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ORTHOPAEDIC SURGERY

The utility and benefit of a newly established postgraduate training course in surgical exposures for orthopedic and trauma surgery

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Abstract

Introduction Limited data exist on specialty surgical cadaver courses for graduates, their skill gain, and whether the course contents are transferable to other surgical disciplines.

Aim We present the details on the establishment of a specialist trauma and orthopedics approach course, and explore educational and career outcomes from this program.

Methods A 3-day surgical approach course was developed, including a dissection program utilizing Thiel embalmed cadavers. The course was accredited with the local orthopedics association. Participants were assessed by survey on acquired surgical knowledge, skill, decision-making, confidence, and on self-development and effect on career.

Results Thirty-one participants successfully completed the courses over 3 years. Increases in surgical skill, knowledge, surgical decision-making and confidence were reported. Skills and confidence also positively impacted on other surgical disciplines. Courses rated highly for learning outcomes; comments highlighted usefulness, applicability, and practicing opportunities, while also impacting positively on career opportunities.

Conclusion Surgical courses have shown being useful for the acquisition of skills, knowledge, confidence and decision-making, with a positive impact on confidence and decision-making. This information is relevant to future participants, benefactors, surgical programs, and tertiary institutions who want to establish specialist surgical courses.

Keywords Education · Orthopedic surgery · Surgical anatomy · Surgical exposures · Traumatology approaches

Introduction

In recent years, a burgeoning market in post-graduate surgical anatomy courses has developed. The volume of such courses could reflect lack of anatomy training during undergraduate training [5, 11, 35], a lack of self-confidence in anatomy knowledge [14], or a perceived lack of institutional support and opportunities [19]. Surgical anatomy courses provide an increase in the topographical and procedural knowledge required to undertake surgery successfully [8], and can facilitate participants acquiring places on surgical training programs. Despite the increasing numbers of surgical anatomy courses, there are fewer specialty-focused surgical approaches where newly graduated doctors can practice and learn techniques guided by specialists.

Such surgical anatomy training programs are an attractive educational proposition, and the audience is generally different from postgraduate anatomy courses [35]. Surgical approach anatomy training courses cater for the growing demand of surgical training opportunities [39], providing an opportunity for the proactive mentoring and the acquisition of surgical skills and competence that enables surgical development and clinical decision-making [3, 21, 24, 30]. They provide an opportunity for practicing procedures in a low-risk, safe environment [7, 26]. There is ongoing debate about

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the efficacy of current surgical training programs [10, 28], the time available for trainees to learn surgical approaches [37], and the time for trainees to develop skills with specialized equipment [13, 22, 25].

Given of the lack of specialty surgical anatomy education opportunities in Australasia, we developed and implemented a program focusing specifically on trauma and orthopedic surgical approaches. This report details the course structure which was implemented and the assessment data gathered over the first 3 years of this course, including course rating, perceived skills, confidence, knowledge, and experience the participants gained from the course. We also explored whether any skills and confidence gained would be transferable to other surgical specialties. Information on the establishment and utility of such courses' is important to employers, benefactors, potential host institutions and future participants to allow informed decisions to be made about the value and potential benefits of such programs.

Materials and methods

Course development

The course was designed to specifically address the needs of medical doctors at an early stage of their postgraduate training, in particular registrars and Surgical Education and Training (SET) trainees for orthopedic surgery. Advice on course structure and delivery was sought from the New Zealand Orthopedic Association (NZOA) and educational committee and members of the Royal Australasian College of Surgeons (RACS). The NZOA accredited the course and awarded continuing professional education points for its successful completion. The course was designed as a 'stand-alone' educational offering, and a prior work history in an orthopedic department was recommended for persons interested in participating. The first course was delivered in 2016.

Course structure

Two course concepts were developed, including basic and advanced options. Since their inception, one basic and three advanced courses have been delivered. Apart from the different number of exposures taught in the basic compared to the advanced course, the exposures were studied in more detail in the basic setting. Courses were 3 days in duration, comprising of 7.5–9 contact hours each day. A total of 38 surgical exposures were taught within the advanced course, delivered in 13 modules, while in the basic course there were 20 exposures and 11 modules (Table 1). A maximum of eight participants enrolled, self-selecting into either the basic or advanced course, with an instructor–participant ratio of 1:3–4. Staffing involved one or two senior orthopedic surgeons (Fig. 1) and an anatomist with experience in surgery. The participant–cadaver ratio was 4:1. Participants were advised on the pre-reading of orthopedic surgical approach literature [29] prior to the course, with comprehensive details of taught exposures provided.

Each module started with a presentation explaining the background and indications for each exposure, including its surgical anatomy overview, landmarks, and local structures at risk during surgery. This was followed by hands-on training of each exposure focusing on delivery of a formative educational experience, where the surgical exposure dissections were carried out by the students on the cadavers under supervision. Relevant prosections and plastinates were available throughout the course, allowing for focused spinout sessions and detailed explanations. Following the completion of each surgical approach, registrants were required to identify and expose various 'at risk' structures such as local nerves or vessels. The course objectives are summarized in Table 2.

Assessment

Participants were assessed on an iterative basis by the teaching staff to ensure successful demonstration of skills and knowledge. This included completion of all exposures, dissection of relevant structures, and visualization of all structures at risk. The educational experience focused broadly on the achievement of skills and knowledge specific to individual surgical approaches and the successful delivery of these in a clinical context, with educators referring back to course objectives to ensure participants were obtaining adequate and appropriate learning opportunities. Staff engaged with students to oversee completion of the approaches and dissection, testing knowledge gain and transition skills, supporting skill development, aiding development of self-confidence, and promoting team work. Participant feedback in the form of a survey questionnaire was developed to align with the objectives to inform future course delivery and confirms that course objectives were congruent with student experience.

Course evaluation

Ethical approval to undertake course assessment was received from the Ethics Committee of the University of Otago (D18/044), and the Ngāi Tahu Research Committee. Evaluation forms were given to course registrants immediately after the completion of the course to evaluate course delivery. Data on course utility and career progress were acquired subsequently (4–24 months) to ascertain whether participant career status or direction had changed. Response options to questions other than those requesting demographic information included Likert-type responses (scale 1–5, strongly agree through to strongly disagree), check boxes (when completing the course may

Table 1 List of surgical exposures taught in both the basic and advanced trauma and orthopedic surgical exposures courses, presented as those delivered for the upper extremity (top), lower extremity (middle), and spine and pelvic regions (bottom)

		Specific approach	Basic course	Advanced course
Upper limb				
1	Shoulder and clavicle	Deltoideopectoral approach	x	x
		Anterolateral delta splitting approach	x	x
		Posterior approach to the shoulder		x
		Superior approach to the supraspinatus fossa		x
2	Humerus	Anterior approach	x	x
		Posterior approach	x	x
3	Elbow	Anterior approach		x
		Lateral approach (Kocher)	x	x
		Medial approach	x	x
		Posterior approach to the elbow and humeroulnar joint (incl. osteotomy)	x	x
4	Forearm	Thompson—approach to the radius shaft		x
		Compartment release		x
5	Wrist and hand	Palmar approach for exposure and release of the median nerve	x	x
		Dorsal approach to the wrist		x
		Volar approach to the wrist	x	x
		Volar approach to the fingers	x	x
		Approach to the MCP I and navicular bone		x
		Dorsal approach to the humerus	x	x
Lower limb				
6	Hip joint	Posterior approach (Kocher–Langenbeck)	x	x
		Lateral approach (Bauer, Hardinge)	x	x
		Anterolateral approach (Watson–Jones)		x
7	Femoral shaft and thigh	Lateral approach to the femur shaft	x	x
8	Knee joint	Anterior approach (incl. direct anterior, midvastus and subvastus)	x	x
		Posterior approach		x
9	Tibia and leg	Anterolateral approach to the tibia head	x	x
		Compartment release	x	x
10	Ankle and achilles tendon	Posterolateral approach to the ankle and posterior tibia		x
		Anterior approach to the ankle		x
		Posteromedial approach to the achilles tendon and ankle	x	x
11	Foot	Medial approach to the talus and hind foot		x
		Lateral approach to the calcaneus	x	x
		Dorsomedial approach to the mid foot and TMT-joint		x
Spine and pelvis				
12	Spine	Anterior cervical, extended anterior cervical		x
		Posterior cervical		x
		Trans-thoracic, posterior thoracic		x
		Anterior, lateral and posterior lumbar		x
13	Pelvis	Posterior approach to the sacroiliac joint		x
		Anterior approach to the pubic symphysis	x	x
		Ilioinguinal approach (Letournel)		x

be useful), and free-text questions (recommendation of the course, general feedback). Assessment included information on course delivery ('Course and Learning Experience' and 'Assessment of Teaching'; Fig. 2) and perceived outcomes in the categories: 'Knowledge and Confidence', 'Self Development', and 'Decision Making for Orthopedic Surgery'.

Fig. 1 Students in the trauma and orthopedics surgical approach course always have specialist input provided by a senior orthopedic surgeon. Curtesy Christine Hammer

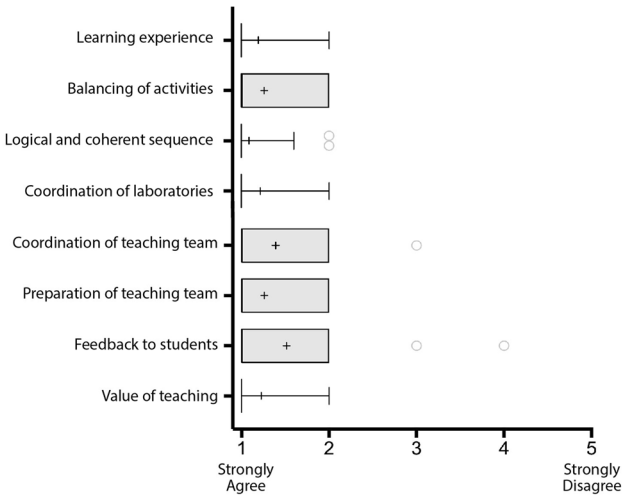

Fig. 2 Combined course assessment data for assessment of teaching and course and learning experience for the orthopedic surgical approach courses. Data are presented as medians in 25th and 75th percentile ranges, error bars depict the 10th and 90th percentile, while '+' indicates mean values and 'o' outliers. The *Y*-axis represents questions asked of participants; the *X*-axis the Likert-type responses ranging from 'strongly agree' to 'strongly disagree'

Statistical analysis

PRISM 7 (GraphPad Software Inc., La Jolla, CA) software was used for statistical analyses. Because of the modest number of participants, combined data for the basic and advanced courses are presented; significant differences are stated where they exist between the courses. Comparison was conducted utilizing a Kruskal–Wallis test of non-parametric data, followed by Dunn's post hoc test for non-parametric pairwise comparisons. Data are presented as mean values and standard deviations in text [*X* (SD)]. *P* values of 0.05 or less were considered statistically significant.

Results

Demographic information

To date, 31 participants (8 females, 23 males) have successfully completed the courses delivered. Participants have been mostly from throughout New Zealand (30), with one participant from Australia. During the course, 50% of participants were in non-training positions, and 50% were in orthopedics training. At the time of the follow-up assessment, 8% were still on a non-training position, and 82% were on a training scheme. The number of participants working in orthopedics decreased from 92 to 83% between the initial and follow-up assessment, in favor of participants moving into radiology or still waiting for a training position (17%). Response rates were 100% in both the basic and advanced courses for the initial assessment on course delivery, with follow-up response rates of 75% (basic; $n = 6$) and 74% (advanced; $n = 17$) for the assessment of course utility and career progress.

Table 2 Educational aims of the course

The educational aims of the courses were developed as follows:
1. Participants will acquire detailed regional–anatomical knowledge of the spatial anatomy related to trauma and orthopedic surgical exposure, including anatomical structures at risk and pitfalls relating to each approach
2. Participants will demonstrate skills relating to surgical exposures adapted to the individual anatomical locations, including implant placement
3. Participants will demonstrate skills surrounding less commonly used or other types of exposure usually not performed by early career doctors
4. Participants will demonstrate an understanding of evidence-based best practice related to each surgical exposure, including risk assessment
5. Participants will develop their decision-making and procedural skills relating to each surgical exposure, both prior to and during performance of these procedures
6. Participants will improve their confidence relating to trauma and orthopedic surgical exposures

Course and learning experience, assessment of teaching, general comments

Course delivery was rated extremely positively (Fig. 2). Significant differences were noted between the advanced and basic courses for 'learning experience' (mean 1.1 advanced vs. 1.5 basic; $p=0.03$) and 'value of teaching' (mean 1.1 advanced vs. 1.6 basic; $p=0.04$) questions with advanced courses respondents rating the course higher in both instances. Free-text responses about the course were positive, with common themes relating to the usefulness and applicability of the course, the support available during the course, and the opportunity to practice on cadavers.

Knowledge and confidence

Mean scores for all questions ranged between 1.3 (0.7) and 1.5 (0.8) (Fig. 3), therefore, falling between 'strongly agree' and 'agree', with no significant differences between responses for the advanced and basic courses.

Skill and decision-making

Mean scores ranged between 1.5 (0.9) and 2.2 (0.8) with a significant difference ($p=0.004$) noted between advanced [1.6 (1.2)] and basic [2.7 (0.5)] courses for 'this course

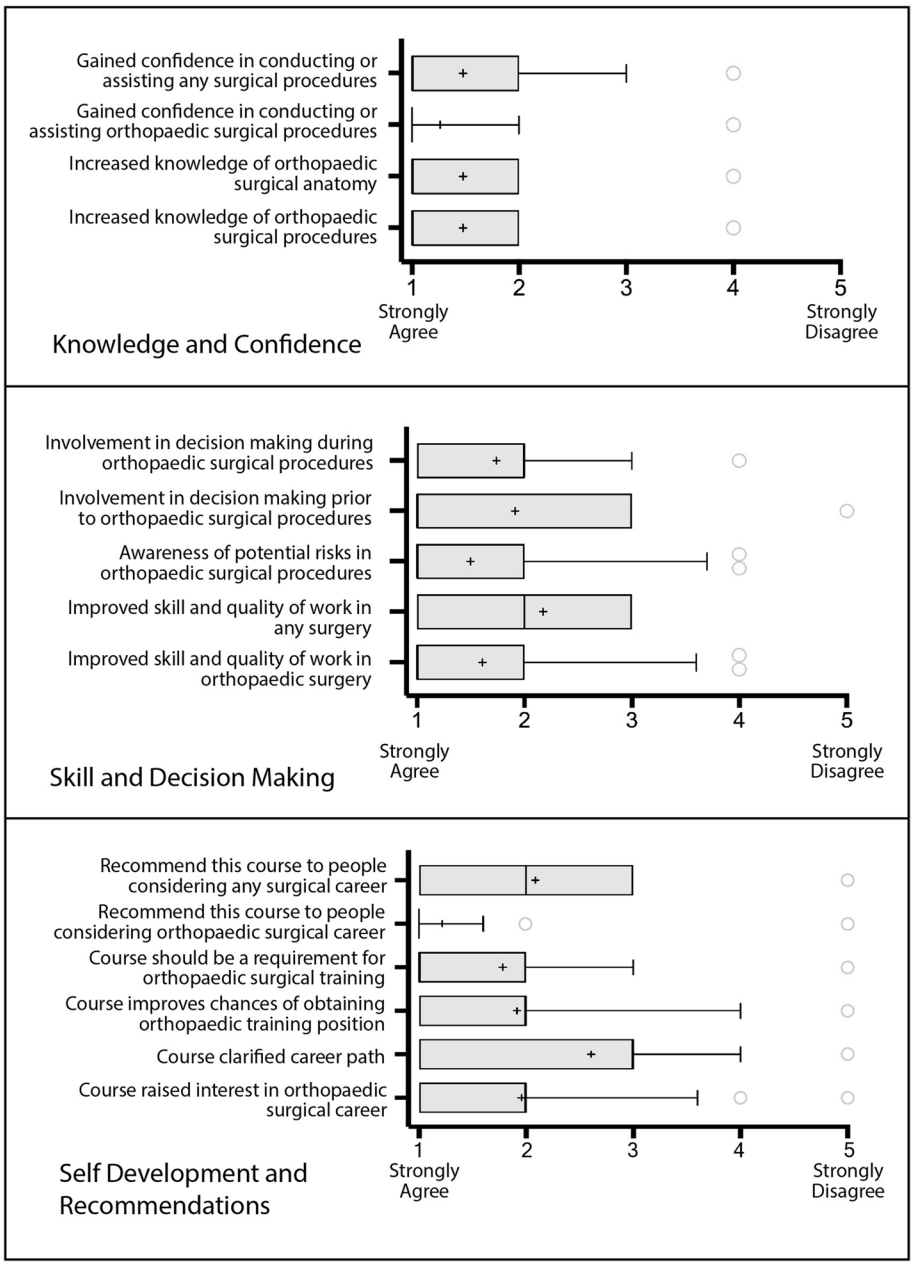

Fig. 3 Combined course assessment data for the development of knowledge and confidence (top), skill and decision-making (middle), and self-development and recommendations (bottom) from the orthopedic surgical approach courses. Data are presented as medians in 25th and 75th percentile ranges, error bars depict the 10th and 90th percentiles, while '+' indicates mean values and 'o' outliers. The *Y*-axis represents questions asked of participants; the *X*-axis the Likert-type responses ranging from 'strongly agree' to 'strongly disagree'

helped me become more involved in the decision-making processes prior to orthopedic surgical procedures' (Fig. 3).

Self-development and recommendations

Mean scores for the six questions in this category all fell between 1.2 (0.8) and 2.6 (1.2), with three questions having significant differences between responses from the advanced and basic courses (Fig. 3). Differences were seen to the questions relating to clarifying career path ($p = 0.02$), improving the chance of obtaining an orthopedic trainee position ($p = 0.005$), and recommending the course for people considering a career in any type of surgery ($p = 0.003$), with the advanced course scoring more positively in each instance. A majority of the participants would specifically recommend the course to non-trainees of any specialty (55%), followed by recommendations to participants at all training levels in orthopedics (27%) and first-year registrars (18%). When asked to comment on the ideal timing for course participation as being prior, during or after conclusion of their traineeship, 75% of the participants rated a prior > during > after sequence more highly, followed by the sequence of during > prior > after sequence (25% of participants).

Discussion

Overall, the courses have been rated very positively, with participants suggesting that they are highly beneficial for persons wanting to focus on orthopedic surgery, as well as having benefit for persons interested in other types of surgical specialties.

Course and learning experience, assessment of teaching, general comments

The structure and delivery of the course were rated very highly by the participants, indicating satisfaction with the current course format and delivery. General comments on the course showed that participants recognized value in the course for its relevance to orthopedic surgery, perhaps reflecting the use of a surgery-like environment that included a variety of instruments and active learning approach [15], with one operating 'surgeon' working closely with one assisting peer to undertake each surgical approach. Participants also welcomed the support provided by the experts delivering the course, corroborating previous observations of the benefit from teaching provided simultaneously by an experienced surgeon and anatomist [32]. There were also positive references to the exploration of uncommon approaches during the courses.

It has been suggested that training using cadavers is a pillar for postgraduate surgical education [12, 16, 22], and in congruence with this statement the use of cadavers was viewed favorably by participants. The use of cadavers for this type of training is in many aspects superior to the use of training simulators [1, 6, 9, 38], and the form of embalming utilized for cadaver preparation was specifically used to capitalize on both on the educational strengths of cadaver use and the advantages of using Thiel fixation. This includes realistic color, tissue pliability, and joint mobility and was considered necessary to facilitate practice of techniques as close to reality as possible [2, 33, 40]. The disadvantages of Thiel fixation include the price of the fixatives and the dissolving of muscle tissues. The expense and difficulty of preparing cadavers using Thiel embalming must also be considered when planning courses such as these [23, 34] and weighed up against the benefit of providing a 'realistic' experience. More details on the embalming procedure can be found in Thiel [36] and Hammer et al. [18].

Knowledge and confidence

Anatomical knowledge and confidence in surgical skills are requisites for successful surgery [20]. Participants in these courses reported high levels of agreement with knowledge gain of the relevant surgical procedures and confidence in participating the procedures they experienced. Interestingly, there was a high level of agreement for confidence in conducting or assisting procedures in other surgical disciplines, demonstrating transfer of confidence between specialties. This shows specialist courses have wider utility that is useful for participants who may be undecided on whether the subject matter is likely to be the focus of their future career. Findings support other work indicating that focused courses deliver increases in medical confidence and skills [4, 31].

Knowledge of surgical anatomy, rated highly after participating in the course, was likely influenced by the detailed nature of the surgical explorations [26]. Participants were also taught extensions and variations of known approaches, with this including discussion of both the advantages and disadvantages. This improvement in surgical anatomy knowledge likely contributed to improving confidence in the surgical environment [14, 21, 24] and providing the opportunity for trainees to develop competence in uncommon procedures [23].

Skill and decision-making

Participants perceived that their work quality in orthopedic surgery had improved, including their awareness of surgical risk and decision-making both prior to and during orthopedic surgery. This is similar to outcomes observed in simulation-based surgical education [34] and medical training [27], possibly because of the ability of participants to focus on practicing and acquiring skills in a low-risk, low-stake

environment. Interestingly, participants also rated their skill and quality in any type of surgery had benefited from taking the course. This cross-specialty utility means that persons interested in attending these courses will likely acquire benefit to their surgical skill-set, regardless of the specialty or training aspirations, with the most benefit being to those who wish to train in orthopedics [17].

Self-development and recommendations

Despite the majority of participants gaining training positions in the period after the course, the course was perceived by participants of the basic course as less useful in both clarifying a career path, and improving the chance of obtaining a position as an orthopedic trainee. Despite this difference, there was very strong agreement that the course should form part of a training requirement for orthopedic surgery, and it was highly recommended to those considering a career in orthopedics. There was a difference between the advanced and basic participants in relation to recommending the course to persons considering a career in any other type of surgery. This suggests that while people acquire skills that are transferable to other surgical settings, such as confidence in conducting or assisting any type of surgery, the greatest benefit of the course is likely to be specific to those persons interested in orthopedics.

Limitations

There are few participants, and the modest amount of data is split between responses from the advanced and basic courses. Despite this, there were few question responses that were significantly different between the two courses (4 of 23 differ), and the high consistency of results from participants supports the success of this newly established educational offering.

Conclusions

These recently developed surgical anatomy courses deliver a focused training opportunity on trauma and orthopedic surgical approaches using Thiel embalmed cadavers to enhance the realism of the surgical experience. Participants suggest these courses have benefits and utility for the development of orthopedic-specific skills and see an increase in orthopedic-specific participant knowledge. There is also benefit for other specialist surgical areas as they improved confidence across all surgical environments. Feedback suggests the courses fill an educational niche, providing an opportunity to train surgical exposures using life-like cadavers in a low stress environment, allowing participants to experience and practice a wide range of surgical exposures without the risks associated with surgery on the living [4]. This information is relevant to surgical trainees, benefactors, stakeholders, or institutions who wish to develop such courses, as it supports their utility, benefit, and attractiveness to a wide range of potential participants who may wish to improve their competence in a surgical arena [23].

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Compliance with ethical standards

Conflict of interest None related to this study.

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