Abstract:

At our institution, as in many other medical schools worldwide, the time devoted to teaching anatomy has been reduced significantly. In order to minimize the effects of this reduction two optional cadaveric dissection courses, each of a semester duration, were introduced in the first two years of our medical school. These courses were named Regional Anatomy I (RAI) and Regional Anatomy II (RAII). In RAI the regions being dissected were the ~~following:~~ thorax, abdomen, pelvis and perineum. In RAII the head, neck, back, and upper and lower limbs were dissected. This paper analyzes prospectively the academic results and students' perceptions of these two, newly-introduced, cadaveric dissection courses ~~in this particular context~~.

Student satisfaction was assessed anonymously through a questionnaire that encompassed questions regarding students' perception of the usefulness of the courses for undergraduate teaching and for future professional activity, as well as with regard to the adequacy of the courses' structure and teaching methods.

For each of the 3 academic years studied, better final scores were obtained in the optional dissection courses than in the compulsory general anatomy course, in which dissection was not performed ($p < 0.01$). Furthermore, students undertaking both dissection courses ranked highly their importance in consolidating knowledge of anatomy, in preparing for other undergraduate courses, and for future clinical practice. The good academic results observed associated with the good opinion of students attending the dissection courses lend strong support to the adoption of similar courses as complimentary and compulsory disciplines in a modern medical curriculum.

Keywords: Anatomy education; Teaching Methods; Cadaver dissection; Medical curriculum; Student satisfaction; Questionnaires; Undergraduate medical education; Prospective study.

Text:

Introduction:

The time allocated to the teaching of anatomy to medical students has been steadily declining in most countries. (Drake et al., 2009; Drake et al., 2014; Grkovic et al., 2009; McLachlan et al., 2006; Moxham et al., 2015a; Moxham et al., 2015b; Moxham et al., 2011; Nutt et al., 2012; Pabst, 1993; Pais et al., 2013; Turney, 2007) NOTE … these should be in date order. This has also happened recently at our institution in Lisbon, where gross anatomy was taught for many years in two annual courses to first and second year medical students. However, following the academic year 2010/2011, anatomy started to be taught in the first semester of medical school (the *General Anatomy* course, in which cadaveric dissection was not performed), and as part of the syllabus of two biannual courses in the second year of the medical course (*Fundamentals of Neuroscience* and *Radiological and Clinical Anatomy*). This resulted in a substantial decrease in the amount of time spent in teaching and learning anatomy.

Looking into the literature in order to minimize the deleterious effects of such a reduction, multiple strategies could be found. (Bergman et al., 2008; Collett et al., 2009; Collins, 2008; Gogalniceanu et al., 2008; Grkovic, Marinovic Guic, Kosta, Poljicanin, Caric and Vilovic, 2009; Kerby et al., 2011; McLachlan et al., 2004; McLachlan and Patten, 2006; Moxham et al., 2007; Moxham, Shaw, Crowson and Plaisant, 2011; Pabst, 1993; Pais and Moxham, 2013; Turney, 2007) NOTE … these should be in date order. One of the options advocated by

several authors, was to reinforce the importance of practical cadaveric dissection in either classical anatomical courses or in optional dissection courses. (Sugand et al., 2010; Winkelmann, 2007) NOTE … these should be in date order. However, although there is substantial evidence supporting the use of cadavers in this context (Burgess et al., 2014; Korf et al., 2008; Marshak et al., 2015; Naz et al., 2011; Regan de Bere et al., 2010) NOTE … these should be in date order., there are also some conflicting papers. (Hill et al., 2011; Winkelmann, 2007). NOTE … these should be in date order. In particular, time, finance, and ethical constraints have curbed the enthusiasm for cadaveric dissection in many places. (Gogalniceanu, Madani, Paraskeva and Darzi, 2008; Warnick, 2004; Winkelmann et al., 2004). NOTE … these should be in date order. Therefore, objective evidence supporting the usefulness of practical cadaveric dissection, through both objective performance evaluation and ~~through~~ evaluation of students perception of the utility of this approach, is needed as a priority (Pais and Moxham, 2013; Winkelmann, 2007). NOTE … these should be in date order.

In order to fulfill the aim of broadening the anatomical learning experience at the undergraduate level through cadaveric dissection, the senior author (DP) strove to introduce two optional cadaveric dissection courses, each of a semester duration, in the first two years of our medical school. To evaluate objerctively the results of this experience, the academic results and students' satisfaction in these two courses were prospectively evaluated in the 3 year period after the courses inception. HYPOTHESIS?

Characterization of the Optional Dissection Courses

The two optional dissection courses were named “Regional Anatomy I” (RAI) and “Regional Anatomy II” (RAII). These courses were chosen by first and second year medical students by voluntary application to one of the 60 and 70 places for RAI and RAII, respectively. The places were taken up on a “first come first served” basis. For RAI, the regions dissected were the thorax, abdomen, pelvis and perineum. For RAII, the head, neck, back, and upper and lower limbs were dissected.

Each course lasted for 17 weeks and each had at least 14 practical classes with human cadaveric dissection in the anatomical dissection room. Additional classes and dissection times were frequently arranged according to students’ interest and teaching staff’s availability.

At the beginning of each class, a member of the staff gave a brief 10 minute talk on practical aspects of their dissection and the most prominent anatomical structures in the region being dissected. For the remaining 110 minutes, each student dissected, in groups of 2 or 3 persons, 2 distinct anatomical regions on the ventral aspect of the cadaver, followed by another 2 anatomical regions on the dorsal aspect. The chronological sequence of the regions to be dissected ventrally and dorsally (NOTE most American and British anatomists would use anterior and posterior) was established before commencing the course. A dissection checklist comprising the most important anatomical structures in each ~~anatomical~~ plane of each region was also available before the course’s commencement. ~~This checklist was intended to help guide dissections.~~ Note – this is too obvious for inclusion There were 6 embalmed cadavers for RAI and 7 embalmed cadavers for RAII. Because of a special embalming method

developed at our department.(Goyri-O'Neill et al., 2013), the cadavers retained most of their original characteristics, with minimal odor exhalation and without causing ~~no~~ mucosal discomfort in participants. Groups of 9 to 10 students were assisted by at least one junior and one senior teaching staff member. The junior staff member was frequently a medical student attending one of the last 2 years of medical school. On all occasions, at least one professor of the Anatomy Department was present. The senior author (DP) supervised both optional courses.

All students were given a final mark for the course that ranged between 0 and 20. NOTE this is an arithmetic mark not a grade (A,B, C etc). Half of this mark was provided by the two members of the staff that had assisted the student during the entire duration of the course ~~based,~~ and was based on a class-by-class assessment of multiple evaluation parameters explicitly established before the start of the course. These parameters were: anatomical knowledge, critical analysis and application of knowledge, ability to identify anatomical structures, dissection technique, following safety measures, respect for the cadaver, interest, initiative, motivation, communication skills, ability to work in a group, and punctuality. A quarter of the final mark was given by a written examination at the end of the course that tested the fundamental anatomical knowledge pertaining to the anatomical regions dissected. The remaining quarter of the final mark was derived from an oral presentation of one of the regions dissected by each student. Although students presented anatomical regions in groups, each student was evaluated individually. In order to pass the course, each student must have a positive evaluation (≥ 10 score from 0 to 20 in each parameter).

Methods:

The final score of each student attending RAI and RAII during 3 consecutive academic years (2012/2013; 2013/2014; 2014/2015) was prospectively registered.

During these 3 years, at the end of each course, students were invited to fill in an anonymous questionnaire regarding their personal experience while attending the course, as well as their evaluation of the course. The questionnaire was devised before the introduction of the two optional dissection courses, and it was applied prospectively. Note – how was ethical approval obtained? This paper won't be published in ASE without this! It included the following parameters: number of hours spent studying for the course relatively to all hours devoted to study for all the courses in that semester (expressed as a percentage); importance of the course in terms of consolidating knowledge of anatomy; importance of the course as a preparation for other courses in undergraduate medical training; importance of the course for future professional activity; articulation of the course with other courses attended during the same year of medical school; importance of the introductory lectures at the beginning of each class; adequacy of handouts of the lectures' slides for study and dissection preparation; adequacy of dissection checklist for the dissections performed; adequacy of cadaveric material for the course; quality of practical dissection coaching by the anatomy department staff members.

Categorical answers were graded by students from 1 to 5, according to the following scale:

1 – Bad/None; 2 – Unsatisfactory/Little; 3 – Satisfactory/Reasonable; 4 – Good/Significant; 5 – Very good/Very much.

Statistical Analysis:

The data was inserted into an Excel ® database. Qualitative variables were expressed as percentages. Quantitative variables were expressed as means ± standard deviation. ~~The~~ SPSS 21.0 ® software was used for descriptive and inferential statistical analysis. The Kolmogorov-Smirnov test was used to assess whether variables were normally distributed. ANOVA and t-Student tests were used to compare averages for normally distributed data. Kruskal-Wallis and Mann-Whitney tests were applied to compare means for non-normally distributed data. Proportions were analyzed with the Chi-square test or the Fisher's exact test. Dichotomous variables were compared with the binomial test. A two tailed p value below 0.05 was considered to be statistically significant.

Results:

It was possible to retrieve and analyze the questionnaires from 345 students attending the General Anatomy Course, 171 questionnaires from students attending the RAI, and 195 questionnaires attending RAII. NOTE – what are the % returns?

Figure 1 shows the final results in the anatomy courses at our institution from 2012/2013 to 2014/2015 (General Anatomy, RAI and RAII). The final score (1 to 20) in General Anatomy (GA), RAI and RAII was on average 14.26 ± 1.89; 16.94 ± 1.02; 17.49 ± 1.01, respectively. The mean results were lower in GA than RAI or RAII ($p<0.001$). The difference between the mean final scores of RAI and RAII was not statistically significant. NOTE – very importantly, do the comparisons between the General anatomy course and the optional courses ONLY relate to the students who opted for RAI and RAII or (erroneously) do the General Anatomy marks contain ALL the students in the class and not just those who did the optional courses.

On average, the percentage of time each student reported studying for each anatomy course was 64.0 ± 17.3% for GA, 23.7 ± 17.0% for RAI, and 27.6 ± 18.3% for RAII. This value was higher for GA than for any of the Regional Anatomy courses ($p<0.001$). No significant statistical difference was found between the two latter dissection courses.

Figure 2 portrays students perception of the importance of the anatomy courses. The perceived importance of RAI and RAII to consolidate knowledge of anatomy (4.75 ± 0.60 and 4.87 ± 1.21) was higher than that of the GA course (4.39 ± 0.38; $p<0.0001$). Similarly, students ranked the importance of the two

dissection courses higher in terms of preparation for other undergraduate courses than the GA course (4.5 ± 0.78 [RAI]; 4.65 ± 1.1 [RAII]; and 3.73 ± 0.35 [GA]; p<0.0001). Analogously, students attributed high scores to the importance of the RAI and RAII courses for their future professional activity (4.74 ± 0.89 and 4.54 ± 0.90 for RAI and RAII respectively). These scores were on average superior to those attributed to the GA course (3.93 ± 0.49; p<0.0001). Regarding the articulation of anatomy courses with other courses attended by students in the same year of medical school, students graded the GA course (4.2 ± 1.2) better than RAI (3.8 ± 0.59; p<0.0001) or RAII (4.0 ± 0.78; p=0.037). Concerning overall grading, RAI and II obtained better scores (4.46 ± 0.98; and 4.61 ± 0.45, respectively) than GA (4.35 ± 0.90). However this difference was statistically significant only between RAII and GA (p=0.002). See my previous NOTE

The average scores given by students to the different parameters of the organization, structure and teaching support of the dissection courses are pointed in **Table 1**. All assessed parameters had an average score of at least 4, in a scale of 1 to 5. Most students classified each item as “Good” (4) or “Very good” (5).

Discussion:

It has been reported that shorter anatomy curricula in medical courses worldwide are associated with suboptimal learning. (Drake, McBride, Lachman and Pawlina, 2009; Drake, McBride and Pawlina, 2014; Grkovic, Marinovic Guic, Kosta, Poljicanin, Caric and Vilovic, 2009; McLachlan and Patten, 2006; Moxham, McHanwell, Plaisant and Pais, 2015a; Moxham, Plaisant and Pais, 2015b; Moxham, Shaw, Crowson and Plaisant, 2011; Nutt, Mehdian, Parkin, Dent and Kellett, 2012; Pabst, 1993; Pais and Moxham, 2013; Turney, 2007). NOTE … these should be in date order. It has been argued that this deficiency could be partly circumvented by active cadaveric dissection. (Holla et al., 2009; Older, 2004; Winkelmann, 2007). NOTE … these should be in date order. In order to test this hypothesis, a few studies have been conducted on the merits of dissection at an undergraduate level in medical schools. (Arora et al., 2011; Leong, 1999; Nnodim, 1996; Nnodim et al., 1996; Snelling et al., 2003). NOTE … these should be in date order. The present investigation ~~aims to~~ contributes to the research in this field by prospectively analyzing the academic results, and students' perception of two newly introduced cadaveric dissection courses in the context of a recent anatomy curriculum reduction at our medical school.

Regarding anatomical knowledge, our data revealed, for each of the 3 academic years studied, better final scores in the optional dissection courses than in the compulsory GA course in which dissection was not performed ($p < 0.01$) (Fig. 1). This may be partly explained by the fact that dissection courses boost medical students motivation to study and learn anatomy. (Burgess and Ramsey-Stewart, 2014). Indeed, several authors have demonstrated that

anatomical courses including cadaveric dissection result in students faring better in anatomy exams. (Biasutto et al., 2006). Note – this is one author not several However, it must be noted that the academic success at the two dissection courses may not be necessarily transposable to the general student population, as these courses were optional and predictably chosen by students with a greater interest in studying anatomy. TRUE

Furthermore, it ~~was interesting to~~ should be noted that students undertaking both dissection courses ranked highly the importance of these courses in consolidating knowledge of anatomy, as preparation for other undergraduate courses, and for future clinical practice (Fig. 2). In this regard, the two dissection courses received higher grades for their role in accomplishing each of these purposes than the traditional GA course ($p < 0.001$). Reviewing the literature, it is consensual that undergraduate anatomical dissection has been shown to not only familiarize students with normal topography and morphology, but also to enhance three-dimensional orientation, dexterity, team-working skills and other professional competencies amongst medical students (Bockers et al., 2010; Drake, McBride, Lachman and Pawlina, 2009; Drake, McBride and Pawlina, 2014; Gogalniceanu, Madani, Paraskeva and Darzi, 2008; Grkovic, Marinovic Guic, Kosta, Poljicanin, Caric and Vilovic, 2009; McLachlan and Patten, 2006; Moxham, McHanwell, Plaisant and Pais, 2015a; Moxham, Plaisant and Pais, 2015b; Moxham, Shaw, Crowson and Plaisant, 2011; Nutt, Mehdian, Parkin, Dent and Kellett, 2012; Pabst, 1993; Pais and Moxham, 2013; Turney, 2007). NOTE … these should be in date order. Additionally, the experience of cadaveric dissection is universally described by medical students and doctors as an unique ritual of initiation in the medical profession, heightening drive and motivation to become a better doctor (Dyer et al., 2000; Korf, Wicht, Snipes, Timmermans, Paulsen, Rune and Baumgart-Vogt, 2008; Leboulanger, 2011). NOTE … these should be in date order.

Our survey also recorded that students graded very favorably the structure of the 2 dissection courses, as well as the close proximity-coaching by a senior and a junior anatomy teacher (Table 1). This teaching anatomy model, in which

students are supervised by a near-peer (frequently a final year medical student), has been demonstrated to facilitate learning in a practical setting such as the one herein described (Duran et al., 2012; Evans et al., 2009). NOTE … these should be in date order. This interaction has been shown to be advantageous for both junior teachers and students, which seems to be supported by our data (Cheng et al., 2011; Duran, Bahena, Rodriguez Mde, Baca, Uresti, Elizondo-Omana and Lopez, 2012; Evans and Cuffe, 2009; Jay Erie et al., 2013). NOTE … these should be in date order. Also see the paper in the Journal of Anatomy (Building an open academic environment – a new approach to empowering students in their learning of anatomy through 'Shadow Modules' by Jonathan L. Scott, Bernard J. Moxham and Stephen M. Rutherford – J. Anat. 224, pages 286–295, 2014) However, it must once again be noted that the encomiastic evaluation performed by students regarding RAI's and RAII's structure and teaching may be biased due to the fact that these optional dissection courses were most probably chosen by students with a keen interest in anatomy. Hence, it would be interesting to perform a similar study in a situation where the dissection courses were compulsory.

The authors believe that the good academic results observed associated with the good opinion of students attending the two dissection courses lend ~~strong~~ (Note – I've removed strong because of your correct assetion that there is bias in the students selecting the optional courses) support to the adoption of similar courses as complimentary and compulsory disciplines in a modern medical curriculum. (Bockers, Jerg-Bretzke, Lamp, Brinkmann, Traue and Bockers, 2010; Drake, McBride, Lachman and Pawlina, 2009; Drake, McBride and Pawlina, 2014; Dyer and Thorndike, 2000; Gogalniceanu, Madani, Paraskeva

and Darzi, 2008; Grkovic, Marinovic Guic, Kosta, Poljicanin, Caric and Vilovic, 2009; Korf, Wicht, Snipes, Timmermans, Paulsen, Rune and Baumgart-Vogt, 2008; Leboulanger, 2011; McLachlan and Patten, 2006; Moxham, McHanwell, Plaisant and Pais, 2015a; Moxham, Plaisant and Pais, 2015b; Moxham, Shaw, Crowson and Plaisant, 2011; Nutt, Mehdian, Parkin, Dent and Kellett, 2012; Pabst, 1993; Pais and Moxham, 2013; Turney, 2007). NOTE … these should be in date order.

Note further comment – how was consistency and reliabilty of the marking in RAI and RAII obtained? Also, did you use precisely the same marking parameters for GA and RAI/RAII? If not then can you tease out just the anatomical knowledge components of each? Lastly, could difference between GA and RAI/RAII relate to the different levels of enthusiasm of the teaching staff and the amount of attention and feedback that could be given to the different cohorts?

Conclusion:

The two optional dissection courses were perceived by students as important to consolidate knowledge of anatomy and for their general medical training. The good academic results presented by students attending these courses suggest that they play an important role in expanding and consolidating their anatomical knowledge. For these reasons, similar dissection courses should probably be incorporated in modern medical curricula.

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Notes on Contributors:

DIOGO PAIS, M.D., Ph.D. is an Associate Professor of Anatomy and Course Director of the two optional dissection courses in the Department of Anatomy at Nova Medical School, Lisbon, Portugal. He is also currently the President of the European Federation for Experimental Morphology (EFEM), Secretary General of the International Committee of Symposia on Morphological Sciences (ICSMS) and President of the Portuguese Anatomical Society (AAP/SAP). He teaches anatomy to first and second year medical students and Medical Ethics and Law to undergraduate and graduate students.

DIOGO CASAL, M.D. is a Plastic and Reconstructive Surgeon and an Anatomy Instructor in the Department of Anatomy at Nova Medical School, Lisbon, Portugal. He teaches anatomy to first and second year medical students.

LUÍS MASCARENHAS LEMOS, M.D. is a Pathology Resident and an Anatomy Instructor in the Department of Anatomy at Nova Medical School, Lisbon, Portugal. He teaches anatomy to first and second year medical students.

PEDRO BARATA, M.D. is an Oncology Resident and an Anatomy Instructor in the Department of Anatomy at Nova Medical School, Lisbon, Portugal. He teaches anatomy to first and second year medical students.

BERNARD MOXHAM, M.D., Ph.D. is an Emeritus Professor of Anatomy at Cardiff University, United Kingdom. He is an anatomist interested in studying

craniofacial biology. He also has a profound interest in pedagogic research relating to the biomedical sciences, having published extensively in this field.

JOÃO GOYRI O'NEILL, M.D., Ph.D. is an Ophthalmologist and Full Professor of Anatomy at Nova Medical School, Lisbon, Portugal. He has a keen interest in vascular anatomy and clinical anatomy. He teaches anatomy in several undergraduate and postgraduate courses.

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