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RESEARCH ARTICLE

SHEET PLASTINATION OF LIMB SPECIMENS – A BOON TO STUDY CROSS SECTIONAL ANATOMY

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ABSTRACT

Introduction: In the present era of developing three dimensional multi-planar imaging techniques used for medical examination and diagnosis, there is a pressing need for an in-depth knowledge of cross-sectional anatomy. The technique of Sheet Plastination invented by Dr Gunther Von Hagens which yields solid transparent sections using synthetic resins is a boon to medical fraternity for learning sectional anatomy.

Observation: In JSS Medical College, Mysore, Karnataka, a low cost technique of sheet Plastination was explored, and is being successfully practiced. In this study, Sheet Plastination of cross-sections from upper limb, lower limb, elbow joint and knee joint were prepared and were correlated with corresponding magnetic resonance images and found good overall correlation between plastinated slice & MRI images

Conclusion: The technique of Plastination has promising future in all fields of training, research and health education. Low cost, non toxic, odorless and portable plastinated specimens helps in teaching and learning anatomy and is an useful tool for verifying MRI and CT.

INTRODUCTION

In the present era of developing three dimensional multi-planar imaging techniques used for medical examination and diagnosis like magnetic resonance imaging, computed tomography and ultrasonography, requires an in depth knowledge of cross sectional anatomy. It is very essential for a medical practitioner to interpret these images in their professional life (Entius *et al*., 2004). The study of gross specimens is an integral part of learning anatomy, which provides an illustrative and explanatory adjunct in understanding of the disease. The decay is the vital process in nature which is an impediment to morphological studies, teaching and for research and is particularly true for biological specimens. Hence it has always been a goal to find suitable preservation technique (Ravi and Bhat, 2011). The traditional means of preservation and display of perishable biological specimens utilized formaldehyde. Formaldehyde has its own side effects like discoloration of the specimen, its unpleasant fumes causes irritation to eyes and skin. All these factors in addition to the health hazards associated with formalin limit the usefulness of such methods of specimen preservation (Ravi and Bhat, 2011). All these problems are overcome by a technique called Plastination. Plastination is a technique of body tissue preservation, which was originally introduced by Dr Gunther Von Hagens in 1977 which produces dry, odorless and durable specimens. In this process, water and lipids in the biological tissues are replaced by curable polymers like silicone, epoxy, and polyester which are subsequently hardened (Pashaei, 2010). Sheet plastination is a type of plastination which is considered to be a vital tool in the enhancement and clarification of concepts of cross sectional anatomy and relationships previously often difficult to appreciate (Pashaei, 2010). The introduction of sheet plastination has provided us an opportunity to combine modern cross-sectional imaging techniques with corresponding slices of humans and animal tissues (Entius *et al*., 2004).

Hence the present study was undertaken with an objective of:

a) Finding an effective technique in making permanent cross-sectional specimens mainly of limbs for better anatomical and clinical correlation,
b) To explore a new inexpensive Plastination technique in making cross sectional specimens; to be displayed in the museum as an important teaching and learning aid.
c) To compare and correlate the sheet plastinated sections with the corresponding MRI images.

MATERIALS AND METHODOLOGY

Materials required are fresh embalmed cadaver, electric band saw, acetone, Resin, catalyst, accelerator, glass sheets, clamps/ Fold back clips

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Methodology: Fixation and Section Cutting

A recently embalmed cadaver with moderate muscle built was selected for the study. The limbs were disarticulated from the cadaver and were kept in 0° C to 2° C for two days to ensure smooth cut surface while sectioning. While preparing the band saw is adjusted to obtain the sections of desired thickness. Sections of 5 mm thickness were taken with representation from the upper 1/3rd, middle 1/3rd and lower 1/3rd of the arm, forearm, thigh and leg of both sides. Sagittal and coronal sections of elbow and knee joint were also taken. The sections were cleaned off the saw dust, dried with tissue papers and transferred into labeled zip lock covers which were punched all over. The sections were then lowered into glass jars containing acetone of volume at least 10 times that of the specimen.

Dehydration and Degreasing

These jars were kept in -25°C. Sections of 5 mm thickness were completely dehydrated in 7 days with 2 changes of acetone in between. Degreasing was effected by acetone in room temperature.

Impregnation

The sections were left in a tray containing resin for two days, they became transparent and ready for casting.

Casting and Curing

A leak proof flat chamber was constituted using two glass sheets and a rubber tube in between, held together by fold back clips in three sides. The fourth side on the top is left open to pour the resin - hardener mixture. The specimen, threaded with a thin nylon string in its bottom is kept on the glass sheet even before the clips are fastened to position the specimen while viscous resin is poured. Required amount of resin (volume of flat chamber minus volume of the specimen) and accelerator (5% of volume of resin) are mixed thoroughly and later same volume of catalyst (5% of volume of resin) is added to the mixture. The chamber with the specimen is held vertically and the resin - hardener mixture is poured through the top till the resin reaches an inch above the specimen. The chamber is made to stand vertically and left overnight to cure. The next day, the glass sheets were removed and the plastinate is ready for display.

Comparison with MRI images

All the structures were identified in the plastinated sections and were compared with corresponding MRI images.

OBSERVATION

The pronator quadratus muscle and its attachments are well appreciated. The architecture is so well presereved that with the very sight of the section, the level of section can be identified.

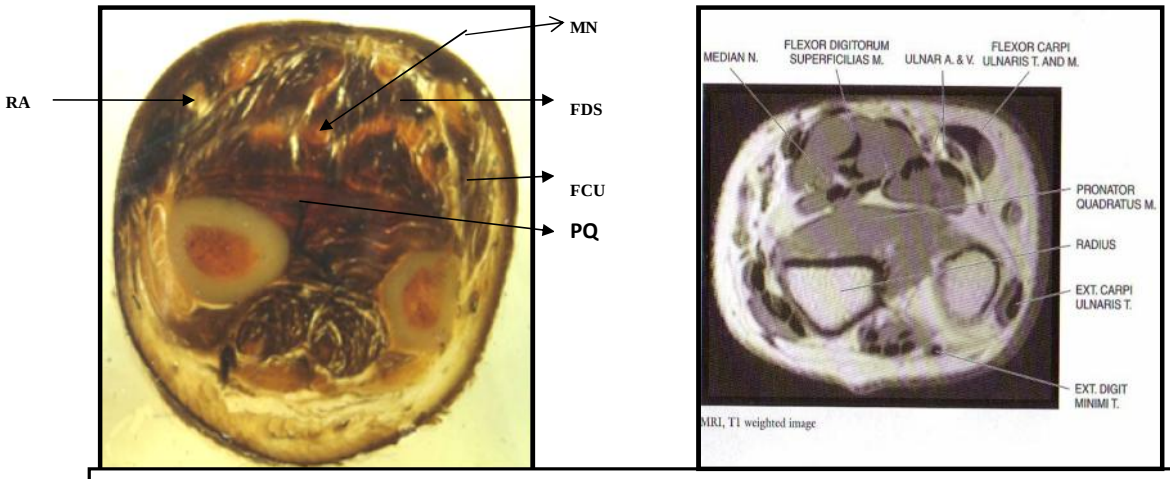

FIGURE 1: TRANSVERSE SECTION OF LOWER 1/3 OF FORE ARM & CORRESPONDING MRI

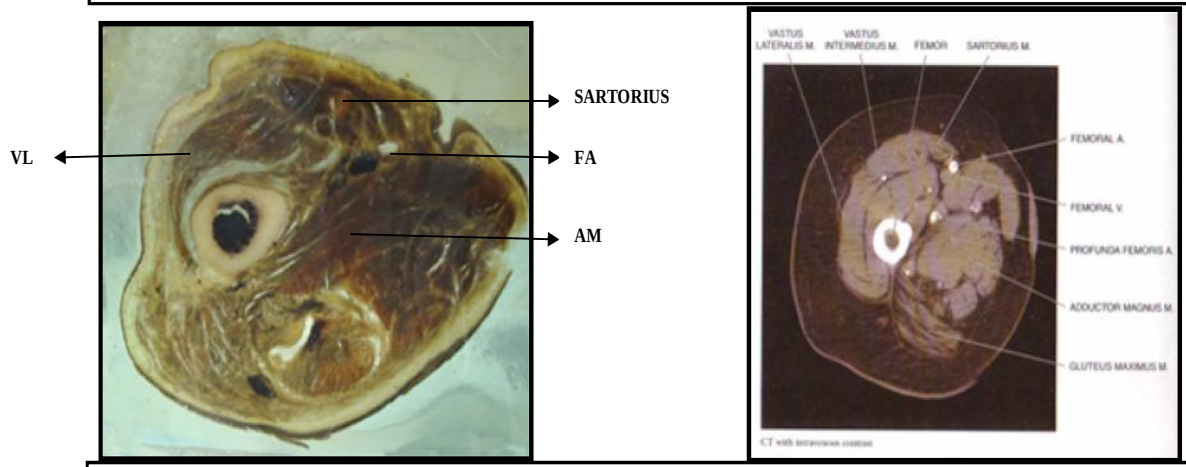

FIGURE 2: TRANSVERSE SECTION OF UPPER 1/3 OF THIGH (RT SIDE) & CORRESPONDING MRI

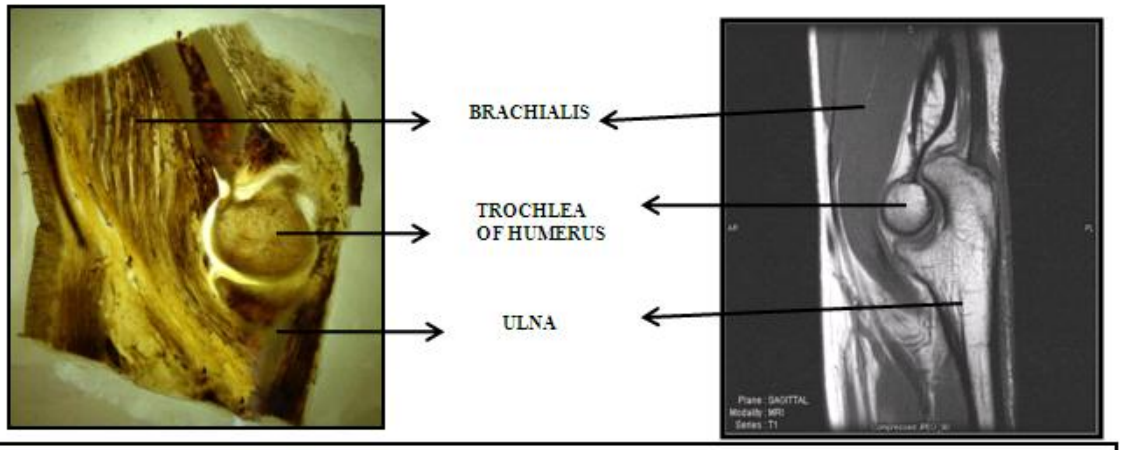

FIGURE 3: SAGITTAL SECTION OF ELBOW & CORRESPONDING MRI IMAGE

FIGURE 4: SAGITTAL SECTION OF RIGHT KNEE & CORRESPONDING MRI IMAGE

The intermuscular zone is very well demarcated. The relationship of femoral artery and vein at the apex of the femoral triangle is demonstrated. The joint cavity is very well defined. The articular cartilage covering the articular surfaces can be made out and correlate well with the MRI image. The various structures and their relations within the knee joint like anterior cruciate ligament (ACL), suprapatellar bursa, infrapatellar pad of fat and structures in popliteal fossa like popliteal artery, vein and popliteus muscle are appreciated.

All MRI image pictures are taken from reference No 12

DISCUSSION

Thin sections of organs, limbs, brain, and hollow visceras may be processed and encapsulated with a clear and smooth resin sheet. Even ultrathin plastinated sections can be obtained and been used to construct three dimensional computer models of anatomical structures (Pashaei, 2010). The comparison between E12 serial sectioned specimens with the equivalent MRI and CT images provides much clear understanding of anatomical structures to the medical students in their learning process (Cook, 1997). The technique of plastination had rapidly expanded in human and veterinary laboratories first in Europe and North America and now it is practiced in more than 250 universities and colleges around the world (Gilles Grondin, 1998). Latorre *et al.,* 2007 have evaluated the use of plastinated specimens as teaching resources and found to improve the quality of teaching and learning anatomy (Latorre *et al.*, 2007). (Latorre, *et al.,* 2007). Sheet Plastination can be applied in the histopathology. The sections of resected (cancerous) mastectomy specimens were sheet plastinated and studied both macroscopically and microscopically to verify the accuracy of the in vivo instrumental study (Guhr *et al.,* 1987). E12 Epoxy method of Sheet plastination of sections taken from different regions of the human body cut in sagittal, horizontal and coronal planes including head and neck, trunk, inguinal region, limbs and joints were made to facilitate the students with significant gross details down to submacroscopic level retaining in situ structural integrity in a complete and uninterrupted manner involving cross-sectional anatomy, radiology and histology disciplines (Cook and Al-Ali, 1997). Plastinated specimens carries great educational values and minimizes the cost of buying corpse as these specimens are low cost, non toxic, odourless and durable for longer period of time and makes students learn anatomy with more enthusiasm and excitement (Priya and Lama, 2007). In University of Georgia, a project was taken up to improve efficiency of students to identify structures and pathways on transverse sections of the brain and correlate them three-dimensionally with the whole brain. The use of plastinated tissues were found to be ideal for use in the computer assisted learning centre (Purinton, 1991). The interpretation of CAT and NMR images is sometimes very difficult and requires the support of normal morphology to reach the formulation of certain unequivocal diagnosis. Serial

sections of some human body regions were performed following a careful radiological indication. These slices were plastinated using the standard S10 technique. The plastinated specimens and the correspondent NMR-CAT images were subjected to study which revealed that the direction of the cross-sectional images and the anatomical cuts coincide and the anatomical support can be clearly useful for the diagnosis (Ripani, *et al.,* 1996).

Conclusion

The introduction of modern imaging techniques, especially ultrasound, computed tomography and magnetic resonance imaging has enormously expanded the importance of cross sectional anatomy. Precise diagnosis as well as detailed planning of therapy (for example, the ablative surgery of extensive cancer) and of interventional radiology often depends on the sound knowledge of cross-sectional anatomy. The plastinated specimens can help the radiologists to refresh their knowledge and to explain the ambiguous details shown in CT and MRI. Thus Plastination can be a useful tool for verifying MRI and CT. Plastination seems to have a great future in all fields of training, research and also public health education throughout the world. Cheaper costs and also vivid appearance of the specimens make the plastination a unique window to the world of anatomy for learners. Plastination the best technique for preparing museum specimens, improves the quality of teaching and learning anatomy which has been considered as an important tool in recent proposals and is increasingly appreciated in the field of research. Thus our sheet plastinated cross-section specimens will be a value addition in the curriculum to teach the cross sectional anatomy not only to the undergraduates, but also to the postgraduates in various disciplines like radio diagnosis, anesthesia and surgery.

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