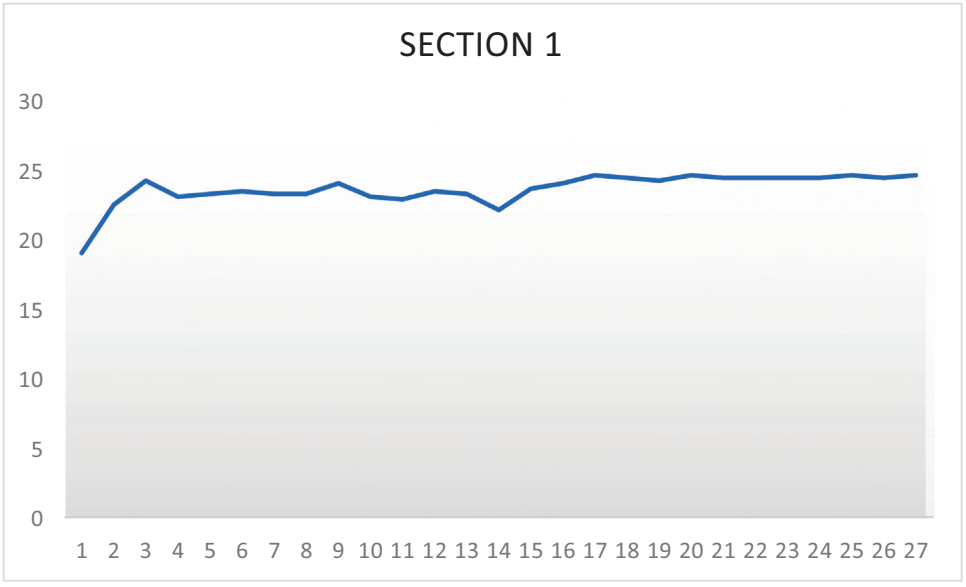

Fig. 1. Trend of scores in section 1.

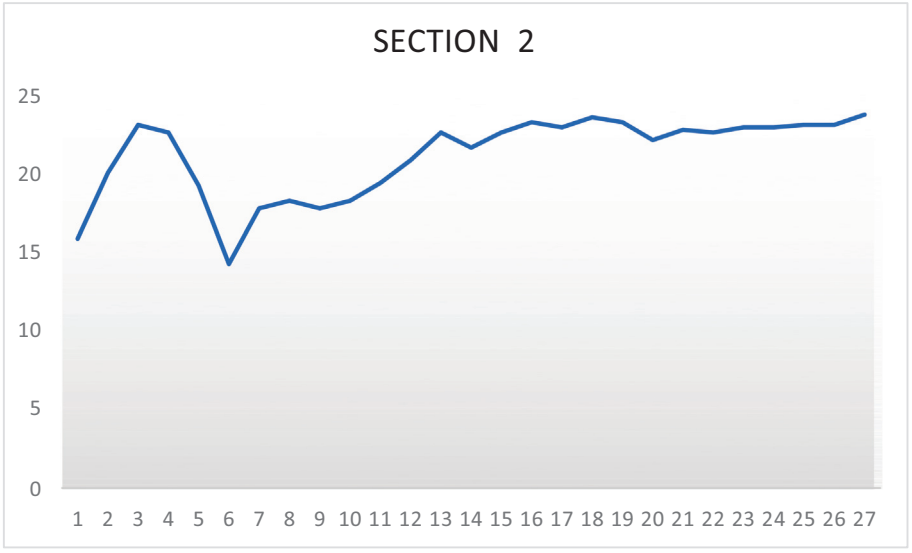

Fig. 2. Trend of scores in section 2.

Feedback from the trainees based on three key questions resulted in the following responses.

I found the test easy to understand and complete

In total, 57.1% agreed and 42.9% strongly agreed.

I found the test useful for measuring my skills

All the responses were strongly agree.

I found the test useful for improving my skills

In total, 71.4% strongly agreed, while 28.6% agreed.

The feedback provides insight into the test's effectiveness and its acceptance by the trainees.

Discussion

Surgical training within medical specialty schools, particularly in the field of maxillofacial surgery, has not, to our knowledge, been extensively explored in the scientific literature. Typically, such training involves two concurrent educational aspects: clinical and surgical skills. These are intended to complement each other, but they often progress independently. Clinical skills are usually acquired more quickly while manual surgical skills require a longer time to develop, necessitating a blend of theoretical knowledge and hands-on surgical practice.

A national survey conducted in 2009 revealed that 27.5% of doctors undergoing specialist training expressed concerns about not achieving sufficient autonomy by the end of their studies.[1,5,6]

Unlike previous studies, this research not only evaluated the surgical component but also the clinical aspect, aiming to identify a tool that could assess progress in both clinical and surgical learning.[1,2,6,7]

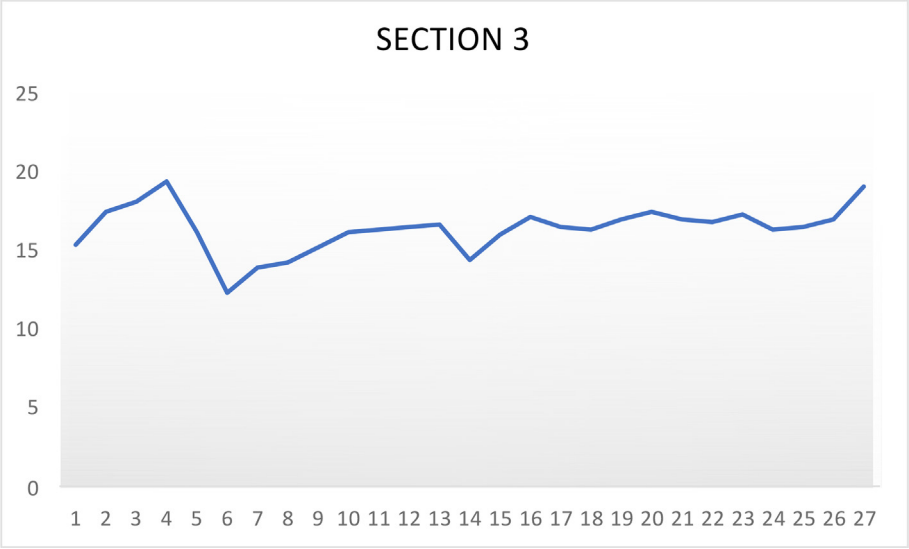

Fig. 3. Trend of scores in section 3.

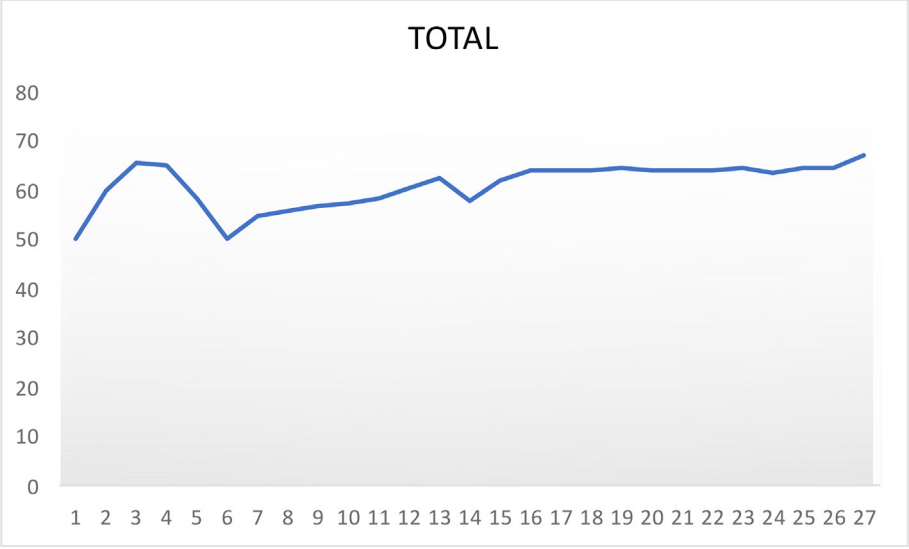

Fig. 4. Trend of total scores.

Drawing from the scientific literature, we have delineated a unique learning curve specifically tailored for residents in surgical training. This curve differs from conventional ones designed for seasoned practitioners, which evaluate innovative surgical techniques, and is characterised by distinct phases that reflect the residents' evolving proficiency and understanding.

The initial phase in which residents show a lack of awareness about surgical procedures and limited theoretical knowledge, is marked by a steep learning curve as they begin to understand the fundamentals of surgical practice. The second phase involves a positive peak when residents gain a minimum level of unconscious competence and feel more confident in their abilities, although this confidence may not always align with actual proficiency. The third phase has a noticeable shift in awareness as theoretical knowledge begins to surpass practical skills. This leads to residents becoming more aware of their technical limitations, prompting introspection and self-assessment.[8]

Subsequent phases of the learning curve follow a classic trajectory, leading to incremental improvements in both theoretical understanding and surgical proficiency. By recognising these phases educators and mentors can effectively tailor training programmes to support residents through their learning journey, fostering growth and competency in surgical practice.

The evaluation and self-assessment test in this study aims first to identify clinical gaps, then to rectify them and progress to phases such as surgical planning and execution. The study provides a comprehensive view of the clinical cases, enabling the trainee to personally evaluate their progress.

Analysis of the preliminary study data has shown that initial scores already exceeded half the minimum score, indicating a strong foundation, most likely due to prior theoretical knowledge. However, an initial dip in performance was noted in the first five cases, followed by a stabilisation phase with slight fluctuations. This pattern was mirrored across other sections, with each displaying unique trajectories and challenges, underscoring the complexities and nuances inherent in the journey towards surgical proficiency.

Numerous methods have been described in the literature to evaluate the progression of doctors in specialist training. A classic example can be defined by procedure-based assessment (PBA) whose training role in terms of surgical progression is certainly well established. However, the need to perform a minimum number of PBAs to achieve the right surgical experience is, in some cases, counterproductive.[9]

The authors found greater effectiveness in an evaluation using Miller's pyramid, which better integrates theoretical skills with application in surgical practice.[10] For this reason, development of the test examined earlier in this study was based on the evaluation of theoretical, surgical, and personal skills, divided into distinct sections. Traumatology was selected as the focal point for this preliminary study due to its significance in maxillofacial surgery training. Mastery of traumatology is deemed crucial for expediting the training process for specialists.[11]

The study's strength lies in its integration of both theoretical and practical components. The self-assessment aspect encourages self-criticism and gap identification, supported by tutor evaluations and numerical scoring, which simplify the assessment of progress.

Feedback from the study was overwhelmingly positive, with high agreement on ease of execution, comprehensibility, and usefulness of the test to evaluate and advance skills. The findings encourage further research to validate the method.

However, the preliminary nature of the study limits the ability to conduct extensive case studies for official validation. If this evaluation method is to become accessible to more trainees, future studies will be essential, and may extend the test to other surgical specialisation schools, potentially applying it to all medical specialisation schools.

This evaluation and self-assessment test serves as a valuable tool for learning progression among trainees, effectively assessing both theoretical and clinical progression while highlighting surgical advancement. It nurtures self-criticism, problem-solving, and personal growth, and enhances individual strengths while identifying areas that require further study. It also allows tutors to gauge their teaching efficacy and adapt their methods to optimise learning.

Conclusion

This preliminary case series study has validated an evaluation system aimed at enhancing the clinical and surgical skills of doctors undergoing specialist training.

Conflict of interest

All the authors have no financial relationships to disclose. All the authors have no conflict of interest related to this publication.

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Ethics statement/confirmation of patients permission

Not needed.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author(s) used Chat GPT 4 to improve the readability of the manuscript. After using this tool, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bjoms.2024.07.004.

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