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Review

Systematic review and meta-analysis of the role of mental training in the acquisition of technical skills in surgery

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Abstract

BACKGROUND: Mental training is rehearsal of mental imagery without physically performing the task. The aim of the study was to perform systematic review and meta-analysis on all the available data to evaluate the role of mental training in the acquisition of surgical technical skills.

METHODS: The following search databases were used: EMBASE, MEDLINE, Web of Science, Clinicaltrials.gov.uk, SIGN guidelines, NICE guidelines, and Cochrane review register. Meta-analysis was performed using Revman 5.2 statistical software.

RESULTS: There were a total of 9 randomized controlled trials with 474 participants, of which 189 participants received mental training. Five randomized controlled trials concluded positive impact of mental training. Mental training group did not show any significant improvement in overall performance of the task carried in each study ($P = .06$).

CONCLUSION: Mental training can be used as an important supplementary tool in learning surgical skills when run in parallel with physical training and applied to trainees with some experience of the skill.

Mental imagery is one's ability to "view" and "feel" the task without physically conducting it.[1,2] It can occur in all sensory modalities. Mental training of the task can be used to learn cognitive, kinesthetic, psychomotor, or technical skills.[3,4] Terms such as "mental rehearsal," "mental practice," and "mental imagery" describe the same phenomena. The role of mental training is firmly established in psychology, music, and sports.[2] Extensive studies conducted in stroke, rehabilitative medicine, and neurophysiology recognize the use of mental training to develop motor skills.[2,5–9] Mental training in these specialties is used alone or in conjunction with conventional physical practice.

Mental images have been shown to play same role in the production of motor action as being performed physically.[2] Mental images were previously described as "imagens," which had same specific modalities of the image as object imagined in real.[2] Without external stimulus, mental image possess properties of natural object in terms of vision, touch, audio, smell, and taste.[8,10] Fitt's law further suggested that the time taken during mental motor task linearly correlated with the imagined complexity of the task.[2]

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Currently, surgical training is facing great challenges. In early 1900s, Halsted's idea of "see one, do one, teach one" was propagated across surgical education programs in the United States.[11] Surgical trainees learnt technical skills through apprenticeship spending ample time in theatre. The Accreditation Council for Graduate Medical Education in the United States and European directives in Europe restricted the number of hours trainees could work and added intense pressure to fulfill all procedural competencies.[12,13] With the emergence of minimally invasive surgery, trainees were exposed to a variety of new procedures, which required different set of motor and cognitive skills.[14,15] This environment was less than optimal for surgical training.

Different surgical educational centers tried to incorporate supplementary and alternative modes of training for surgical technical skills. Chief Medical Officer in the United Kingdom and American College of Surgeons[16] recommended the virtual simulation technology. Another important form of surgical education was the study of applied kinesiology.[10] It dealt with the science of movements and ergonomics. Mental imagery training is a relatively undiscovered venue of surgical education; however, it has seeked attention in recent times.

Mental training provides a potential alternative or adjunctive solution for surgical units to acquire technical skills in surgery.[17,18] Eldred et al[19] identified that experienced surgeons mentally rehearsed complex operations to prepare themselves for complex stressful situations in operating theatre. The concept of "mind's eye" was proposed to describe surgeon's ability of perceiving sensory modalities while mentally conducting the task.[19]

Most of the studies that looked into the effect of mental training in surgery have been conducted in the last 20 years. Most of these trials were randomized. They focused on the acquisition of surgical technical skills with the use of mental imagery. Some of these studies have shown beneficial role of mental training in surgical tutoring; however, other studies concluded futile results with this form of training method. These studies have analyzed various outcome measures in learning of skills while comparing it with other teaching methods directly. We aim to perform a systematic review and meta-analysis on the effect of mental training on the learning of surgical technical skills.

Method

The literature search was conducted from February 15, 2014 to April 1, 2014. The following search terms were used: mental practice, mental training, mental imagery, "visual imagery," "motor training," "auditory imagery," "olfactory imagery," and "motor imagery." These terms were further combined with "surgery," "laparoscopic surgery," and "education" to search for relevant articles. The following search databases were used to perform literature search: EMBASE, MEDLINE, Web of Science, Clinicaltrials.gov.uk, SIGN guidelines, NICE guidelines, and Cochrane review register. Further studies were identified through cross-reference of studies reviewed initially.

The following inclusion criteria were used:

1. Only randomized controlled trials (RCT) assessing the role of mental practice in surgical training.
2. The participants of the studies were healthy volunteers with medical background. They may be medical students, surgeons, surgical trainees, or trainers.
3. RCT evaluating any aspect of mental imagery and practice in context of surgery that is auditory, visual, olfactory, motor, tactile, or cognitive.
4. RCT evaluating the effect of mental practice on surgical training measuring any outcome or parameter, that is, cognitive, physiological, or imaging-based evidence.
5. RCT assessing mental training in surgery utilizing any mental training session, for example, script memorization, psychotherapy, hypnotherapy, or laboratory experiments.
6. RCT published in English language.

The following exclusion criterion was used: any nonrandomized study, case series, observational study, or case report that suggest association of mental training and surgery without conducting experiments or involving participants.

All the raw data were collected in Microsoft Excel (Microsoft Corp., Redmond, WA). The process of identifying studies to include in the review is mentioned in Fig. 1 and the excluded studies are presented in Table 1 with the reason for exclusion. Two independent reviewers (A.R. and A.A.) analyzed each study used in the review. In case of any disagreements regarding inclusion and quality of the study, the issue was resolved by the third author (I.T.).

Statistical analysis

The statistical software Review Manager version 5.2 (The Cochrane Collaboration, Software Update, Oxford, UK) was used to conduct the meta-analysis. For dichotomous variables, relative risk was used which indicated the relative benefit of mental training compared with other teaching methods. Mean difference was used to compare continuous variables. This was used to take into account the sample size effect. Either standard deviation or value of range was used to complete analysis on continuous variables to standardize the data. Because there was apparent heterogeneity between the studies, random effect model for meta-analysis was used to formulate Forrest plot. Any heterogeneity between the studies was calculated using chi-square test, with a value P less than .100 indicating heterogeneity. Confidence interval of 95% was reported for each analyzed value. A Forrest plot was graphical representation of the relative strength of treatment effects. A diamond-shaped dot with the horizontal line showing the 95% confidence intervals depicted the outcome measure. The vertical line in the graph is the line of no effect. If any horizontal line of the outcome measure of the study was crossing the vertical line of "no effect," it meant that the study did not show any significant difference between the comparison groups. To assess the quality of RCT methodology,