



Original research

Crossover study of the effect of coffee consumption on simulated laparoscopy skills

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HIGHLIGHTS

- Coffee has an effect on psychomotor skill and mental alertness in many fields in and out of medicine.
- This study aims to isolate the psychomotor effects of coffee from the mental effects by using well rested individuals.
- Coffee has a deleterious effect on psychomotor parameters when performing laparoscopic skills in the well-rested novice.
- Coffee however has a slightly positive effect on accuracy when performing laparoscopic skills in the well-rested novice.

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ABSTRACT

Aims: To observe the effect of caffeine on performing laparoscopic skills in novices in a simulated setting.**Background:** Coffee is consumed almost ubiquitously by surgeons not just as a stimulant but also socially in the well-rested individual. It's therefore worth investigating its potentially negative effect on performance of surgical skills as it is known that coffee has psychomotor effects.**Methods:** This is a single-blind crossover study in which 31 novices were tested under three different conditions: decaffeinated, 100 mg caffeine and 200 mg caffeine. Candidates were asked to perform 3 repetitions of task 3, 6, 7 and 8 using the Lap Mentor™ (Simbionix®). Outcomes measured were completion time, accuracy, number of movements and total path length. The candidates were crossed over to the other caffeine doses on a different day.**Results:** 20 candidates completed the study, mean age 21.3 years, with 10 males and 10 females. Candidates performed tasks 7 and 8 faster in the decaffeinated group than the caffeinated groups with significant differences between decaffeinated and 100 mg caffeine (p-value = 0.001, 0.019 respectively) and decaffeinated and 200 mg in task 8 (p-value = 0.042). Total path length was significantly less in the decaffeinated group in tasks 7 and 8 and total number of movements was less in tasks 3, 7 and 8.**Conclusion:** Caffeine had no marked effect on accuracy, but had a negative effect on task economy (hand movements, total path length and completion time).

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1. Introduction

There has been a great deal of research into coffee as a stimulant and performance enhancer in many different fields however it is often conducted in the sleep deprived individual [1–4]. Coffee has long been known to have psychomotor effects; not only does it increase an individual's tremor [5], it also increases one's alertness,

reflexes and reactions whilst having varying effects on cognition and judgement [6,7]. It therefore has the potential to detrimentally affect surgical performance by decreasing economy of movement and accuracy by means of increasing tremor. This study aims to primarily investigate its motor effects on novices to laparoscopic surgery.

Coffee is widely used by all members of the healthcare team from medical students to consultants as a stimulant and it has been shown that it has a beneficial effect on performance when used in the sleep deprived [8]. However coffee is also consumed by staff at break times for social reasons even if the stimulant effects aren't

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required. Coffee was used in this study to more closely mimic actual coffee habits as caffeine is not the only component of coffee that exerts an effect.

Caffeine has many major pharmacodynamic effects. It plays a role as an adenosine A₁/A₂ receptor antagonist, in ryanodine receptor dependent intracellular calcium release and as a non-selective inhibitor of phosphodiesterase [6,9]. Caffeine's action as an adenosine receptor antagonist accounts for most of its CNS effects [7]. By acting on adenosine receptors, caffeine has a wide range of secondary effects on other receptors. Of these secondary effects, the receptor which has the most relevance to this investigation is the effect on adenosine A₂ receptors on striatopallidal neurones [7]. Caffeine has been shown to increase dopamine transmission at this level via A₂ receptor inhibition and should therefore theoretically have the property of modulating involuntary behaviour and coordination [7].

Laparoscopic surgery is required in most general surgical training curriculums and the potential effect of coffee on its performance is an area that needs investigation. Due to the nature of laparoscopy, it is easier to develop a virtual training platform for it and there is much widespread research pertaining to its use in training future surgeons. The virtual environment allows for easier objective performance metrics measurement in order to compare treatment groups and participants than open surgery. In addition, working in a smaller space requires greater precision meaning that any effects coffee may have on a surgeon's motor skill performance may be magnified in a laparoscopic environment.

Though the motor effects of caffeine have previously been investigated in other surgical specialties such as microsurgery [10] and ophthalmology [11], this study aims to investigate the effects of coffee in a well-rested individual in laparoscopic surgery.

The hypothesis is that coffee has a deleterious effect on the psychomotor parameters (completion time, accuracy, total number of movements and total path length) of a well-rested novice medical student performing virtual laparoscopic tasks.

2. Method

2.1. Participant demographics

Medical students who are novices to laparoscopy were used because they have a similar baseline of laparoscopic skill. 31 medical students were recruited in this randomised single-blind crossover study. The students completed a pre-study

questionnaire regarding their background, caffeine use and previous surgical experience. Inclusion criteria included students who were over the age of 18 and were currently studying at a medical school. Subjects were crossed over in order to limit any bias between subjects though each candidate also completed a preliminary task which was the peg transfer task on the Lap Mentor™ by Symbionix® to assess whether there were any gross problems encountered by the candidate with the equipment. Exclusion criteria excluded any students who had prior practical experience of laparoscopy beyond camera manipulation, who had gross problems with the equipment whilst performing the preliminary task, drank more than 1 cup of tea or coffee a daily, who had known adverse reactions to coffee or caffeine, who had relevant health problems that would affect performance such as uncorrected visual or motor conditions or conditions that would be affected negatively by caffeine.

2.2. Interventions

Students were told to be well rested and to abstain from any caffeine products for at least 24 h before each study which was confirmed by each participant before the study started. The study was single blinded and each participant was randomised to one of three intervention groups using pre-prepared envelopes and asked to perform the tasks. The intervention groups used were 100 mg of caffeine, 200 mg of caffeine and decaffeinated.

The coffee that was used was NESCAFÉ Original and NESCAFÉ Original Decaffeinated which contains 3.4 g of caffeine and 0.1 g of caffeine per 100 g of product respectively. 100 mg caffeine dose was selected based on the average caffeine content of a cup of coffee depending on volume and brand [12,13]. This was also approximately the amount of caffeine if one were to make coffee based on their directions. 200 mg was selected to ascertain whether there was any dose response relationship. Participants were asked to drink a cup of black coffee on arrival. Each cup was prepared so that the level of caffeine in the coffee matched the intervention group the participant was initially randomised to.

After drinking the coffee the students were then asked to wait for 1 h before beginning the study in order for the caffeine to reach peak serum levels. Based on pharmacokinetic data, 1 h was chosen as the average time to allow for caffeine to reach peak serum levels [14].

Table 1
Summary of tasks used from Lap Mentor™ by Symbionix® with parameters measured for the study.

Task	Description of task	Skills tested in each task
Task 3 – Hand-Eye Coordination	Red and blue hook diathermy electrodes are inserted. A series of red and blue balls at varying heights and depths flash in a specific sequence and the candidate must touch the balls in sequence with the corresponding electrode. Errors include touching with the wrong coloured instrument. See Fig. 1 for reference.	<ul style="list-style-type: none"> • Hand-eye coordination • Depth perception • Laparoscopic orientation • Bimanual skills
Task 6 – Two-handed Manoeuvres	Red balls in a jelly matrix must be placed into the endobasket with two endograspers. The jelly must be adequately retracted to allow for sufficient access to the balls which will then turn green. Errors include dropping the ball outside of the basket or performing the task with inadequate retraction. See Fig. 2 reference.	<ul style="list-style-type: none"> • Advanced bimanual skills • Laparoscopic instrument manipulation • Hand-eye coordination • Tissue handling skills
Task 7 – Cutting	A jelly mass is affixed by surrounding fibres. The jelly must be retracted and freed from the fibres by using endoshears. Errors include making cuts onto the matrix or over retraction of the matrix. See Fig. 3 for reference.	<ul style="list-style-type: none"> • Applying traction • Accurate cutting • Bimanual skills • Hand-eye coordination
Task 8 – Electrocautery	There are twenty blue fibres that turn green in sequence. Two hook diathermy instruments must be used to cauterise the green fibres. Errors include cauterisation of any blue fibres before they turn green. See Fig. 4 for reference.	<ul style="list-style-type: none"> • Safe and accurate use of electrocautery • Hand-eye coordination • Manual skills with one instrument

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