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Quiet eye training improves surgical knot tying more than traditional technical training: a randomized controlled study

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Abstract

BACKGROUND: We examined the effectiveness of technical training (TT) and quiet eye training (QE) on the performance of one-handed square knot tying in surgical residents.

METHODS: Twenty surgical residents were randomly assigned to the 2 groups and completed pretest, training, retention, and transfer tests. Participants wore a mobile eye tracker that simultaneously recorded their gaze and hand movements. Dependent variables were knot tying performance (%), QE duration (%), number of fixations, total movement time (s), and hand movement phase time (s).

RESULTS: The QE training group had significantly higher performance scores, a longer QE duration, fewer fixations, faster total knot tying times, and faster movement phase times compared with the TT group. The QE group maintained performance in the transfer test, whereas the TT group significantly decreased performance from retention to transfer.

CONCLUSIONS: QE training significantly improved learning, retention, and transfer of surgical knot tying compared with a traditional technical approach. Both performance effectiveness (performance outcome) and movement efficiency (hand movement times) were improved using QE modeling, instruction, and feedback.

Experts consistently exhibit more efficient and effective gaze behaviors, comprised of fewer fixations of longer duration, compared with less expert and novice groups.[1,2] The number of fixations is thought to reflect the information processing demands placed on the individual, whereas the fixation location reflects the important cues used in guiding action. Of particular interest to researchers is the final fixation before the initiation of a critical phase of the movement, termed the quiet eye period (QE).[3] The QE period appears to functionally represent the time needed to organize the neural networks and visual parameters responsible for the precise control of movements.[4] The onset of the QE occurs before the critical movement and the offset when gaze deviates off the location. Both an earlier onset and longer QE duration have been consistently reported to be associated with higher levels of expertise and performance.

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Examining gaze and movement-based indices enable us to capture the perceptual and motor mechanisms that underlie efficient action. Gaze and hand movement behavior have previously been examined during several surgical procedures and skills. For example, in a computer-based laparoscopic surgery task, which involved reaching for and touching a small target, expert surgeons reported faster movement times, fewer errors, and longer final fixation on the target location compared with novices, who fixated the tool and target intermittently.[5,6] Researchers have also examined QE and hand movement times of surgeons with high and low levels of experience during identification and preservation of the recurrent laryngeal nerve during a thyroid lobectomy on a cadaver model.[7] Highly experienced surgeons had a longer duration QE on the nerve before performing blunt and sharp dissections, providing evidence of greater focus and concentration at critical moments during the operation.

Researchers have also reported differences in QE and hand movement behavior between expert and novice surgeons during a knot tying task.[8] Expert surgeons not only possess superior knot tying performance and faster movement times, but have a longer QE on the knot before the placement phase compared with novices, who had a higher percentage of fixations on their hands.[8]

QE training programs involving the use of video-based expert QE models and video feedback of individual QE characteristics, have been shown to increase QE duration, motor performance, and efficiency in a number of tasks.[9–14] In addition, virtual laparoscopic trainees in a gaze training group reported higher performance score, faster movement times, and longer fixations on the target location compared with movement training and discovery learning groups.[15]

The aim of the study was to examine whether a QE or technical training (TT) program would lead to increased knot tying performance in one-handed square knots in 1st-year surgical residents. Gaze and hand movement data were recorded during pretest, retention, and transfer conditions. It was hypothesized that the QE and TT groups would increase their knot tying performance from pretest to retention and transfer. It was predicted that the QE group would demonstrate a longer QE duration, fewer fixations, and faster hand movement times compared with the TT group in the retention and transfer tests.

Methods

Participants

Twenty 1st-year surgical residents (age: 26 ± 1.6 years) volunteered for the study. All participants had previously received a half-day of basic knot tying training using the Ethicon knot tying board and manual as part of their surgical skills module. Participants were randomly assigned to either a QE or TT group. All had normal or corrected to normal vision. Ethics approval was obtained through the University of Calgary Conjoint Health Ethics Research Board.

Equipment

A SensoMotoric Instruments (SMI) ETG eye tracking system was used to collect gaze and hand movement data. The SMI-ETG is a lightweight (76 g), glasses mounted binocular system that uses dark pupil tracking to measure the point of gaze with a spatial resolution of .1° and temporal resolution of 30 Hz (33.3 ms/frame), with a built-in high-definition scene camera. A Simulab Boss knot tying board was used for the pretest and retention, with red markers indicating desired knot placement location placed on the parallel tubing at a separation width of 2 cm (Fig. 1A). An Ethicon knot tying cylinder was used for the transfer test, with a red marker indicating desired knot placement location placed at the center of the hook (Fig. 1B). Both boards were covered with surgical drapes and Ethicon 2-0 Perma-hand silk sutures were used throughout the testing sessions.

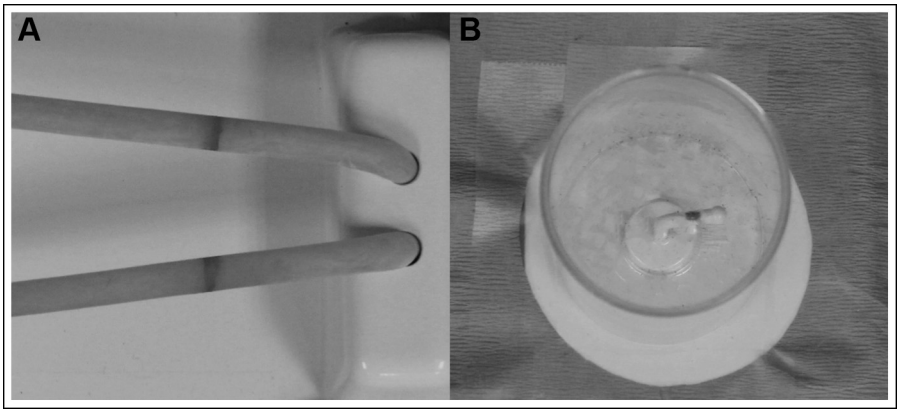

Figure 1 (A) Simulab Boss knot tying board, used for the pretest and retention, with markers indicating desired knot placement location; (B) Ethicon knot tying cylinder, used for the transfer test, with marker indicating desired knot placement location placed at the center of the hook.