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Abstracts from The 18th International Conference on Plastination
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1. Up-scaling the repertoire of anatomical teaching and learning materials at the University of KwaZulu Natal: the making of molds of bones

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Introduction: While it is becoming increasingly difficult to demonstrate intricate anatomical structures using wet mounted specimens coupled with shrinking cadaveric material numbers, use of casts and moulds comes in handy to increase the repertoire of instructional anatomical materials in medical schools.

Objectives: To produce adequate and accurate moulds of osteological anatomical specimens using real bones for teaching and learning in the Medical School.

Materials and Methods: Selected osteology samples, devoid of defects, were prepared by maceration and defatting. We have evolved an eight-step process that eventually results in the final mould (made from real osteological source-cadaver).

Results: By filling anatomical spaces with extraneous material that reproduces a three-dimensional replica of the space, we have produced (at very low cost) various collections of moulds of bones of the upper limb with clear labelling and accuracy. These represent the real anatomical details for the bone demonstrated. These have been greatly resourced by the students in the department and continue to be requested by other academic faculties within the South African region.

Conclusions: Making moulds of bones has proved invaluable teaching and research in anatomy especially in the period of cadaveric shortage.

2. Morphological relationship between the superficial cortical and deep gray matter structures in adult human brains: a cadaveric study

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Introduction: While various neurodegenerative diseases affect the cortical mass and mass of deep grey matter differently, finding an optimal and accurate method for measuring thickness and surface area of the cerebral cortex remains a challenging problem due to the highly convoluted surface of the cortex. We therefore investigated the superficial and deep gray matter thickness and surface area in a sample of cadaveric specimens at the Discipline of Clinical Anatomy, Nelson R Mandela School of Medicine, and University of KwaZulu-Natal, South Africa to provide some clue as to possible variations in these parameters.

Materials and Methods: With ethical approval, 60 brain samples were uniformly sectioned at 5mm thickness. Eight slices containing the deep nuclei were taken from each brain and stained by Mulligan's technique. Thickness was measured at selected angles 0º, 45º, 90º, 135º and 180º for both right and left cerebral hemispheres. The cortical thickness and surface area of selected slices for both the superficial cortex and the corresponding deep nuclei were measured.

Results: Mulligan's stain produced good gray mater differentiation and clear images that enabled manual delineation of structures. There was rightward asymmetry of cortical thickness of the selected slices at the suggested angles which corresponded to structurally and functionally important brain regions. There was a positive correlation between the mean surface area of superficial cortex and deep nuclei across the regions of interest (ROI).

Conclusion: Baseline data from 55 brain samples provided a range of means and 95% confidence intervals for the three parameters of cortical thickness, cortical surface area and surface area of deep nuclei to be made for a reference table comprising eight coronal slices taken at five angles. This allows an objective assessment of thinning of the cortex or loss of deep gray matter to be made from measurements of the same parameters for the equivalent slices from a post-mortem brain slice or an appropriate radiographic image.

3. Evaluation of combined plastination and diafanization (clearing) techniques to produce high quality specimens

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Introduction: Diafanization (clearing) is a technique that when applied to organic tissues allows for 3D visualization of the internal structures through transparency or translucency of the tissues. Along with the use of specific pigments, the technique is very useful for the study of delicate skeletons, as it keeps all its components in their original positions, facilitating anatomical study. The aim of this study was to combine the diafanization technique with plastination using polyester resin made in Brazil.

Materials and Methods: An ornamental fish after euthanasia was gutted and had the eyeballs removed. It was fixed in 10% formaldehyde, dehydrated in acetone series until no further change in concentration. It was then diaphanized (cleared) with potassium hydroxide (KOH) 2% to a complete transparency. The specimen was then stained with Alizarin red. After staining, the fish was placed in a demountable glass chamber, and immersed in polyester (Avipol™) + Catalyst + deaerate. A glass desiccator was used as a vacuum chamber. Vacuum was applied for impregnation and embedding. After the curing process was completed the specimen was removed from the mold and its surface was polished.

Results and Conclusion: The crystal polyester (Avipol™) proved to be a satisfactory resin. The diafanization (clearing) technique did not interfere with the plastination process. This method is one more tool available for teaching, research and museum display.

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4. Team based learning: a model for teaching gross anatomy

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Introduction: Team-based learning (TBL) can be defined as an instructional strategy that is considered active learning. This type of instruction has been proven to enhance long-term knowledge, retention and quality of student learning in many different types of courses.

Materials and Methods: At the start of the TBL instructional unit, students are given readings and other assignments that contain information on the concepts and ideas that must be understood to be able to solve the problem(s) outlined for the unit. Students complete the assignments and come to the "recitation" class period prepared to take a "test" on the assigned materials. Each unit of TBL instruction provides the foundation for individual and team accountability which include: (1) assigned readings/assignments/ laboratories, (2) individual quizzes, (3) team assignments, (4) instructor feedback and (5) a group problem solving exercise where students can apply the concepts they have learned to selective clinical scenario. Three years ago the anatomy faculty modified the lower limb unit of the medical gross anatomy course to reflect a team based learning approach. Over this time we have made minor changes to the format primarily based on student feedback.

Results and Conclusion: The results of our student survey indicate that most medical students enjoy this unit and feel that TBL is an effective means for learning the salient anatomical concepts for the lower limb. Student performance on this unit is consistently higher than it was when the lower limb information was taught in a traditional manner.

5. Kidney impregnation using silicone Polisil P10

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Introduction: Plastination requires many chemicals, which can be purchased from specialized companies. In Brazil, polymers for plastination must be imported, which makes the plastination very expensive. The aim of this study was to test the silicone P10 of Polisil Inc., distributed in Brazil. The silicone P10 of Polisil Inc. has a viscosity of 1250 mPas, as an alternative to Biodur silicone S10 which the viscosity of 500 mPas. The silicone was tested in both cold and room temperature plastination.

Materials and Methods: Eight bovine kidneys used for the experiment were donated by Mafrical slaughterhouse. The kidneys were fixed in 10% formalin, and divided in two groups: 4 kidneys were plastinated at room temperature (RT) and 4 at cold temperature (CT). Each group was divided into 2 subgroups with 2 kidneys each. Each two kidneys were impregnated as follows: S10 (control) RT-S10, CT-S10 and P10, RT-P10 and CT-P10. Kidneys were dehydrated in acetone at room temperature (RT group) (25 to 30˚C) and at -25˚C, (CT group). Kidneys were impregnated at room temperature (RT-P10 and RT-S10 subgroups) and at -18˚ C (CT-P10 and CT-S10 subgroups) respectively. Kidneys of RT-P10 and RT-S10 subgroups were cured with their respective catalysts, DBTL (Polisil) and S3 (Biodur), while those of the cold subgroup (CT-P10 and CT-S10), were cured with their respective cross-linkers, that is, TES (Polisil) and S6 (Biodur).

Results: Plastination of the kidneys was successful in all subgroups. The average shrinkage before and after impregnation was: RT-P10 55%, RT-S10 32%, CT-P10 and CT-S10 40%.

Conclusion: P10 Polisil silicone, despite the higher viscosity of 2.5x, produced higher shrinkage at room temperature when compared to Biodur S10. Cold temperature impregnation produced a similar shrinkage rate when compared with Biodur S10.

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6. Set up of a plastination laboratory at the faculty of veterinary science at the University of Buenos Aires

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Introduction: Plastination is a current conservation method with most advantages in terms of duration and storage. This technique was developed by Dr Gunther von Hagens in 1977 and since then many researchers have implemented the technique. The aim of this paper is to report on the setting up of a Plastination Laboratory at the Faculty of Veterinary Medicine, University of Buenos Aires.

Materials and Methods: For the development of the plastination technique, we used Biodur equipment: vacuum chamber (for small and medium size corpses), Biodur S-10, catalyst Biodur S-3, hardener Biodur S-6, local resins, acetone, ultraviolet light, curing chamber, and a vacuum pump. The technique was applied in animal corpses. The plastination technique at room temperature developed in this work corresponds to the method previously described for silicone, and the plastination technique was also developed at room temperature with resins (P-40, E-12).

Results: We achieved the implementation of a Laboratory of Plastination and Anatomical Techniques, in the facilities of the Department of Anatomy, Faculty of Veterinary Science, at the University of Buenos Aires, with the necessary equipment for the development of the following techniques for plastination at room temperature: S-10, P-40, and E-12. Plastinated specimens are presented.

Conclusion: From the plastination laboratory we will seek to achieve preparations of high quality, durability and free from toxicity caused by the formaldehyde, essential pillars in the development of our laboratory. We will offer undergraduate students, professionals at the graduate level, and the community in general, specimens that will be a source of learning and knowledge in anatomy and morphological sciences.

7. Room-temperature plastination with Brazilian silicone: Polisil® silicones Poliplast 40

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Introduction: Plastination is a technique used to preserve bodies or body parts that consist of replacing the tissue fluid and fat by a curable polymer such as silicone, polyester or epoxy. The object of this study is to present the results of a Brazilian silicone, POLISIL® Poliplast 40, used in plastination.

Materials and Methods: The POLISIL® Silicones products are: Poliplast 40 and Poliplast 20 (polymer silicone); DBTL (catalyst and chain-extender, premix) and TES (cross-linker). Polisil 40 is mixed with TES at 93:7 to prepare the reaction-mixture and stirred thoroughly. A child hand previous fixed in formalin 10% was used. The specimen was dissected to expose the anatomical structures of interest, washed in running water for 48 hours and subjected to dehydration and degreasing process by soaking in acetone in different grades, until the acetone purity reading reached 99%. After this step, acetone was drained and the specimen was immediately immersed in the polymer in order not to dry the surface. The vacuum chamber was closed and the specimen allowed to equilibrate in the polymer-mix overnight. The next morning the vacuum pump was turned on and the pressure was decreased to 230 mm/Hg when rapid bubbles formed. These bubbles were controlled for 12 days and the pressure was decreased to maintain the bubbles until they ceased (4 mm/Hg). Curing occurred in 10 days. The specimen was brought to atmospheric pressure and allowed to drain. Then it was placed on absorbent towel and the excess polymer-mix on the surface was wiped off. This step lasted for 4 days. On the 5th day DBTL was applied to the surface of the specimen, which was then wrapped in plastic film. For the next 5 days the cure rate was checked and more DBTL applied. The specimen was ready to use after these steps.

Results: The Poliplast 40 impregnated and cured specimen is dry, odourless, durable, maintains good flexibility and preserves the anatomical structures.

Conclusion: The room-temperature plastination technique produces real specimens with reliable structures, and not models. These specimens promote excellence in anatomical teaching practices.

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8. Plastination history

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Plastination birthed 1975 - Dr Gunther von Hagens

First publication: 1978, “Impregnation of large specimens with polymers”, in Verhabdlungen der Anatomischen Gessellschaft, 1978.

Plastination brought to USA, 1979 by Dr Harmon Bickley and first plastination lab established.

First plastination meeting, 1982, San Antonio, Texas “The First International Conference on Plastination”.

2nd International Conference on plastination: April, 1984, San Antonio, Texas.

3rd International Conference on Plastination: April 21-25, 1986, San Antonio, Texas. International Society for Plastination (ISP) founded. Harmon Bickley - First Journal Editor.

January 1987, 60 members: five are still active: Carlos Baptista, AW Budenz, Gunther von Hagens, Steve Holladay, Bob Henry.

First Volume, Journal of the International Society for Plastination, January, 1987.

4th International Conference on Plastination: Macon, Georgia, March 21-25, 1988. 1st Biennial Meeting of ISP.

5th International Conference on Plastination: Heidelberg, Germany, July 22-27, 1990. 2nd Biennial Meeting of ISP.

6th International Conference on Plastination: Kingston, Ontario, Canada, July 26-31, 1992. 3rd Biennial Meeting of ISP.

7th International Conference on Plastination: Graz, Austria, July 24- 29, 1994. 4th Biennial Meeting ISP: ISP formally organized. Distinguished Members elected: Gunther von Hagens and Harmon Bickley.

8th International Conference on Plastination: Brisbane, Australia, July 14-19, 1996. 5th Biennial meeting of ISP: Plastination Index presented.

9th International Conference on Plastination: Trois-Rivières, Québec, Canada, July 5-10, 1998. 6th Biennial meeting of ISP.

10th International Conference on Plastination: Saint-Etienne, France, July 2-7, 2000. 7th Biennial Meeting.

11th International Conference on Plastination: San Juan, Puerto Rico, July 14-19, 2002. 8th Biennial Meeting ISP.

12th International Conference on Plastination: Murcia, Spain, July 11-16, 2004. 9th Biennial Meeting ISP.

13th International Conference on Plastination: Vienna, Austria, July 2-7, 2006. 10th Biennial Meeting ISP.

14th International Conference on Plastination: Heidelberg and Guben, Germany: July 20-26, 2008. 11th Biennial Meeting ISP, *Journal name change.

Last issue of “Journal of the International Society for Plastination”: Vol. 23, 2008

New name “Journal of Plastination”: Vol 24, 2009-2012. Http://journal.plastination.org

15th International Conference and workshop on Plastination: Honolulu, Hawaii, Joint Meeting with AACA, July 19-24, 2010. 12th Biennial Meeting ISP:

16th International Conference and workshop on Plastination: Beijing, China, July 23-27, 2012. 13th Biennial Meeting ISP.

17th International Conference on Plastination: Saint Petersburg, Russia, July 13-17, 2014. 14th Biennial Meeting ISP.

18th International Conference and Workshop on Plastination: Toledo, Ohio, June 26-July 1, 2016. 15th Biennial Meeting ISP.

Interim Meetings

1st Interim Conference and Workshop on Plastination, November, 1989, Knoxville, Tennessee.

2nd Interim Conference on Plastination, Rancho Cucamonga, California, August 7-9, 1991.

3rd Interim Conference on Plastination, Mobile, Alabama, August 3-7, 1993.

4th Interim Conference on Plastination, Columbus, Ohio, July 14, 1995.

5th Interim Conference and Workshop on Plastination, Knoxville, Tennessee, June 29 - July 3, 1997.

6th Interim Conference and Workshop on Plastination, Rochester, New York, July 11-16, 1999.

7th Interim Conference on Plastination and Tour, June 11-15, 2001, Shanghai and Nanjing, People’s Republic of China.

8th Interim Conference and Workshop on Plastination, July 6-9, 2005, Skopje, Macedonia.

9th Interim Conference and Workshop on Plastination, July 8-10, 2007, Ann Arbor, Michigan.

10th Interim Conference and Workshop on Plastination, July 9-12, 2011, Toledo, Ohio.

11th Interim Conference and Workshop on Plastination, July 9-12, 2015, Vitoria, Brazil.

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9. Plastination of fungi and fragile biological specimens

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Introduction: It is often difficult to preserve biological specimens in a fashion that is easily accessible, not easily destroyed, and functional. Some specimens are tough and fibrous while others are soft and delicate. The plastination technique replaces cellular and interstitial fluid with a curable polymer, like silicone, to preserve the tissue at the cellular level. Specimens are preserved forever and are not affected by insects as dry preserved specimens often are.

Materials and Methods: Silicone plastination, both the new room-temperature method and classic cold-temperature silicone process, was used to impregnate specimens. Both methods are similar: 1. Specimens prepared, 2. Dehydrated, 3. Impregnated with silicone, 4. Cured. Reptilian and mammalian preparations were fixed with 10% formalin, while plants and insects were frozen in appropriate position by placing them in -20° C acetone which commences the dehydration step. Formalin-fixed specimens were flushed in running tap water for 2 days and then placed in -20° C 100% acetone for a week with 3 weekly acetone changes to complete dehydration. Acetone-filled specimens were submerged in appropriate polymer-mix in the vacuum chamber. Cold temperature method (carried out in a -15° C deep freezer) used silicone polymer mixed with 2% catalyst, while the room temperature method used silicone polymer mixed with 8% cross-linker. Specimens equilibrated overnight in polymer-mix, and vacuum was then applied. From ambient atmosphere, pressure was lowered to 50 mm Hg over a 2-week period (room-temperature) or nearly one atmosphere, 4 mm Hg (cold temperature), over a month. Impregnation was monitored by bubble formation and a manometer. After impregnation was complete (2 weeks, room temp and 4 weeks, cold temp), vacuum pumps were turned off and chambers returned to ambience. Excess polymer was drained from the specimens for a few days and the specimens were cured/hardened by application of cross-linker (cold temperature impregnation) or catalyst for room temperature impregnation.

Results: Specimens plastinated by either warm or cold methodology produced quality specimens. Only the time allotment from start to finish was different. Room temperature required about 2 weeks less time. Mushroom stems tended to shrink a small amount. However, life-likeness and fine details of anatomical features were remarkable. Insects were fragile and life-like, but more durable after plastination than in their previous dried/ battered states. Reptilian keratinized skin was maintained along with good anatomical detail.

Conclusion: Plastination is a good method for preservation of mushrooms and other delicate biological specimens.

10. A time- and space-saving alternative to molecular sieve regeneration

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Introduction: During dehydration of specimens for plastination, acetone replaces water, embalming fluid, fat and other fluids in specimens. The end of this collective-stage process produces "dirty" acetone that requires either distillation or costly and wasteful disposal. Mechanical filtration followed by solvent distillation brings the purity of acetone to 95-97% at best. After this process, the acetone purity outcomes are not adequate for complete dehydration of the specimen. After solvent distillation, molecular sieves are used to purify acetone to above 99.5%. Work done by Baptista on the regeneration of molecular sieves was accomplished by heat drying the sieves at 250° C for 24 hours in a conventional oven. Although this a very effective way to reprocess molecular sieves, many labs may be limited on space and time to carry out this method. Subsequently, another method of molecular sieve regeneration was tested.

Materials and Methods: mSORB® 3Ångstrom molecular sieve beads were used in the dehydration of solvent distilled acetone. A conventional microwave oven was used in the regeneration process of the used sieves. Clean distilled acetone was diluted with tap water to 90% and 97% respectively. Three batches of used, air-dried, acetone-free molecular sieves were dehydrated in a microwave oven for three time intervals 20, 40 and 60 minutes. Sieves were cooked for 10 minutes, cooking stopped for 5 minutes to stir (to prevent overheating of the container) and then the next cooking cycle until completion. By volume, 200 ml of sieves were placed in each filter sock (Tuffy®, milk filters) and submerged in 900 ml of 90% acetone and 900ml of 97% acetone respectively. To increase the sieves/acetone ratio, 300 ml of sieves were placed in 2 filter socks, then submerged in 850 ml of 90% and 850 ml of 97% acetone respectively. The sieves were allowed to react at room temperature for 24 hours and then the acetone purity was checked with an acetonometer.

Results: In experiment #1 (90% acetone) the H_2O saturation of sieves increased in effectiveness as cook time increased (0.9 and 1.7 to 2.3 %↑). In experiment #2 (97% acetone) the range of saturation was less defined (0.9 and 1.0% to 2.4 and 3%) between cooking times but saturation limits (%↑) were much higher.

Conclusion: This method has been effective in regenerating sieves to make more pure acetone (98→100%) for end stage dehydration. A microwave oven can be placed on a counter top and cooking of sieves can easily be done while accomplishing other lab duties. For this method to be effective, at least 25% of the total volume of sieves to distilled acetone should be used. The forty minute cook times in both experiments proved to be the most effective in time management sieve regeneration. Note: for safety reasons handling of acetone must always be carried out in spark proof areas.

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11. Chemistry and physical properties of polymers for plastination

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The basic chemistry and some physical properties of polymers used in the plastination process will be discussed. Three classes of polymers, namely: polyesters, silicones and epoxy resins constitute the main plastination polymers. The functional groups, which are active for polymerization and curing processes, are identified for each class of polymers. The chemical routes for the curing process of the different polymers will be presented. Experimental techniques can be used to determine the optimum temperature and time for the curing methods of different polymer blend recipe. Two methods will be discussed.

12. Plastination combined with wet cadaver dissection in veterinary anatomy learning

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Introduction: The aim of this study was to scrutinize learners' perspectives by exploring how first- and second-year veterinary students perceive the use of plastinated anatomical prosections, not only during wet cadaver dissections in their anatomy practicals, but also in small-group tutorials.

Materials and Methods: A collection of 135 plastinated specimens including isolated organs, cavity prosections, prosections of specific regions such as head and neck, etc. was accessible during practical sessions with wet cadavers in the dissection room. After the practicals students also had free access to the plastinated specimens in the Veterinary Anatomy Museum, and during supervision meetings with their supervisors. An anonymous closed questionnaire, using estimation Likert scale (1-5 grades), was completed.

Results: All students (100%) positively appreciated the use of plastinated specimens in combination with wet embalmed cadaver dissection. Overall, 87% of students would have liked to have had more plastinated specimens during wet cadaver dissection in the practicals. The possibility of having plastinated specimens in advance to prepare for the practical sessions was important for 76.6% of second year students. Overall, 97.7% of students thought that the plastinated specimens helped them to understand and learn anatomy. All students surveyed agreed to recommend the use of plastinated specimens in the following year.

Conclusion: The use of plastinated specimens in the dissection room and anatomical museum benefited the learning of anatomy in the opinion of students and therefore they recommended it as a permanent resource in combination with wet cadaver dissection and supervision in small groups.

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13. Endoscopic training: how can plastinated specimens be used?

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Introduction: The use of live animals as models for endoscopic training has been recommended as the ideal option since this is the real situation. Training with simulators can provide a safe and controlled environment for learning basic endoscopic skills without risk to patients; however, both virtual simulators and artificial organs have limitations in terms of their procedural realism and degree of fidelity, and therefore users acquire specific skills that may not apply to the patient when performing procedures such as gastrointestinal endoscopy. When beginning to learn endoscopy, if proper training models are not available for practice, complications may result. The learning curve for digestive and respiratory endoscopy is not easy, therefore it is essential to visualize and understand the external anatomy of the gut or the lung during endoscopic maneuvers. Training simulations designed for use with fresh *ex-vivo* gastrointestinal tracts, allow movement of the endoscopic tip to be seen as well as show reaction of the gut during endoscopic advancement. However, because of autolysis fresh material from slaughterhouses may be used for only a short period of time. Plastinated organs are used mainly as a teaching tools in anatomy; however, there are references describing the application of plastinated specimens in postgraduate teaching and specialized courses, particularly in the training of minimally invasive surgical techniques. Modifying the plastination process will help retain the soft flexible properties of the plastinated organs and this benefits the handling and durability limitations of virtual simulators used with artificial organs.

Materials and Methods: The changes in the plastination process are increasing the pre-curing time after impregnation and reducing the use of cross-linker. During this pre-curing time the hollow specimens remain at room temperature dilated with circulating air for several months to allow excess polymer to drain and elongation of the silicone polymer chains. Once weeping has finished and the surface is dry, specimens are placed for 1-2 days in a curing chamber with cross-linker.

Results: The plastinated specimens retain not only their external or superficial morphology but also the internal or intraluminal anatomy. The flexibility of these specimens allows routine endoscopic maneuvers to be performed during exploration techniques such as upper gastrointestinal endoscopy, colonoscopy and bronchoscopy. These specimens are routinely used in a regular surgical theatre before starting training with live animal models.

Conclusion: Plastinated experimental models can be used at the entry level of an endoscopic learning and training program. The development of new training protocols that include the use of plastinated organs is of the greatest importance. This would decrease time and costs of the training, while minimizing risk for both patients and clinical staff.

14. The human body and the harms of modern life: itinerant museum of anatomy (IMA) using plastinated specimens and anatomical models

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Introduction: The Itinerant Museum of Anatomy (IMA) targets middle and high school students, and teachers use anatomical models and plastinated specimens to promote an innovative learning experience, creating a better understanding of the human body. It also creates an awareness of the harms that the habits of modern society and its contemporary behaviors cause to the organism.

Methods: The first stage of this project covers four visits to one Brazilian public school in Salvador, Bahia State, Brazil. The IMAs were done in two steps: lecture followed by correlated anatomical models exposition. A 10-question pre-test was administered to students over 18 years of age. Following the lecture, a post-test containing the 10 questions given in the pre-test plus 5 additional new questions was administered. The anatomical models exposition comprised plastinated specimens and anatomical teaching aids related to the IMA's topic. Four IMA modules were created: (1) STD, early pregnancy and contraception; (2) Legal and illegal drugs; (3) Locomotor and cardiovascular system; (4) Nervous system and skin.

Results: A mean of 17 students answered the pre-tests during the first, second, third and fourth IMA sessions, achieving an average score of 61.9%, 64.3%, 75.7% and 75.2% in each, with worse results on topics of: female reproductive system, AIDS/HIV infection; harms of tobacco, marijuana and alcohol. A mean of 15 students answered the post-tests during the first, second, third and fourth IMA sessions, achieving an average score of 70.5%, 66.3%, 79.3% and 71.7% in each, with worse results on topics of anatomy; improved results on STD and pregnancy prevention; worse results on the effects of cocaine, but better results on the effects of alcohol abuse.

Conclusions: The tests revealed that entertaining, didactic teaching methods, when appropriate to teenagers' age range, are effective in enriching knowledge and suggesting positive behavioural changes. Thus, perceiving anatomy through plastinated specimens and resin anatomical models made it easier to realize how risky behaviors can impact on human lives. The value of IMA visits can be attributed to the facilitators' age group being similar to the students', but also to curiosity about the novelty of the display of anatomical models.

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15. Three-dimensional and two-dimensional reconstruction of plastinated specimens with silicone at room temperature

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Introduction: Plastination is presently used in college teaching and it is increasingly used in research. This technique is also used in conjunction with imaging techniques, serving as a complementary tool to living human body images. Plastination allows the creation of three-dimensional reconstructions of the body's anatomy. Using slices in three- and two-dimensions allows visualization of the specimen's internal anatomy through application of these imaging techniques.

Materials and Methods: A modified room temperature plastination technique is used: dehydration, two weeks, in acetone concentrations above 90% for the first bath, and acetone 100% concentration for the second one. Forced impregnation: 3/4 days, the specimens were placed in a silicone/catalyst (polydimethylsiloxane/dibutyltindilaurate) mixture 100:1. Forced impregnation using vacuum is complete when pressures are decreased to 5 mm Hg. This process is done in two stages: active forced impregnation (activation of vacuum pump for 8 hrs) and passive forced impregnation (vacuum pump off, for 12 hrs) until 5 mmHg was achieved, and acetone bubbles were no longer present. Silicone excess was removed and the specimen positioned. Specimens were cured with tetraethylorthosilicate (TEOS) for 2 days (30 minutes/day of TEOS exposure). Once the plastination process was finished, specimens were scanned using a GE Optima CT660 Second Edition – Multislice 16-slice, CT scanner. Tomographic images were obtained and three-dimensional reconstructions were created.

Results: Three-dimensional reconstructions were obtained from plastinated specimens. Further three-dimensional and two-dimensional cuts were achieved.

Conclusion: Creating three-dimensional reconstructions of plastinated specimens is possible and the generation of three-dimensional and two-dimensional images are of great use. It is an excellent tool for teaching and research.

16. How to select vacuum equipment for plastination

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Vacuum pumps are used throughout industry, being employed in a host of different applications. Unlike other technologies being used in the industrial arena, vacuum is often misunderstood. This leads to vacuum equipment, particularly vacuum pumps, being incorrectly selected due to the lack of fundamental knowledge being readily available.

This presentation will explain the basic selection criteria to enable the correct choice of vacuum pump and associated equipment to undertake the task of plastination.

About Daniel Pascoe: Daniel is manufacturing engineer from the UK with origins in the British aerospace production industry. Having worked in that environment for some years as a production and design engineer, Daniel changed paths in the early 1990s and began a career in the fluid power industry with a focus on vacuum technology. Having established a vacuum component distribution firm in the UK in 1996, Daniel emigrated to Canada in 2003, and in 2005 incorporated Vacuforce, a vacuum solutions provider for automation houses in the USA and Canada. In 2013 Daniel moved Vacuforce to Indianapolis from Ontario to better serve its American customer base. At the same time Daniel started an industrial distribution consultancy firm, Davasol Inc, which occupies the majority of his time today. Daniel continues to oversee Vacuforce operations from his base in Ontario, Canada which includes administering vacuum technology surveys to large industrial users across North America.

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17. Documenting plastination runs with a Microsoft™ Excel template

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Introduction: The purpose of this lab management tool is electronically to document, track, and graph information about important aspects of the plastination process. Electronic record keeping provides access to tools that are capable of tracking chemical usage, formulations, and procedural details. Capturing and reporting these aspects of the plastination process are important from an experimental and lab management perspective.

Materials and Methods: A template was developed in Microsoft™ Excel using basic mathematical, macro, and graphing functions. Each event (e.g. acetone measurement or change in vacuum) is time-stamped within the data portion of the worksheet. Calculations within the worksheet are automatically updated to report such variables as days-in-procedure, acetone volume used (recycled vs. new), and an estimate of acetone purity. During the polymer impregnation process, pressure within the chamber is monitored with a digital manometer and estimates of the percentage of total vacuum are recorded. Time-line graphs demonstrate acetone usage and vacuum chamber readings throughout the process.

Results: Electronically documenting the plastination process provides a method to track, assess, and report on important aspects of lab activity. Although documenting protocols and overall chemical usage is easily accomplished through conventional laboratory logbooks, the current method provides a more efficient collection of summary data. For example, tracking the total volume of acetone (i.e. recycled and new) in each plastination run can then be linked to total lab volumes for inventory. In addition, tracking the volume of recycled acetone used in each run provides excellent data to assess the value of the laboratory's acetone distillation/recovery system. The graphing function of the Excel template also provides a visual verification to indicate the necessary times for changes in the acetone bath. Quantitative values, along with graphical depiction, indicate the dehydration potential of the acetone that is based on slope functions. Pressure/vacuum readings within the chamber are recorded during the polymer impregnation phase, along with temperature, and these are graphed. These data, coupled with observation, are used to incrementally adjust chamber pressures.

Conclusion: The current Excel template provides an efficient method for documenting protocols and lab values during the plastination process. Planned updates to the template include monitoring local barometric pressure, temperature differentials, and lab chemical inventory monitoring.

18. Recording cadaver medical history and pertinent dissection findings enriches the role of anatomy in enhancing medical students' professionalism

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Introduction: During the past couple of decades there has been a remarkable emphasis on the role of anatomy lab in promoting professionalism among medical students. Several studies and surveys proved that medical students' encounter with dissection represents a major opportunity to develop the attitudes of empathy, respect, and humility while integrating them with attitudes of scientific enquiry and evidence-based medicine. This study aimed to introduce first-year medical students at OUWB School of Medicine to cadaver medical histories early in the semester, and to offer them the opportunity to record dissection notes and pertinent pathological findings. It is believed that this interaction with cadavers will undoubtedly contribute to enhancing students' professionalism in addition to improving anatomy knowledge and comprehension.

Materials and Methods: Students were provided with their donors' cause of death and medical history. They filled out a cadaver assessment form to outline inspection findings before dissection. The rationale was to create a deeper and a more meaningful appreciation of the cadaver's role in facilitating anatomy education. Students filled out dissection findings and recorded pertinent pathological findings. Care of their tables and donors were monitored periodically. Students were informed categorically of any inadequate table care. A survey was administered at the end of the semester to assess students' opinions about these measures.

Results: Participation rate was 93%. More than 47% agreed that the new measures helped to improve their teamwork skills, relationships with donors, and ability to express empathy. However, only 35% believed that the new measures improved their ability to cope with death.

Conclusion: The new measures had positively influenced students' perception of the cadaver as an individual and recognizably promoted respect, better teamwork, and empathy. The lower mean response to the influence of these measures on students' ability to cope with death is noteworthy. Further steps are needed to ensure that students' interaction with cadavers is a more positive experience and enhances professional attitude. The survey will have a more significant impact if measures are reassessed regularly, and responses of future students are analyzed and compared to ensure a sustainable outcome.

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19. Changing the face of anatomy at University of Texas School of Dentistry: a preliminary report on a plastinated approach

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Introduction: Following a redesign of the basic science curriculum in the School of Dentistry, the school chose to forgo a traditional anatomy course, and, in 2016, replaced the use of dissecting cadavers with the study of dissected plastinated specimens and sections.

Materials and Methods: The class was divided into eight groups for the labs (12-13 students per group). Each group would meet twice a week for two hours per session. Travel, preparation, and clean-up time was eliminated. Students were encouraged to work together utilizing the plastinated specimens, models, PowerPoint slides, online resources and atlases. At the end of each lab, the students were given a 5-question PowerPoint quiz, utilizing photos of the specimens.

Results: The change from a cadaver dissection anatomy course has improved the efficiency of teaching anatomy. The prior dissection course involved 66 lab hours, while the new course involves 48 lab hours. Final grades and student evaluations have not yet been established. However, undocumented observations have been made:

1. Very few complaints on the practical examinations and very few contested questions.
2. Students work together well. Students have commented on how much they enjoy seeing “great dissections”.
3. Students are improving their grade performance, particularly the practical exams. Comparing the first lab practical exams, 19 students failed in the 2015 course. In contrast, 5 students failed in the 2016 course.
4. A financial advantage is predicted due to the life span of the specimens and no recurring costs of the dissection laboratory cadavers. Specimens will be further utilized for undergraduate and post-graduate anatomy courses, as well as CME courses for the public practicing professionals.

Conclusion: UTSD made the decision to abandon cadaver dissection in 2014, and implemented the new course in 2016. Preliminary results have shown this mode of teaching and learning has been successful. Students have made considerable positive comments about the experience. Following a viewing of traditionally dissected cadavers, students indicated a preference for the use of our plastinated specimens. Students’ grades have been exceptionally high, with few failures. Further analysis of the grades, student course evaluations, and comparison of the anatomy results on the NBDE Part 1 will enhance our comparison of the new curriculum vs the former dissection course.

20. Working with millennial learners: the active classroom

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Our classrooms are changing. They are changing in terms of the technology and resources available to us as teachers and even in terms of location. We now have virtual classroom as well as traditional face-to-face options for the presentation of our content; and our students are changing as well. Students who enter our classrooms as first-year students this year will have never licked a postage stamp and have never known a world without the internet and Google.

This presentation will address the characteristics of our current students compared to earlier generations and integrate these with the pedagogical strategies that make use of growing array of materials and resources available to faculty – with an ultimate goal of increasing students' engagement and content mastery.

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21. Plastination technique of brain specimens: minimizing shrinkage

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Introduction: One of main difficulties of whole brain plastination is shrinkage. According to different authors, volumetric changes in brain specimens during plastination can be up to 20% of its primary volume. Here we present a technique of brain plastination that minimizes shrinkage.

Materials and Methods: Brains should be taken in autopsy as soon as possible. The brains that were not fixed until 5 days after death are not suitable for getting good plastinated brain specimens. While carefully taking the brain out of the cranial cavity we incised the internal carotid and vertebral arteries at the maximal distance from the brain in order to leave long segments of these vessels. To fix the brain we inserted tubes for injecting with fixation solution into both internal carotids and one vertebral artery. The second vertebral artery should be ligated. Formalin (10%) was injected into each cannula in amounts of 50-100 ml. After injection, cannulae were closed with special corks and the whole brain was suspended in a bucket with 1% formalin solution for 2 weeks. It is important to arrange the hemispheres of the brain symmetrically and to ensure that the brain does not touch the side or bottom of the bucket. Every two weeks the brains were moved into increasing formalin solution (3, 5, and 7%) and, and then stored for 4 more weeks in 10% formalin. After fixation, the arachnoid mater with blood vessels should be carefully dissected away without removing the cranial nerves on the base of the brain. Specimens can be bleached in 1-2% perhydrol solution for 5 - 12 hours. After that, brains were washed under cold running water for 1-2 hours, and cooled in water to 4-5° C for 6 - 10 hours. Wood and metal pins were used to fix the cerebellum and brain stem to prevent deformation. Dehydration was carried out according to the standard method in cold acetone for 5 weeks. After dehydration, the brains were placed into a polymer-mix of 80% low-molecular silicone P-27 with 15% of polymethylsiloxane-5 and 5% of cross linker (tetraethoxysilane), and impregnated at +20°C. Pressure in the vacuum chamber was slowly lowered from 300 to 30 mm Hg, maintaining a moderate boil. Curing was done by spraying the surface with 30% of catalyst P-27A (dibutyltindilaurate).

Results: This silicone plastination technique is quite simple to do and permits less deformed specimens, and minimizes shrinkage up to 8%. However, it takes a longer time because of the prolonged fixation stage.

Conclusion: This silicone plastination technique yields three-dimensional whole brain specimens with good demonstration features. They have minimal shrinkage and less deformation and can be successfully used in teaching the anatomy of the central nervous system.

22. Comparison of cold and room temperature silicone plastination techniques

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Introduction: Today, two well-known silicone plastination techniques produce large numbers of plastinated specimens. The first one was introduced by Gunter von Hagens in 1977, and is considered now as the S10 cold-temperature (classical) plastination. The second technique was proposed by Daniel Corcoran & Dow Corning Corporation in 1998 and uses a room-temperature silicone mix for impregnation. Both methods have differences in polymer components and in the sequence of their combination in the final plastination stages. We assumed cold- and room-temperature plastination techniques should have other quantitative and qualitative differences in features of the plastinated specimens, as well as other results of both standard methods.

Materials and Methods: A variety of tissue cores, organs, regions and whole body specimens were plastinated using the standard procedures for cold temperature and room temperature silicone plastination. From these plastinates, advantages and shortcomings of both methods were evaluated. Criteria used for evaluation of plastinates included: shrinkage, duration of impregnation and curing, quality of plastinated specimens, need for extra equipment and its maintenance, as well as other cost considerations. To efficiently evaluate shrinkage and duration of plastination, 3 cm core samples of parenchymatous organs were collected, dehydrated and plastinated using standard procedures for both plastination techniques. Core sample volume was evaluated at the end of each stage of the process by fluid displacement.

Results: The average shrinkage for tissue cores plastinated by the room-temperature technique was 1.5 times less than the cold-temperature method ($p < 0.05$). The total duration of impregnation and curing stages of core samples for cold-temperature plastination proved to be 1.54 times longer than the room-temperature technique. The silicone impregnation-mix for the room-temperature technique, because of its low viscosity, drains very easily from impregnated hair, fur, and feather specimens which is a large time saver. The cold-temperature plastinated hollow organs and body part specimens were more flexible and elastic after curing than those made with the room-temperature technique, which produced specimens that were harder and more fragile. An additional freezer for the impregnation vacuum chamber, and a special chamber equipped with a fan, an aquarium pump and desiccant were needed for the cold-temperature technique.

Conclusion: The cold-temperature technique makes specimens more flexible and elastic, but this process takes longer and specimens tend to shrink more. Cold temperature is preferable for plastination of hollow organs (gastrointestinal tract, lungs and the whole body). Room-temperature plastination is more economical to set up, allows production of good quality specimens with minimal shrinkage and in a shorter period of time. Room-temperature protocol is recommended for brain, parenchymatous organs, body parts, fetus, fur/hair/feather covered specimens, and reptiles & fish. This technique is also preferable for plastination of long-term formalin-fixed specimens, as well as for archaeological and fossil objects.

23. Myodural bridge: a universal, normal mammalian anatomical structure, based on P45 sheet plastination

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Introduction: The suboccipital region is one of the most complex anatomical regions in the human body. Recently, gross dissection, histology, and medical imaging studies revealed that connective tissue exists between the deeper muscles of the suboccipital region and the spinal dura mater. This connective tissue is referred to as the “myodural bridge”. As a constant structure in the human body, the MDB seems to be a universal, normal anatomical structure in mammals.

Materials and Methods: Gross dissection was conducted, and P45 plastinated sheets were created from these specimens. In order to examine whether the myodural bridge exists in other mammals, three mammalian orders were examined in this study, represented by *Neophocaena phocaenoides* (finless porpoise), dogs, *Macaca mulatta* (rhesus monkey) and a mandrill.

Results: In all the mammalian subjects, a bundle of muscular fibers was discovered protruding from the rectus capitis posterior minor, entering the posterior atlanto-occipital interspace, passing through the posterior atlanto-occipital membrane and terminating at the posterior aspect of the spinal dura mater. This structure was the same as the myodural bridge observed in humans. Thus it can be seen that the myodural bridge is a universal, normal anatomical mammalian structure.

Conclusion: The findings of this study illustrate that the headache patients suffered from obvious hypertrophy of the rectus capitis posterior minor, compared to the normal group. Statistically, a correlation of rectus capitis posterior minor hypertrophy with chronic headache was confirmed. According to the novel physiological function of the myodural bridge, the hypertrophic rectus capitis posterior minor could lead to abnormal CSF flow and pressure via the myodural bridge, thus inducing the chronic headaches. However, substantial evidence still need to be found to support this hypothesis.

24. Body donation for plastination

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Introduction: The Body Donation program of the Institute for Plastination was started in 1983 at the University of Heidelberg, and transferred to the newly-established Institute for Plastination in 1993. At the end of 2015, a total of 15,959 donors had registered, of whom 14,270 are still living. So far 1,689 bodies have been received.

Materials and Methods: Potential donors are provided with a brochure and questionnaire giving full details of the program. There is no financial incentive; within Germany, the Institute for Plastination covers the costs of transport of the deceased. Donors sign a 'Declaration of Intent' to donate: this is not a binding contract and can be revoked at any time. Regular meetings of body donors are held, and there is an 'Independent Federal Association of Body Donors' in Germany.

Results: Breakdown of donors according to age and sex: of the living donors, 8,068 (56.5%) are female and 6,202 (43.5%) are male; of the deceased, 712 (42.2%) were female and 977 (57.8%) were male. Just under half of the donors (49%) are over 61 years of age, 24.8% are between 51-60 years, 25.3% are aged 50 years or below. Approximately a third of donors are also organ donors.

Conclusion: Motivation for donation is varied, with the most common reasons being altruistic: 88% of donors agreed with the statement "I would like to donate my body to a good cause"; an almost equal number (81%) agreed that "I would like to contribute to medical research".