Effects of Temperature on the Flexibility of Selected Pig Organs in Silicone (S10) Plastination

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Abstract

Background: The quality of plastinates is often not as satisfactory as expected. Among many factors responsible for producing a good plastinate, temperature is one of the most important factors. The present study was aimed at determining the relative efficacy of the cold temperature method compared to the room temperature method regarding silicone (S10) plastination of selected pig organs.

Methods: This experimental study was carried out in Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh during the period of March, 2015 to February, 2016. Six (6) pieces of firmer sectioned organ (pig kidney) and six (6) pieces of softer sectioned organ (pig lung) were collected from a government authorized slaughter house of Dhaka, Bangladesh which were designated as the 'Cold Temperature group' and the same numbers of pieces as the 'Room Temperature group'. Then their percentage of changes in flexibility after every stages of plastination were measured and compared.

Results: After fixation, the flexibility of the softer organ was significantly lesser at cold temperature than at room temperature. After dehydration, the flexibility was significantly lesser at cold temperature of both firmer and softer organs. After forced impregnation, the firmer organs showed significantly greater and the softer organs showed significantly lesser flexibility at cold temperature. After gas-curing, the flexibility was greater at cold temperature reasonably close to significant level ($p= 0.06$) for the firmer organ and significant for the softer organ.

Conclusions: In the present study, in case of the softer organ, there was a decrease in the mean percentage of change in flexibility (yielding greater flexibility) at room temperature and an increase (yielding lesser flexibility) at cold temperature. But in case of firmer organ, cold temperature silicone (S10) plastination demonstrated variable effects on flexibility compared to room temperature S10 plastination, but this finding was not proved statistically. So, further researches with larger samples are recommended to reach a definitive conclusion.

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Keywords: Temperature, firmer organ, softer organ, change in flexibility, silicone (S10) method.

Introduction

Anatomy has been a foundation stone of medical education for hundreds of years. The study of gross anatomy is an integral part of learning anatomy in medical education. Human cadavers and gross specimens of body parts have been considered essential tools for the teaching of anatomy. Traditional methods of preservation include drying, immersion in chemical preservatives or perfusion of blood with chemical preservatives.[1] Commonly, cadavers and specimens of human body are preserved in formalin. In the anatomy dissection rooms, cadavers and gross anatomical specimens are found soaked with formalin, discoloured and they spread unpleasant odour that cause tearing of eyes, burning sensation in nose and throat, tightening of the chest and palpitation of the heart.[2]

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Students lose their concentration while studying in the dissection hall. Therefore, there has always been a desire for specimens that would be dry, odourless, real, non-dangerous that do not require rigorous maintenance and do not deteriorate with time and which can be used in classrooms without gloves.[3] These expectations from anatomical learning tools have been fulfilled to a great extent by applying the modern method of body preservation, 'plastination'. Plastination is a novel method of preservation of biological specimens developed by Dr. Gunther von Hagens in 1977 at the Department of Anatomy of Heidelberg University in Germany who patented it between 1977 and 1982.[4]

The plastination method consists of slowly replacing tissue fluids and a portion of the tissue lipids with a plastic polymer, under vacuum. The results are clean, dry, odourless, and durable real biological specimens that can be handled without gloves and do not require any special storage conditions or care.[5] These specimens prevent exposure of staff and students to the toxic substances (e.g., formaldehyde, phenol and alcohols) used in the classical preservation of biological tissues.[6] It even preserves cell identity at a microscopic level.[7]

Although plastination is a simple process, the results are often not as satisfactory as expected. Various factors have been found to contribute to the determination of the quality of plastinates. Among them temperature is one of the most important factors. Bangladesh is a tropical country and temperature ranges from 14^{o}C to 30^{o}C.[8] It is said that cold temperature (-18^{o}C to -21^{o}C) plastination method produces good quality specimens. But it can be possible in room temperature (20^{o}C to 28 ^{o}C) also. If a good quality specimen can be produced by room temperature method the expenditure will be reduced more times. There are no known reports of the use of plastinates[8] in Bangladesh as teaching aids in medical education. Recently, the first plastination laboratory of the country has been established in the Department of Anatomy of Bangabandhu Sheikh Mujib Medical University (BSMMU) in 2012, through the funding of a Subproject (CP-036) of the Higher Education Quality Enhancement Project (HEQEP) of the University Grants Commission of Bangladesh provided by the Academic Innovation Fund (AIF) of the World Bank.[9] The aim of the study was to give detailed information about the production of plastinated specimens and to highlight the advantages of their use in combination with the traditional wet specimens in the teaching and learning of gross anatomy.

Methods

The specimens were collected from a government authorised slaughter house of Bangladesh (Shandon Pork Meat Shop, Farmgate, Dhaka). Three (3) pig kidneys were taken as the firmer organ from pigs and three (3) lungs were also taken from same animal as the softer organ. Three (3) kidneys were sectioned transversely into 2 pieces each at the level of the hilum and three (3) lungs were sectioned transversely into equal two halves with sharp knife. For the present study, sectioned organs were considered as individual sampling unit. Each of these units was numbered with a tag. Six (6) pieces of sectioned organ (three pieces of kidney and three pieces of lung) were designated as the 'Cold Temperature group' and the same numbers of sectioned organ as the 'Room Temperature group'. The organs were fixed with 10% formalin solution.[10,11] Then rinsed with water.[10, 12] Pre-cooling was done only in Cold Temperature group.[13] Afterwards, the specimens of Cold Temperature group was dehydrated with cold temperature acetone at -19 ^{0}C to -23 ^{0}C in deep freezer[14] and the specimens of Room Temperature group was

dehydrated with room temperature acetone at 20 ^{0}C to 28 ^{0}C separately. Forced impregnations of the specimen of two groups were done with silicone S10 and S3 at both temperatures separately.[13, 15] Lastly, gas-curing of the specimens of two groups were done with S6 at room temperature.[13]

A weighing machine was modified for measuring the flexibility of the sectioned organ. A wooden frame was fitted with the body of the machine to make a platform for putting the sectioned organ on it. A linear scale (in millimetres) was attached at one side of the wooden box. An indicator was fixed to the margin of the circular plate (originally for putting materials on for weighing) of the machine.

A hole was made on the circular plate and a screw was passed through the hole and a nut was attached around the screw, so that the plate could be pushed down by moving the nut clockwise (Figure 1). The sectioned organ to be examined for flexibility was placed on the platform of the wooden frame and was compressed slowly by pushing down with the circular plate (Figure 2). The linear movement of the plate as indicated by the metallic indicator was measured on the scale in millimetres. Each sectioned organ yielded a value from zero to the last value on the millimetre scale beyond which no compression was possible.

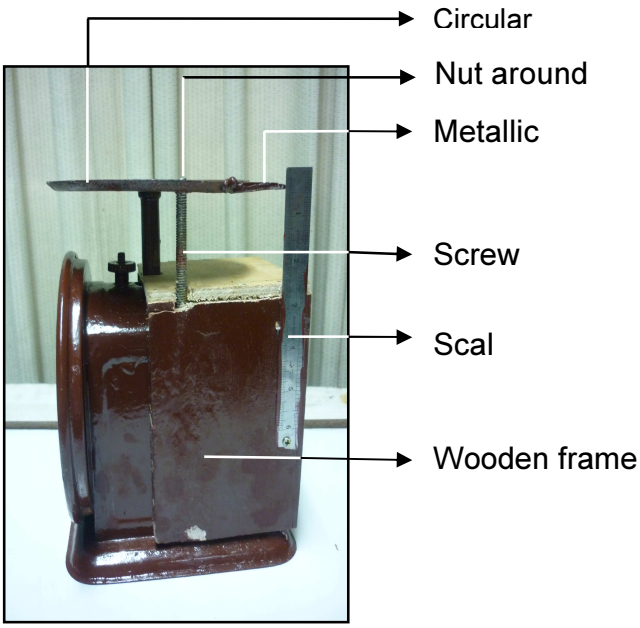

Figure 1. The specially constructed flexibility measuring instrument

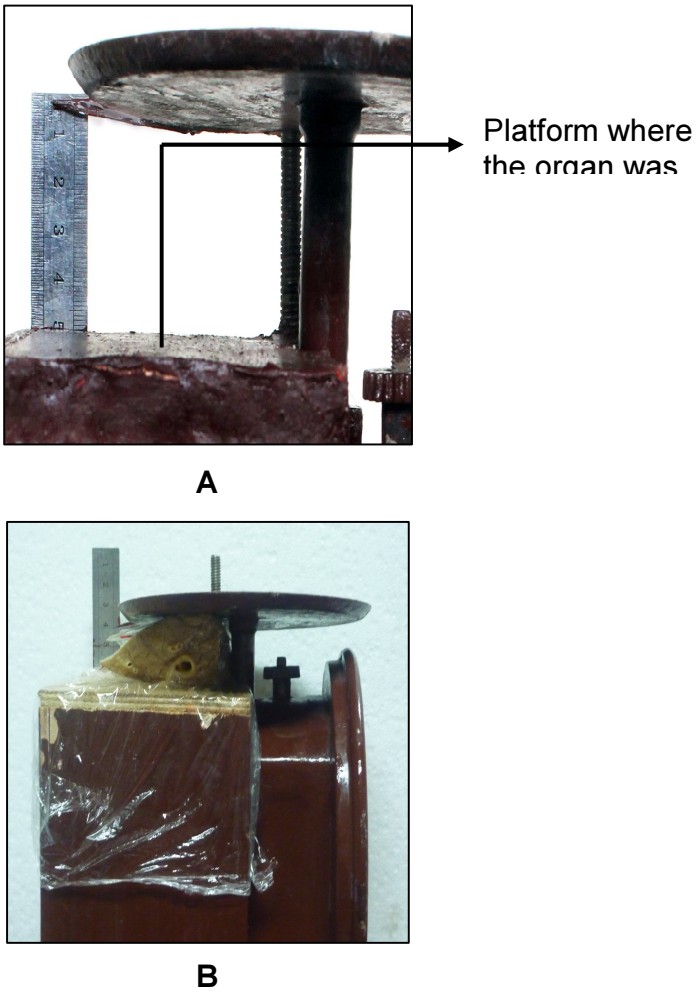

Figure 2. A and B: Procedure for measuring the flexibility of the specimen

Change of flexibility was measured from each piece (sampling unit) of sample unit. At fresh stage and after every stage of plastination the percentage of change in flexibility was calculated. Overall percentage of change in flexibility was also measured. For the comparison of percentage of change in flexibility, the values of the individual sample units were expressed as means and medians (as there were non-normal distributions as well) for the two groups. Hypothesis testing was done for the differences between the two groups using Mann-Whitney U test with the help of software Statistical Package for Social Sciences (SPSS) Version 20.

Ethical clearance

The research was dealt with animal materials (kidney and lung of pig) collected from already dead animals in government authorized slaughterhouses which were sacrifice by maintaining international animal sacrificing protocol.[16] Permission was taken for carrying out the research from the Institutional Review Board (IRB) of BSMMU.

Results

In Cold temperature group, the percentage change in flexibility of firmer sectioned organs was the highest (18.42%) at fixation stage and the lowest (- 0.67%) in forced impregnation stage. The percentage change in flexibility of softer sectioned organs was the highest (25.75%) in dehydration stage and the lowest (- 8.53%) in gas-curing stage (Table I and Table II). The overall mean (± SD) percentage change in flexibility of firmer sectioned organs was 14.08±4.13% and the softer sectioned organs were 34.05±8.91%.

In Room temperature group, the percentage change in flexibility of the firmer sectioned organs was the highest (22.10%) in fixation stage and the lowest (- 0.92%) in gas-curing stage (Table I and Table II). This percentage change in flexibility of softer sectioned organs was the highest (22.57%) in gas-curing stage and lowest (- 5.93%) in forced impregnation stage (Table I and Table II). The overall percentage change in flexibility of firmer sectioned organs was 22.09±4.70% and the softer sectioned organs were 36.77±5.98%.

Table I: Comparison of percentage changes in flexibility of firmer and softer organs in the first two stages of plastination at cold temperature with that at room temperature

Stage of plastination	Consistency and sectioning	No. of pieces (n) (for each temperature group)	Percentage of change in flexibility (Mean±SD)		p	Significance
			Room temperature	Cold temperature		
Fixation	Firmer: sectioned	6	22.10± 4.34	18.42 ± 3.23	0.078	NS
	Softer: sectioned	6	6.54 ± 1.25	16.56 ± 4.56	0.00	S
Dehydration	Firmer: sectioned	6	- 6.37± 3.57	9.14 ± 2.53	0.00	S
	Softer: sectioned	6	17.35 ± 4.01	25.75 ± 6.89	0.02	S

S: Significant ($p \leq 0.05$); NS: Non-significant

Table II: Comparison of percentage changes in flexibility of firmer and softer organs in the last two stages of plastination at cold temperature with that at room temperature

Stage of plastination	Consistency and sectioning	No. of pieces (n) (for each temperature group)	Percentage of change in flexibility (Mean±SD)		p	Significance
			Room temperature	Cold temperature		
Fixation	Firmer: sectioned	6	7.97 ± 7.50	- 0.67 ± 2.61	0.01	S
	Softer: sectioned	6	-5.93± 10.67	8.55 ± 8.81	0.02	S
Dehydration	Firmer: sectioned	6	-0.92 ± 6.09	-15.24 ± 4.60	0.06	NS
	Softer: sectioned	6	22.57 ± 4.26	-8.53 ± 10.71	0.00	S

S: Significant ($p \leq 0.05$); NS: Non-significant

Discussion

After fixation stage, the mean percentage of change in flexibility was smaller (yielding greater flexibility) at cold temperature than at room temperature for the firmer organ and the percentage difference was reasonably close to significance (p = 0.08). But the percentage was significantly greater at cold temperature (yielding lesser flexibility) for the softer organ. No literature was available on flexibility in this regard. After dehydration (in acetone) stage**,** there was a decrease in the mean percentage of change in flexibility of (giving greater flexibility) of the firm organ at room temperature and an increase in the mean percentage of change in flexibility (giving lesser flexibility) at cold temperature. The difference between the two temperature groups was significant. For the softer organ, the percentage of change in flexibility was significantly greater at cold temperature, yielding lesser flexibility. No literature was available on flexibility in this regard. After forced impregnation stage, in flexibility (giving lesser flexibility) of the firmer organ at room temperature and a decrease (yielding greater flexibility) at cold temperature. These differences between the two temperature groups were statistically significant. For the softer organ, however, there was a decrease in the mean percentage of change in flexibility (yielding greater flexibility) at room temperature and an increase (yielding lesser flexibility) at cold temperature. These differences between the two temperature groups were statistically significant. No literature was available to compare with the present study. After the gas-curing stage **,** in the present study, the mean percentage of change in flexibility of the firmer organ was decreased (yielding greater flexibility) both at room temperature and cold temperature being more at the cold temperature at a level was reasonably close to significance (p= .06). In the softer organ, there was an increase in the percentage of change in flexibility (yielding lesser flexibility) at room temperature and a decrease yielding greater flexibility) at cold temperature. The difference between the two temperature groups was statistically significant

Conclusion

In the present study, in case of the softer organ, there was a decrease in the mean percentage of change in flexibility (yielding greater flexibility) at room temperature and an increase (yielding lesser flexibility) at cold temperature. But in case of firmer organ, cold temperature silicone (S10) plastination demonstrated variable effects on flexibility compared to room temperature S10 plastination. Further and more specified researches with matched samples as far as feasible are recommended for arriving at definitive conclusions. It is evident from the above discussion that it is difficult to identify any specific pattern of differences in the changes in the two temperature groups. Therefore, a large pool of studies needs to be available before deciding confidently on what and how to do for getting good quality palatinates.

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