UNIVERSITY OF NORTH TEXAS
HEALTH SCIENCE CENTER AT FORT WORTH
1970

Bah, Elizabeth L., Prior Osteopathic Palpatory Training and the Effectiveness of Clinical Breast Exams. Master of Science in Clinical Research and Education, May 2007, 57 pp, 9 tables, 10 illustrations, 28 bibliography titles.

The purpose of this study is to evaluate whether there is an association between osteopathic palpatory training and increased effectiveness of clinical breast exams. Incoming first year medical students, completed second year medical students, and physician assistant students participated in this study. These students palpated six silicone breast models with lumps of varying sizes, depths and hardness. Effectiveness was measured by mean sensitivity, specificity and positive predictive value.

The results of this study showed that there was no significant difference in effectiveness between the three student groups. The outcome of this project did not show an association between osteopathic palpatory training and increased effectiveness of clinical breast exams.

PRIOR OSTEOPATHIC PALPATORY TRAINING

AND THE EFFECTIVENESS

OF CLINICAL BREAST EXAMS

Elizabeth L. Bah, B.S.

APPROVED:

John Licciardone DO

Major Professor

Kimberly Fulda, DrPH

Committee Member

Stuart F. Williams D.O.

Committee Member

University Member

Scott T. Stoll DO/PhD

Chair, Department of Osteopathic Manipulative Medicine

Dean, Graduate School of Biomedical Sciences

ACKNOWLEDGEMENTS

I would like to thank Dr. John Licciardone for his guidance throughout my project. I would like to thank Dr. Kimberly Fulda for all her support and help with my data analysis. I would like to thank Dr. Roberto Cardarelli and Dr. Stuart Williams for their feedback on my thesis. Finally, I would like to thank my family for their continue support and encouragement throughout the year. This research project was made possible thanks to the support of the Osteopathic Research Center in Fort Worth, Texas.

TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF ILLUSTRATIONS

Page

CHAPTER I

BACKGROUND AND SIGNIFICANCE

Osteopathic Principles and Philosophy

Osteopathic physicians are unique in their history, philosophy, and training. From the first day of class, osteopathic medical students learn the distinctive principles and practices that were founded by Andrew Taylor Still. One of the first topics covered is the art of palpation. The Glossary of Osteopathic Terms defines palpation as "the application of variable manual pressure to the surface of the body for the purpose of determining the shape, size, consistency, position, inherent motility and health of the tissues beneath." [1]

Louisa Burns, D.O., a recognizable teacher and researcher on palpation describes this art in the 1946, December issue of the A.O.A. Journal: [2]

> Developing the sense of touch comes through conscious effort and practice. This involves training of the sensory nervous system from the nerve endings in the fingertips to the cells in the brain. Correlation of the information received from the tissues being palpated involves association fibers and other areas in the brain. Interpretation of the message coming from the tissues requires a familiarity with their problems, and this grows with experience and careful study of our cases. Sensory impressions seem to be stored as memories, enabling us to coordinate past with present experiences. An understanding through our fingers develops when we acquire unity with the area we are palpating. All of this becomes an art and a skill worth our sincere efforts.

Another forefront leader in the knowledge of palpation is Viola Frymann D.O. Regarding the process of palpation, she stated: [3]

> The first step in the process of palpation is detection, the second step is amplification, and the third step must therefore be interpretation. The interpretation of the observations made by palpation is the key which makes the study of the structure and function of tissues meaningful. Nevertheless it is like the first visit to a foreign country. Numerous strange and unfamiliar sights are to be seen, but without some knowledge of the language with which to ask questions, or a guide to interpret those observations in the life and history of the country, they have little meaning to us. The third step in our study then is to be able to translate palpatory observations into meaningful anatomic, physiologic or pathologic states.

William Sutherland, founder of the craniosacral concept, used this phrase to describe the work of palpation, "Thinking, seeing, knowing and feeling fingers." Accurate palpation occurs when students "feel" with their hand on the patient, "see" the structures under the palpating fingers, "think" what is normal or abnormal, and "know" with inner confidence that what you feel is real and accurate.[1] Even the smallest sensory perception can be recognized and analyzed with complex peripheral and central processing.[1] During the physical examination, Dr. Burns emphasized that through careful palpation of the tissue, layer by layer from the skin down to the subcutaneous tissue, to muscle and bone, palpatory skills will develop.[4]

Stories are always told of physicians who developed their palpatory skills that now have become legend. One story that inspires most osteopathic students is of Dr. Ball of Eustis, Florida. He won a bet of five dollars that he could locate a human hair placed under five or six sheets of typewriter paper while blindfolded, but the betters actually placed thirteen.[5] Developing palpating fingers can be used for more than just locating a structural problem such as a non-neutral L5. There are many stories of osteopathic physicians using their palpatory fingers to make a clinical diagnosis. One is of Dr. Robuck who could describe in detail the palpatory findings for the chest, including the "feel" of pulmonary tuberculosis and could also demonstrate his skill by locating a leaky valve of the heart.[5]

Somatic Dysfunction

One concept that is very familiar with osteopathic students is somatic dysfunction. Somatic dysfunction is an impaired or altered function of related components of the somatic (body framework) system, which include: skeletal, arthrodial, myofascial, vascular, lymphatic, and neural.[1] Over the last few decades, four criteria have been used to diagnose somatic dysfunction (1) tissue texture changes, (2) asymmetry, (3) restriction of motion, (4) tenderness or soreness. These four criteria are often called TART changes.

To examine tissue texture changes, the student can use both light and deep touch palpation. Light touch employs resting the fingers slightly on the surface of the skin. Light touch palpation can be used to investigate skin temperature, skin moisture, skin drag, changes in contour, roughness or smoothness, the tensile state of subcutaneous tissues and their fluid content.[6] Deep touch palpation employs both compression (force perpendicular to the skin) and shearing (force parallel to the skin) to explore the deeper tissues.[7] Deep touch palpation can be used to investigate changes in muscle contour, turgidity, elasticity, compressibility, irritability, density, and tensile state.[6] Along with visual observations, asymmetry is ascertained by comparing right to left, or looking for any difference in one half of the object to the other. Restriction of motion can be a change in the quality of movement. Tenderness, or pain elicited on pressure or contact, is the most subjective and is based on the patient's own experiences. Becoming familiar with TART changes, students can begin to understand what normal and abnormal tissue feels like.

Even before the evolution of TART changes, Allen and Stinson stated that information related to changes in texture and temperature of skin, alterations in the subcutaneous tissues, variations of contraction and contracture of muscles, tension and alteration of pliability of ligament and fascia, changes in the amount of density of body fluids, modification of cartilage, disc, synovial membrane, periosteum and eventually of bone can all be gained by palpatory findings.[5]

The description of palpatory findings is important to the communication among physicians and in teaching and research. Some common descriptors of palpatory findings are listed in Table 1.[6]

Table 1.
Glossary of Descriptive Terms.

DESCRIPTORS		
Color	Red	White
Depth	Superficial Thin	Deep Thick
Flaccidity	Flaccid	Firm
Hardness	Soft Compressible	Hard Rigid
Moisture	Moist Turgid	Dry Dehydrated
Movement	Restricted Fix Nonyielding	Free Unfixed Yielding
Symmetry	Symmetric Circumscribed	Asymmetric Diffuse
Temperature	Hot	Cold
Tenderness	Painful Irritable	Nonpainful Placid
Tension	Tense	Relaxed
Texture	Rough	Smooth
Time Duration	Acute	Chronic

Anatomy and Histology

Since palpation involves the sense of touch, it is important to review the relevant anatomy and histology. Sense of touch is initiated through Meissner's corpuscles. These corpuscles are located in the connective tissue papillae of the skin and are most heavily concentrated at the palmar aspect of the fingers.[8] The next organ to consider is Merkel's disk which deals with epicritic sensibility or fine texture sense; they are also found at the palmar aspects of the fingers.[8] These two organs help explain why palpation is best using the finger pads instead of finger tips. Pacini's corpuscles, found subcutaneously throughout the body, give the sense of pressure and help produce the ability to gauge how forcefully to palpate.[8] The last two organs are found in the deeper layers of the skin and subcutaneous tissue throughout the body and help sense temperature, Ruffini's corpuscles (heat) and Krause end bulbs (cold).[8]

The Importance of Clinical Breast Examinations

One clinical skill that requires the ability to palpate is conducting a clinical breast exam (CBE). The clinician palpates the breast tissue feeling for breast lumps, masses, or any tissue changes. The clinical breast exam seeks to detect palpable breast masses that may be early breast cancer so that treatment may be more effective and options greater.[9] CBE also plays a significant role in identifying breast cancers at routine health visits among women who do not follow the mammography screening guidelines.[10] Beyond the ability to identify previously undetected palpable masses, CBE is important because it presents an opportunity for health care providers to educate women about breast cancer.[9]

The American Cancer Society recommends that women in their 20s and 30s receive a CBE every 3 years and annually among asymptomatic women age 40 years or older.[9] In practice, this seems to be a common component of breast cancer screening. Data from the 2000 Behavioral Risk Factor Surveillance System revealed that across the United States, 91% of women aged 40 and older had a CBE at least once.[11]

CBE Sensitivity and Specificity

No clinical trial has compared CBE alone with no-screening condition, and since there is evidence demonstrating that mammography alone reduces breast cancer mortality, it is unlikely there will ever be a trail of CBE alone.[12] A review of literature [10] demonstrated that of the most recent studies, four showed 4.6% to 10.7% of cancers were identified by CBE alone. One study calculated that without CBE, 30 invasive cancers would be missed for every 100,000 screening examinations and 3 to 10 small (< 10mm) invasive cancers would be missed for every 100,000 screens.[13] The numbers do not seem too impressive, but each year over 200,000 women are diagnosed with invasive breast cancer (late stage), had only 5% of these cancers been detected by CBE alone, then approximately 10,000 of these undetected women would have been identified.[10]

Sensitivity is defined as the proportion of subjects with the disease in whom the screening test gives the right answer, whereas specificity is the proportion of subjects without the disease in whom the screening test gives the right answer. While emphasis is often placed on achieving high sensitivity, achieving high CBE specificity is important in minimizing the risk of unnecessary medical procedures and decreasing the amount of stress a false positive result would produce.[10] When estimating the number of breast masses that were found to be breast cancer, Barton and colleagues[12] found an overall estimated CBE sensitivity of 54.1% and specificity of 94.0%. These estimates are comparable to the National Breast and Cervical Cancer Early Detection Program (NBCCEDP) which published values for CBE sensitivity as 58.8% and specificity as 93.4%.[14] Although the estimated sensitivity of CBE is low, when CBE is done effectively, it contributes to the detection of palpable breast cancer.

CBE Palpation

When performing a CBE, the examiner should look for all signs of advanced disease by comparing both breasts for major asymmetry and differences in skin color, texture, temperature, and venous patterns.[10] Palpation, at its simplest, involves using the fingers to physically examine all areas of breast tissue and the lymph nodes to identify masses that are discrete and differ from the surrounding tissue.[10] These lumps might move within the tissue, feel fixed or may even be visible, or there could be more subtle changes within the tissue such as areas that do not move or compress as anticipated, asymmetric thickening or slight asymmetry of the breast contour.[15] The contribution of various palpation components to CBE effectiveness have been the focus of several investigations, including the type of finger motion, part of the finger, number of fingers, pressure, search pattern, and duration of search.[10] In terms of breast palpation, the most widely published and studied technique is the MammaCare® method developed by Pennypacker and colleagues which describes using the pads of the middle three fingers moving in a dime-size circular motion, applying three levels of pressure at each point along a vertical strip search pattern.[10] Although evidence exists to support the combined contributions of palpation components, limited information exists regarding the individual contributions of palpation components to sensitivity and specificity.[10]

Hypothesis

When comparing osteopathic terms in TART changes to what physicians do while performing a clinical breast exam, the two are comparable. For example, take CBE in regards to TART changes.

T: Palpate the breast tissue for any changes in thickness, for any masses, or temperature changes

A: Look and palpate for any difference between the breast or asymmetry of the breast contour

R: Palpate for skin drag, movement restriction in the tissue, look for areas of tissue that are not compressible

T: Tenderness on palpation of breast tissue

There are many published papers on examiners' ability to conduct a CBE. There have been published papers on comparing specialty physicians and their performance on CBE[16] and comparing physicians and lay women with respect to CBE.[17] Also, there has been research assessing allopathic medical students' ability to conduct a CBE, attitudes about CBE, and training,[18-22] but there is no evidence of comparing or assessing osteopathic medical students. I hypothesize that since osteopathic students are trained to palpate and begin to become comfortable with their palpatory skills, they are more accurate at performing clinical breast exams.

CHAPTER II

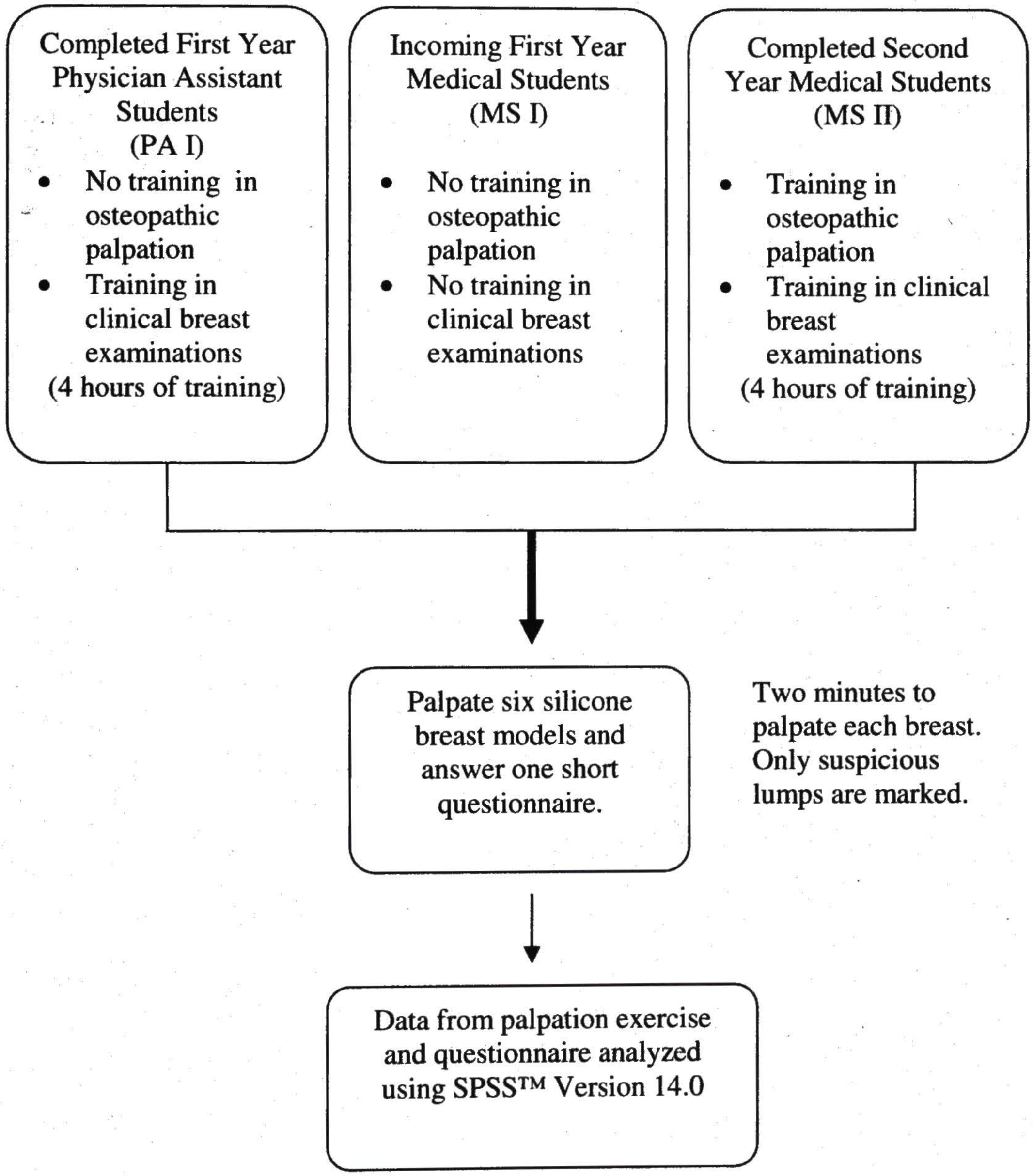
RESEARCH DESIGN AND METHODS

Participants and Recruitment

Three groups were recruited from the University of North Texas Health Science Center: (1) incoming first year medical students (N=171), (2) completed second year medical students (N=130), and (3) completed first year physician assistant students (N=33). Incoming first year medical students (MS I) were recruited during their orientation week before classes started. They represent the students who have no clinical or practical knowledge of breast exams and have not yet begun their training in osteopathic principles and palpation. Second year medical students (MS II) were recruited during their clinical skills weeks before they began third year rotations. Completed second year medical students have both practical and clinical knowledge of breast exams and have studied and practiced osteopathic principles and palpation for two years. First year physician assistant students (PA I) were recruited during their last few weeks of their second semester. These students have had clinical and practical knowledge of breast exams, but do not practice or study osteopathic principles or palpation (Figure 1). Both MS II and PA I students had lecture and lab for clinical breast exams in their curriculum. First year physician assistant students had a total of four hours in instruction of clinical breast exams. Second year medical students received two hours of lecture and lab their first year and two hours their second year.

All students received multiple emails and classroom announcements for the opportunity to participate. Participation was strictly voluntary. Snacks were provided to all students who participated. This study was reviewed and approved by the University of North Texas Health Science Center Institutional Review Board under exempt status.

Figure 1. Research Design Flow Chart



Effect Size

This study had a fixed sample size of 334 students, and the number of students between the groups were unequal. There were 130 MS II students eligible to participate in this study. If the expected difference in mean sensitivity and mean specificity is 20% between MS II and MS I students and 10% between MS II and PA I students, then the expected effect size is 0.40 with an α (two-sided) = 0.05 and $\beta = 0.20$. Thus, if all 130 MS II students participate, then a difference of 8% in mean sensitivity and specificity will be able to be detected between MS II and MS I students. A 4% difference in mean sensitivity and specificity will be able to be detected between MS II and PA I students

Survey Design and Measures

The survey was a one page self-response questionnaire (see Appendix A) that assessed gender (male; female), student status (medical student; physician assistant student), whether the student had any prior palpatory experience (yes; no), any formal clinical breast exam (CBE) training (yes; no), and number of breast lumps detected on a real person and on a breast model (none; 1-2; 3-4; 5 or more). All responses were closed ended. Using a five- point Likert scale, respondents also rated their level of adequacy in CBE training and their confidence in finding a cancerous breast lump (strongly agree to strongly disagree).

Following the questionnaire, students were handed six breast worksheets (see Appendix B). The breast worksheet was a scaled, grid outline of the silicone breast model and was used to mark where the student suspected a cancerous breast lump. Six

MammaCare® silicone breast models (Mammatech Inc, Gainesville, FL) were used in this study. A total of 18 lumps could be detected each of varying size (3mm, 5mm, 10mm), firmness (20, 40, 60 durometers) and depth (deep and medium). Five of the breast models had one to five breast lumps, and one model had none.

Data Collection

Data were collected between May and July 2007 at the University of North Texas Health Science Center. Using a previously described model by Fletcher,[16] the student was told to assume that the breast they were about to examine was a 50 year old female who was asymptomatic for breast complaints, had no personal or family history of breast cancer and had not specifically requested a breast exam. Students were advised that not all breasts had lumps and some breast may have more than one lump and to examine each breast with the same technique they would use on their own patients.

Each student was randomly assigned a breast model and systematically palpated all six breasts. From Fletcher's study,[16] the mean duration of search was 1.9 minutes. Students in this study were thus given two minutes to palpate each breast. When they were finished palpating the breast, they were told to mark an X on their breast worksheet where they found suspicious breast lump(s), if any.

Once all data had been collected, the breast worksheets were divided by the six breast model groups (A-F). Each model had a template (see Appendix D-I) as to the location of the breast lumps and the characteristic of that lump (size, firmness and depth). A true positive detection had to be in the correct quadrant and have a similar pattern as the template. For example, breast model A had five possible lumps to detect (see Appendix D). Two lumps were located in upper right quadrant, one lump in the upper left quadrant and two lumps in the bottom left quadrant. If a student only marked two X's in the lower *right* quadrant, the student scored 0/5 true positive detections and receive two false-positives for breast model A. Another way to score a false- positive was if the pattern was incorrect. In breast model A, the two lumps in the upper right quadrant are located side by side. If the student marked that the lumps were on top of each other, then one lump was counted as a false-positive and the other a true positive. Even though the student had detected two lumps in the correct quadrant, the pattern was not correct.

Data Analysis

Data were analyzed using descriptive and inferential statistics using SPSS™ version 14.0. Effectiveness was measured by overall sensitivity, specificity and positive predictive value. Overall sensitivity was a continuous variable that equaled the number of lumps correctly detected by the student over the total number of lumps possible to detect (18 lumps total). Overall specificity was a continuous variable that equaled the percentage of the six silicone breast models examined without any false-positive detections.[16] It is difficult to determine a true negative with the method of identifying a suspicious breast lump. Sensitivity can use a lesion- based approach, but specificity uses a model-based approach. For example, a student found a total of 10 breast lumps that did not exist in breast model A. Because this student found no other false-positive detections in the other five breast models, the specificity for this student would be 5/6= 83.3%. If another student found two false positive detections, but found one false-positive lump in breast model A and the other in breast model B, then this students' specificity would be 4/6= 66.7%. Positive predictive value was a continuous variable that showed the probability that a positive test reflects the underlying condition being tested for. For this study, it means that a breast lump detected truly is a cancerous breast lump. Positive predictive value equaled the number of true positives over true positives plus false-positives. This test took into account the total number of false-positive lumps detected for the six breast models despite how many models were affected. Sensitivity, specificity and positive predictive value is demonstrated in Figures 2-4.

Figure 2. Illustration of a 2 x 2 table for Clinical Breast Exams and the Calculation for the Outcome Variable: Sensitivity.

		Cancerous Breast Lumps (18 total lumps)	
		True	False
Clinical Breast Exam Outcome	Positive	**True Positive**	**False Positive**
	Negative	**False Negative**	**True Negative**
		↓ **Sensitivity (TP/TP+FN)**	

True Positive: Number of breast *lumps* correctly detected
False Negative: Total number of lumps (18) minus the number of breast *lumps* correctly detected

Figure 3. Illustration of a 2 x 2 table for Clinical Breast Exams and the Calculation for the Outcome Variable: Specificity.

		***Breast Models* with Cancerous Breast Lumps**	
		True	False
Clinical Breast Exam Outcome	Positive	**True Positive**	**False Positive**
	Negative	**False Negative**	**True Negative**
			↓ **Specificity (TN/FP+TN)**

False Positive: Number of breast *models* that had an incorrect detection
True Negative: Number of breast *models* with only correct detections

Figure 4. Illustration of a 2 x 2 table for Clinical Breast Exams and the Calculation for the Outcome Variable: Positive Predictive Value.

		Cancerous Breast Lump (18 total lumps)		
		True	False	
Clinical Breast Exam Outcome	Positive	**True Positive**	**False Positive**	→ Positive Predictive Value (TP/TP+FP)
	Negative	**False Negative**	**True Negative**	

True Positive: Number of breast *lumps* correctly detected
False Positive: Number of detections that were not correct

Group differences for gender, prior palpatory experience, and any formal CBE training were evaluated using Chi-square. The number of breast lumps the students detected on a real person and on a breast model were reduced down to none and one or more, then the responses were evaluated using Chi-square. The responses for the level of adequacy in CBE training and the students level of confidence in finding a cancerous breast lump were also collapsed down to either agree or do not agree. Strongly agree and agree were grouped into agree; while neutral, disagree and strongly disagree answers were categorized with do not agree. Responses were evaluated using Chi-square to evaluate differences between the three groups of students. When there was an expected value less than five, a Fisher's Exact test was used. Significance was set at an α of 0.05.

Mean differences in sensitivities and specificities for prior palpatory experience [yes, no], formal CBE training [yes, no], number of breast lumps detected on a real person and breast model [none, one or more], beliefs of adequate training and beliefs in confidence to detect a cancerous breast lump [agree, do not agree] were analyzed for all student groups combined. The mean scores were analyzed using independent samples t-test. Significance was set at an α of 0.05.

There were 11 dependent variables: overall sensitivity, overall specificity, positive predicative value, and sensitivities for each of the lump characteristics (size [3mm, 5mm, 10mm], depth [medium, deep] and firmness [soft, medium, hard]). The mean scores for the three groups of students were analyzed for any difference using analysis of variance (ANOVA). Significance was set at an α of 0.05.

CHAPTER III

RESULTS

Participants

There were a total of 105 participants. Thirty-nine second year medical students (30% of the class), 51 first year medical students (30% of the class) and 15 first year physician assistant students (45% of the class) participated in this study. There was no significant difference among the groups in regards to gender (Table 2). Of the second year medical students (MS II) that participated, 43.6% were male, of first year medical students (MS I) 54.9% were male, and of the physician assistant students (PA I) 40.0% were male. There was a significant difference between the MS I and MSII students regarding prior palpatory experience (Table 2), for example, but not limited to massage training, chiropractic or physical therapy training ($\chi^2(1) = 5.129$, p value= 0.029). Ten percent of MS I students reported having prior palpatory experience. In contrast, MS II students had the most prior palpatory experience 11 (28.2%) with the PA I students following next with 3 (20%) reporting prior experience. When questioned whether they had had formal clinical breast exam (CBE) training, again, 46 (90%) of MS I students reported not having any prior training (Table 2). There was a significant difference between MS I and MS II students ($\chi^2(1) = 44.713$, p value < 0.001) and MS I and PA I students ($\chi^2(1) = 17.475$, p value <0.001). About 31 (80%) MS II students had formal training in CBE, and 9 (60%) PA I reported having had formal training in CBE.

Table 2.
Baseline Characteristics of the Three Student Groups.

Characteristic	PA I (n= 15)	MS I (n= 51)	MS II (n= 39)	χ^2		d.f.	P-value
Gender (% Male)	40.0	54.9	43.6		1.647	2	0.439
Prior Palpatory Experience (% Yes)	20.0	9.8	28.2	MS II vs MS I	5.129	1	0.029*
				MS II vs PA I	0.380	1	0.733
				MS I vs PA I	1.131	1	0.368
Formal CBE Training (% Yes)	60.0	9.8	79.5	MS II vs MS I	44.713	1	<0.001**
				MS II vs PA I	2.142	1	0.175
				MS I vs PA I	17.475	1	<0.001**

* Denotes significance, p value ≤0.05
** Denotes significance, p value <0.001

There was no significant difference among the three student groups regarding number of breast lumps felt on a real person. None of the three groups reported feeling more than 5 breast lumps on a person. Seventy- five percent of MS I students had never felt a breast lump on a real person, while 56.4% of MS II and 53.3% of PA I students had never felt a breast lump on a real person. There was a significant difference between MS I and MS II students and MS I and PA I students ($\chi^2(1)$= 52.745 and 29.244 respectively, p value <0.001) regarding the number of breast lumps felt on a breast model in the past (Table 3). MS II students felt the most breast lumps on a breast model with only 5.1% of the class not having felt any at all, 6.1% of PA I students had not felt a breast lump on a model, while 82.4% of MS I students had not felt any.

Table 3.
Percentage of Breast Lumps Felt on a Real Person and on a Breast Model for the Three Student Groups Based on Questionnaire.

	PA I (n= 15)	MS I (n= 51)	MS II (n= 39)		$\chi 2$	d.f.	P-value
Breast lumps felt on a real person (% None)	53.3	74.5	56.4		4.174	2	0.124
Breast lumps felt on a breast model in past experience (% None)	6.7	82.4	5.1	MSII vs MS I	52.745	1	<0.001*
				MS II vs PA I	0.049	1	1.000
				MS I vs PA I	29.244	1	<0.001*

* Denotes significance, p value <0.001

There was a significant difference among the three student groups regarding their training; however, there was no significant difference in the students' confidence to detect a cancerous breast lump (Table 4). Only one MS II student felt strongly in their abilities to detect a cancerous breast lump, while none of the MS I or PA I students strongly agreed that they felt confident in their abilities. This same student also felt strongly about adequate training in CBE. MS II students agreed the most (28.2%) that they had adequate training in CBE; 6.7% of PA I and 3.9% of MS I students agreed they had adequate training. There was a significant difference between MS II and MS I students regarding belief in adequate training ($\chi^2(1)=10.546$, p value =0.002). Only 7.7% of MS II students agreed they felt confident they could detect a cancerous breast lump, while 6.7% PA I and 3.9% MS I students were confident.

Table 4.
Percentage of Students who Believe they had Adequate Training in CBE and Percentage of Students who Feel Confident in their Abilities to Detect a Cancerous Breast Lump for the Three Student Groups.

	PA I (n = 15)	MS I (n = 51)	MS II (n = 39)	χ^2	d.f.	P-value
Believe they had adequate training in CBE (% agreed)	6.7	3.9	28.2	MS II vs MS I 10.546	1	0.002*
				MS II vs PA I 2.908	1	0.145
				MS I vs PA I 0.201	1	0.545
Feel confident to detect a cancerous lump (% agreed)	6.7	3.9	7.7	0.613	2	0.736

* Denotes significance, p value ≤ 0.05

Sensitivities and Specificities of the Participant Characteristics

Table 5 highlights the mean sensitivities and specificities for the different participant characteristics. There was a significant difference (t(103)= 2.01, p value= 0.047) in mean sensitivity of CBE between those students who had prior palpatory experience (ave = 0.655) and those that had none (ave = 0.563). There was also a significant difference (t(103)= 2.26, p value =0.034) in mean specificity of CBE, however, those students who had no prior palpatory experience had a higher specificity (ave = 0.824) than those that had prior experience (ave = 0.623). There was no significant difference in regards to mean sensitivity and specificity for those students with formal CBE training (ave = 0.582 and 0.752 , respectively) and those who had no training (ave = 0.578 and 0.814, respectively). There also was no significant difference for students who have felt one or more breast lumps on a real person (ave = 0.581 and 0.770, respectively) and those had never felt one (ave = 0.579 and 0.797, respectively). Although not significant, those students who had felt a breast lump on a breast model had a higher mean sensitivity (ave = 0.597) but a lower mean specificity (ave = 0.750) than those who felt none (ave = 0.557 and 0.837, respectively). Neither attitudes toward adequacy in training or confidence in ability to detect a cancerous breast lump were statistically significant. However, those students who did not agree they had received adequate training had a higher sensitivity (ave = 0.582) than those students who agreed (ave = 0.563). Those students who were more confident in their abilities to detect a cancerous breast lump had a higher mean sensitivity (ave = 0.611) and higher mean specificity (ave = 0.790) than those who were not confident (ave = 0.578 and 0.750, respectively).

Table 5.
Sensitivities of the Participant Characteristics for all Student Groups using Independent-Samples t-test.

Characteristic	Sensitivity mean (SD)	Sensitivity t-test	Sensitivity P-value	Specificity mean (SD)	Specificity t-test	Specificity P-value
Prior palpatory experience						
Yes 19 (18.0%)	0.655 (0.148)	2.01	0.047*	0.623 (0.372)	2.26	0.034*
No 86 (82.0%)	0.563 (0.185)			0.824 (0.224)		
Formal CBE training						
Yes 45 (42.9%)	0.582 (0.176)	0.14	0.891	0.752 (0.330)	1.11	0.272
No 60 (57.1%)	0.578 (0.189)			0.814 (0.206)		
Number of breast lumps felt on a real person in the past						
None 68 (64.8%)	0.579 (0.181)	0.05	0.961	0.797 (0.251)	0.48	0.632
≥ 1 37 (35.2%)	0.581 (0.187)			0.770 (0.298)		
Number of breast lumps felt on a breast model in the past						
None 45 (42.9%)	0.557 (0.184)	1.13	0.262	0.837 (0.186)	1.78	0.077
≥ 1 60 (57.1%)	0.597 (0.180)			0.750 (0.311)		
Feel had adequate training						
Agree 14 (13.3%)	0.563 (0.132)	0.47	0.645	0.791 (0.265)	0.381	0.704
Not agree 91 (36.7%)	0.582 (0.189)			0.762 (0.290)		
Feel confident in detecting a cancerous breast lump						
Agree 6 (5.7%)	0.611 (0.122)	0.43	0.668	0.790 (0.266)	0.351	0.726
Not agree 99 (94.3%)	0.578 (0.186)			0.750 (0.312)		

* Denotes significance, p value ≤0.05

Sensitivity, Specificity and Positive Predictive Value

With a total of 18 lumps to identify, the average MS II found 10.64 lumps, MS I found 10.31 lumps and PA I found 10.33 lumps (Table 6). No student found all 18 lumps; however, one second year medical student found 17. All students found at least three. The results for overall sensitivity, positive predictive value, total false positive detections and overall specificity between the three groups are listed in Table 5. There was no significant difference among the groups for overall sensitivity. However, MS II students had the highest sensitivity of 59.12%, ranging from 27.8% to 94.4%. PA I average sensitivity was 57.41% ranging from 22.2% to 83.3% and MS I had the lowest sensitivity at 57.30%, ranging from 16.7% to 88.9%. Positive predictive value was the highest among MS I (88.59%) followed by PA I (87.75%) and then MS II (83.81%); however, there was no statistical significant difference between the groups. Again, there was no statistically significant difference among the groups for total false positive detections. The average number of false-positives detected by MS II was 3.64. This was almost twice as many as MS I (1.90) and PA I (1.60). One second year medical student reported finding 32 lumps that were not there. Although not significantly different, specificity was highest among PA I (81.1%) followed by MS I (80.7%) and lastly MS II (75.2%).

Table 6.
Means for First and Second Year Medical and Physician Assistant Students for Several of the Outcome Variables using ANOVA.

	PA I (n = 15) mean (SD)	MS I (n = 51) mean (SD)	MS II (n = 39) mean (SD)	F-value	P-value
Overall Sensitivity (%)	57.41 (20.4)	57.30 (18.5)	59.12 (17.4)	0.117	0.890
Positive Predictive Value (%)	87.75 (16.1)	88.59 (15.2)	83.81 (18.2)	0.962	0.386
Total False-Positive Detections	1.60 (2.69)	1.90 (3.26)	3.44 (6.27)	1.53	0.221
Overall Specificity (%)	81.11 (27.4)	80.72 (24.1)	75.21 (29.8)	0.534	0.588

The second year medical student who reported 32 false positive detections was the only outlier. This same student found 17 true positive detections. Table 7 shows the means for the outcome variables with the outlier removed. With this student's data removed, the mean overall sensitivity for MS II students was 58.18%. The mean positive predictive value became 85.15%. Average false positive detections were 2.68 and the mean overall specificity was 77.19%. Again, there was no statistically significant difference between the three student groups.

Table 7.
Means for First and Second Year Medical and Physician Assistant Students for Several of the Outcome Variables using ANOVA with the Outlier Removed.

	PA I (n = 15) mean (SD)	MS I (n = 51) mean (SD)	MS II (n = 39) mean (SD)	F-value	P-value
Overall Sensitivity (%)	57.41 (20.4)	57.30 (18.5)	58.18 (26.9)	0.028	0.973
Positive Predictive Value (%)	87.75 (16.1)	88.59 (15.2)	85.10 (16.5)	0.539	0.585
Total False-Positive Detections	1.60 (2.69)	1.90 (3.26)	2.68 (4.22)	0.736	0.482
Overall Specificity (%)	81.11 (27.4)	80.72 (24.1)	77.19 (27.5)	0.237	0.790

To meet proficiency standards set out by MammaCare®, students had to have a sensitivity of 89% or greater and a positive predictive value of 80% or greater. The results of the students' performance in regards to these guidelines are shown in Table 8. No PA I student met both of these standards, and only one MS II and two MS I students met both of these standards. Five students had sensitivities ≥ 89%. Three (7.7% of the class) MS II and two (3.9% of the class) MS I students achieved this guideline. Eighty-one students had positive predictive values ≥ 80%. Forty-two of the 51 MS I students met this guideline (82.4%), followed by PA I (80.0%) and MS II (69.2%).

Table 8.
Percentage of Students who Met MammaCare® Proficiency Standards.

	PA I (n = 15)	MS I (n = 51)	MS II (n = 39)
≥ 89% Sensitivity	0 (0.0%)	2 (3.9%)	3 (7.7%)
≥ 80% PPV	12 (80.0%)	42 (82.4%)	27 (69.2%)
Both guidelines	0 (0.0%)	2 (3.9%)	1 (2.6%)

PPV: positive predictive value

Sensitivities of Lump Characteristics

There was no statistically significant difference between any of the groups with regards to the different lump characteristics (size, depth, firmness) (Table 9). Two of the more difficult to find lump characteristics are deep depth and small size. Second year medical students found these more often. The other difficult to find lump characteristic was the soft breast lump, and MS I students found these more often. All three groups found the 10 mm size breast lumps more often, followed by the 5 mm breast lumps and then the least found breast lumps were the 3 mm size. Hard (60 durometers) lumps were found more often by each group than medium (40 durometers) or soft (20 durometers). Each group found the medium depth breast lumps more frequently than the deep depth breast lumps.

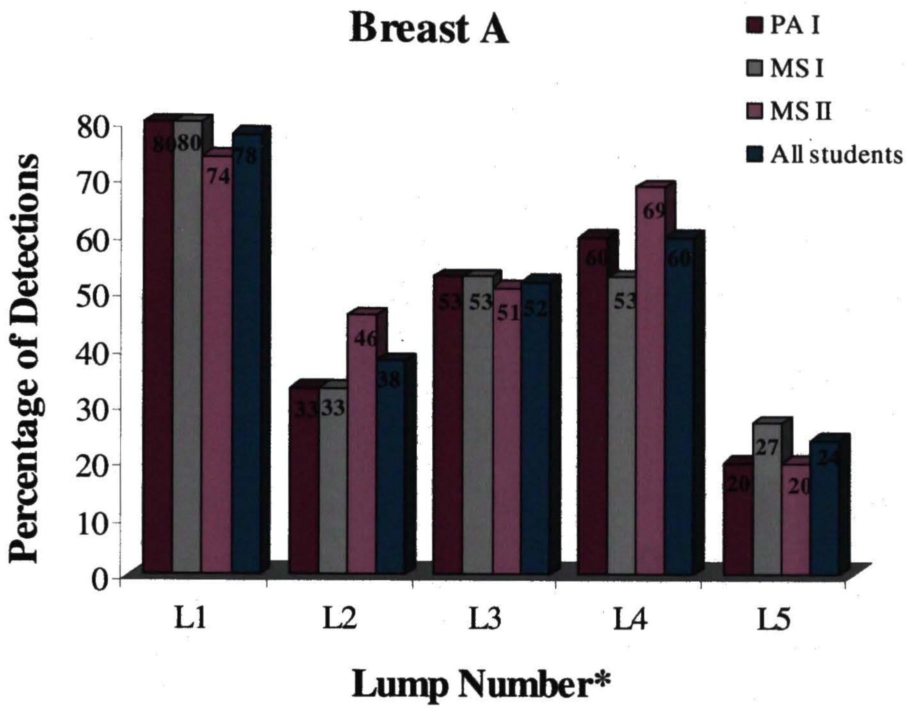
Table 9.
Sensitivities (%) for the Different Lump Characteristics using ANOVA for the Three Students Groups.

Lump Characteristic	Sensitivity (%) PA I (n = 15) mean (SD)	MS I (n = 51) mean (SD)	MS II (n = 39) mean (SD)	F-value	P-value
3 mm	40.32 (22.7)	38.89 (22.0)	41.45 (22.9)	0.199	0.820
5 mm	57.78 (18.8)	62.75 (21.5)	64.53 (22.7)	0.530	0.590
10 mm	72.22 (24.9)	70.26 (24.3)	71.37 (22.6)	0.049	0.952
Soft	52.22 (13.9)	57.84 (19.5)	51.71 (22.2)	1.187	0.309
Medium	57.78 (30.8)	53.92 (23.9)	61.54 (25.1)	0.995	0.373
Hard	62.22 (32.4)	60.13 (25.8)	64.10 (25.8)	0.244	0.784
Deep Depth	51.11 (23.7)	53.59 (22.3)	54.13 (21.4)	0.103	0.902
Medium Depth	65.19 (16.2)	62.75 (17.6)	63.53 (17.5)	0.117	0.890

Figures 3-7 show in a bar chart the different breast models and the characteristics of each lump. Figure 8 shows the number of false positive detections made by each of the different student groups for each breast model. The most difficult to find lump for all students was found in Breast Model C, lump two. This lump was small (3mm) at a medium depth and its firmness was medium (40 durometers). There was a significant difference between MS II and MS I ($\chi^2(1)= 6.98$; p value= 0.019) and MS I and PA I ($\chi^2(1)=13.80$; p value= 0.002). First year physician assistant students found breast lump four (5 mm, Deep depth, Soft) in Breast Model A to be the most difficult with only six percent of the class finding this lump. The most found breast lump for all students was in

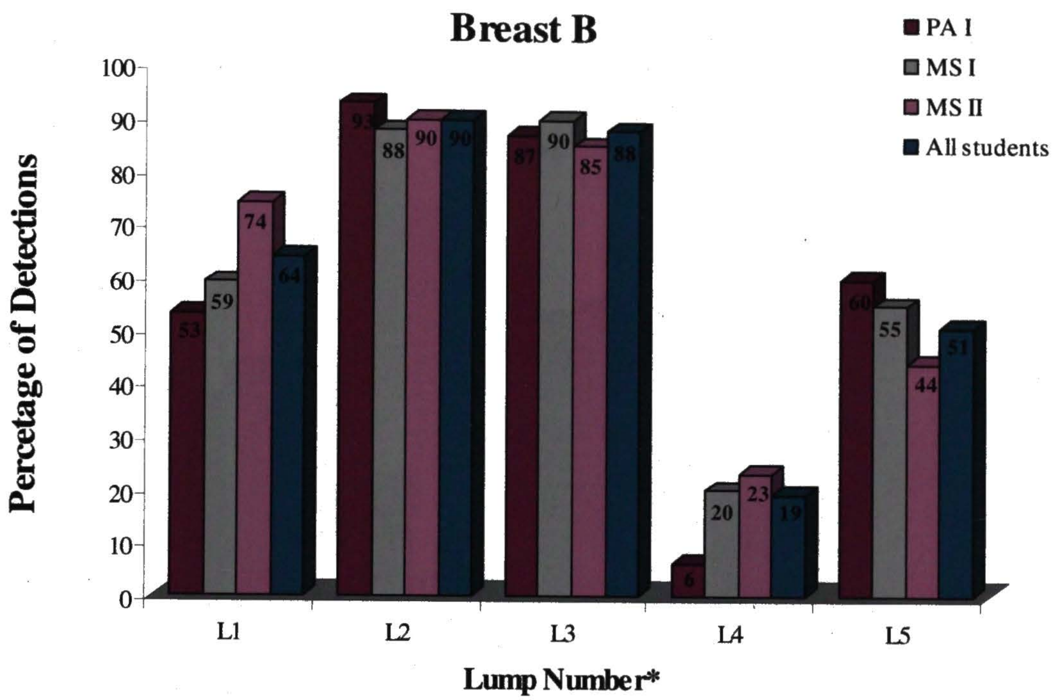
Breast Model B, lump two. This lump was large (10 mm) at a medium depth, and its firmness was hard (60 durometers). However, the least difficult breast lump for MS I students was breast lump four (5 mm, Medium depth, Soft) in Breast Model C with 92% of the class detecting this lump. The breast model with the most false positive detections was Breast Model F, and the breast model with the least number of false positive detections was Breast Model D.

Figure 5. Bar chart of the Specific Breast Lumps Detected by Each Student Group for Breast A.



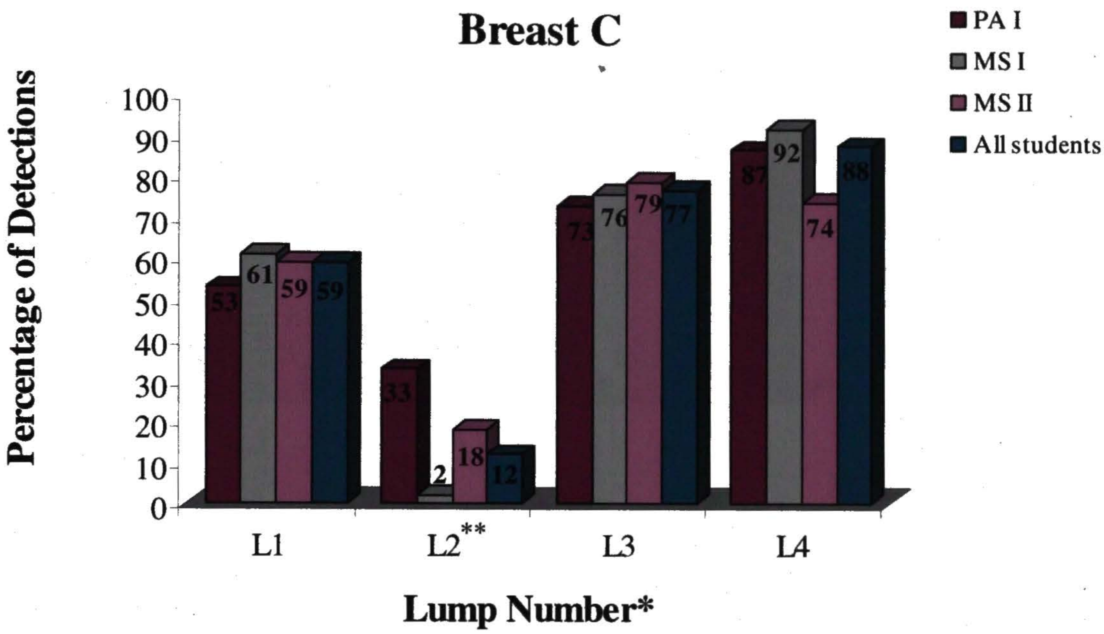
* L1: 10 mm, Medium depth, Soft	L4: 10 mm, Deep depth, Medium
L2: 3 mm, Medium depth, Hard	L5: 3 mm, Deep depth, Soft
L3 5 mm, Medium depth, Medium	

Figure 6. Bar chart of the Specific Breast Lumps Detected by Each Student Group for Breast B.



* L1: 5 mm, Medium depth, Hard
  L2: 10 mm, Medium depth, Hard
  L3: 10 mm, Medium depth, Medium
  L4: 5 mm, Deep depth, Soft
  L5: 3 mm, Deep depth, Hard

Figure 7. Bar chart of the Specific Breast Lumps Detected by Each Student Group for Breast C.



* L1: 10 mm, Deep depth, Soft

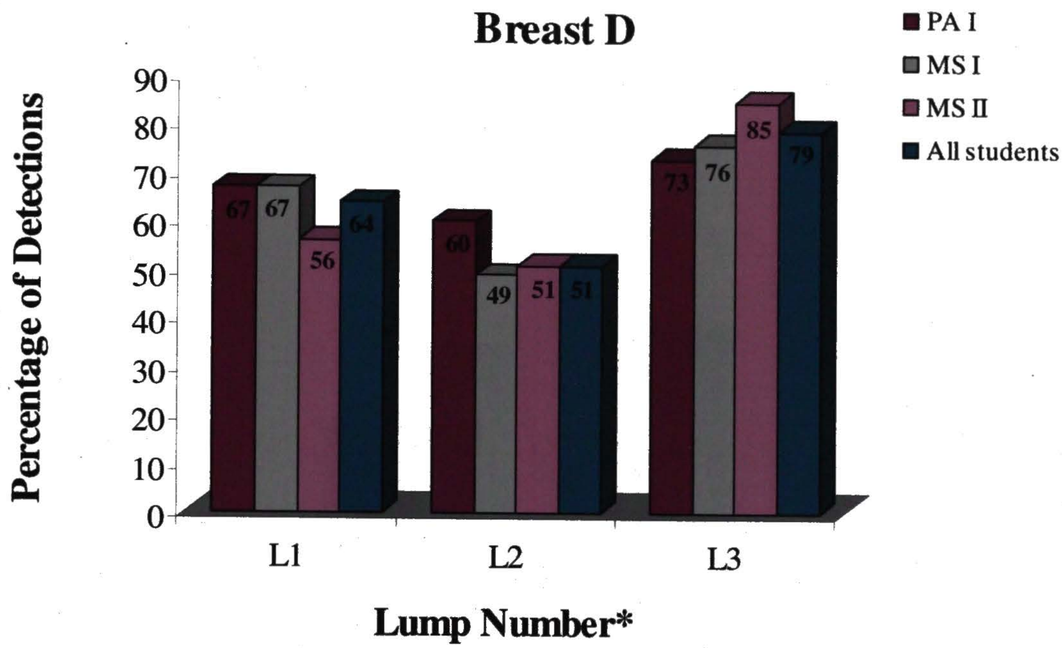
L2: 3 mm, Medium depth, Medium

L3: 5 mm, Deep depth, Hard

L4: 5 mm, Medium depth, Soft

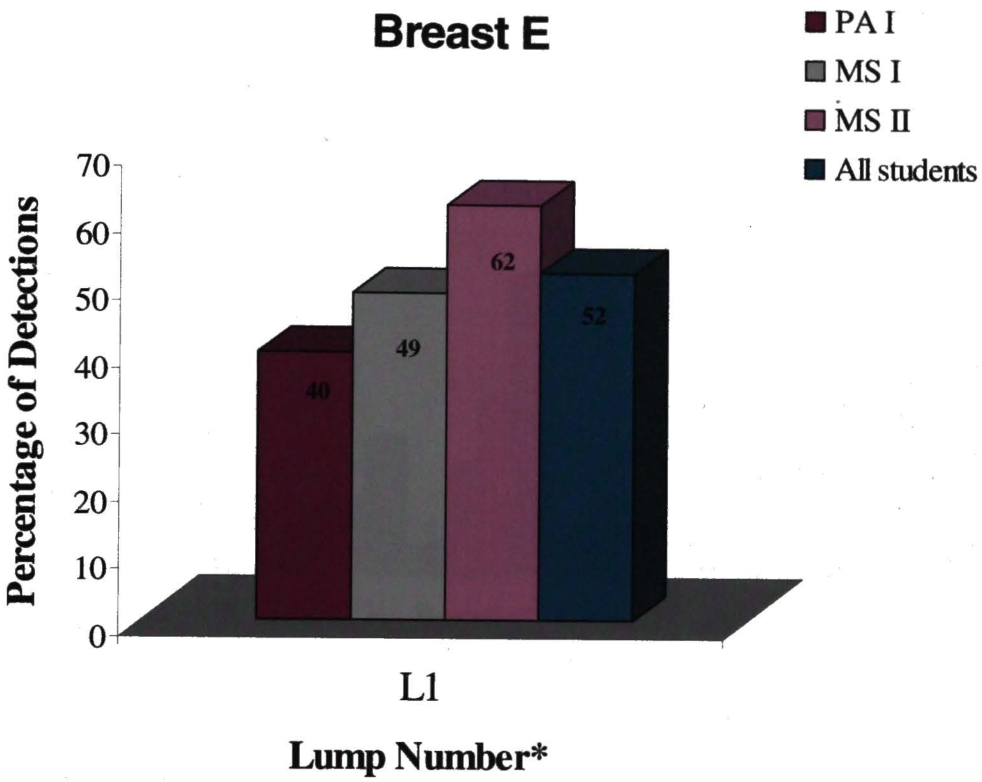
** Significant difference between MS II and MS I (p value= 0.019) and MS I and PA I (p value= 0.002).

Figure 8. Bar chart of the Specific Breast Lumps Detected by Each Student Group for Breast D.



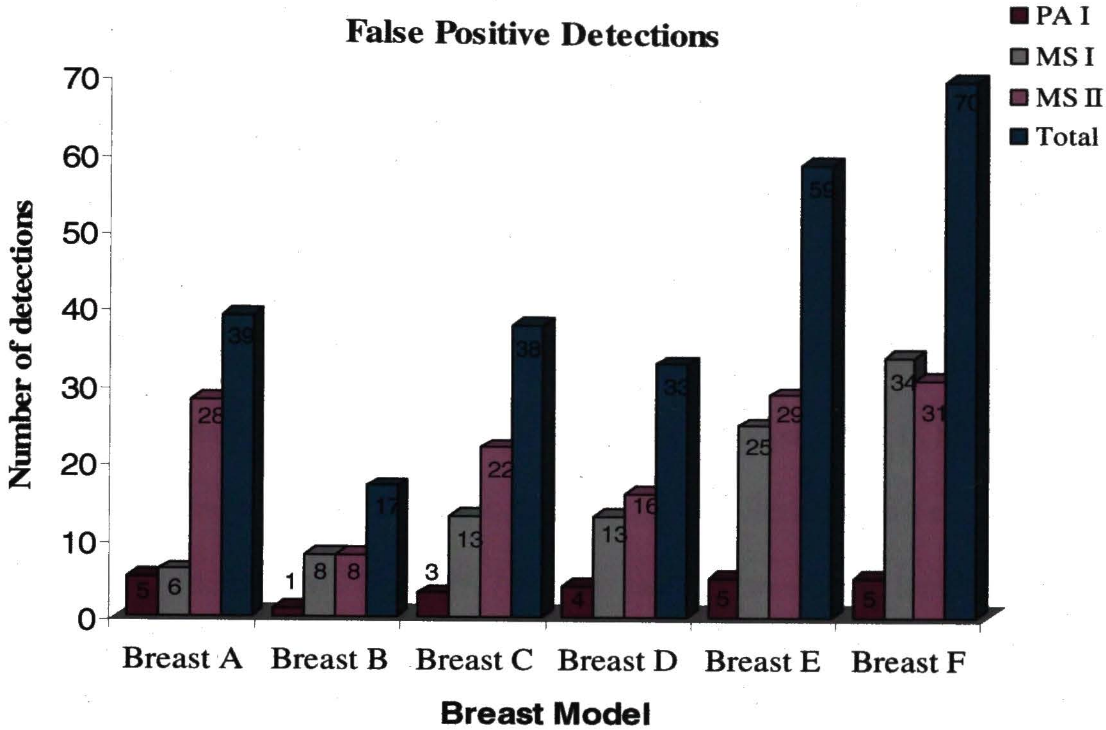
* L1: 3 mm, Medium depth, Soft
L2: 10 mm, Deep depth, Hard
L3: 5 mm, Deep depth, Medium

Figure 9. Bar chart of the Specific Breast Lump Detected by Each Student Group for Breast E.



* L1: 3 mm, Deep depth, Medium

Figure 10. Number of False Positive Detections for each Breast Model for the Three Student Groups and for All Students.



CHAPTER IV

DISCUSSION

Examiner Characteristics

There were several significant differences between the three student groups in regards to their baseline characteristics. Second year medical students (MS II) had more prior palpatory experience than incoming first year medical students (MS I), MS II and first year physician assistant students (PA I) had more formal clinical breast exam (CBE) training than MS I students, MS II and PA I students had felt more breast lumps on a breast model than MS I students, and lastly, more MS II students believed they had adequate training than MS I students. Many of these difference were to be expected because of the academic training of MS II students; however, the large proportion of MS II students with prior palpatory experience was not expected. One explanation could be the wording of the questionnaire suggesting to MS II students that their first year of osteopathic training was included in "prior palpatory experience."

The primary objective of this study was to evaluate MS II students' abilities to detect a cancerous breast lump and compare their results to MS I students who have no prior osteopathic training nor clinical skills training and PA I students who also have no prior osteopathic training but have clinical skills training. While there was no statistically significant difference among the three groups, MS II students had the highest mean sensitivity (59%), and in fact, this is higher than what physicians in earlier CBE performance studies (44%-58%) and other second year medical students (54%) showed using MammaCare® models and similar methods.[16, 21, 23] However, the sensitivities of MS I and PA I (57.3% and 57.4%) were not lagging too far behind the mean sensitivity of MS II students. One explanation is that being less experienced and less confident, the MS I students may have been more careful than were the MS II and PA I students. This hypothesis is supported by Lee and colleagues' study that showed less experienced students tended to be more "thorough" in their examination compared to upper- level students.[21] This might also explain why those students who felt they did not have adequate training had higher sensitivities than those who agreed they had adequate training. Higher confidence levels among the students did not translate into significantly improved lump-detection ability. This was also demonstrated in Lee's study [21]and Barrett's study [20] where confidence in ability did not translate to improved CBE sensitivity. In Powell's study, they found that gender, percentage of breast examinations observed, and the percentage of breast examinations repeated by a supervising physician were not predictors of confidence, but that the sheer number of examinations performed remained the most important predictor of confidence.[24] This is demonstrated in this study with 83% of those students who were confident in their abilities to detect a suspicious breast lump had felt one or more breast lumps on a breast model.

First year medical students had the highest mean positive predictive value of 88.6%, while MS II students had the lowest mean of 83.8%. Physician assistant students had the highest mean specificity of 81.1%, while MS II students were lacking at 75.2%.

The mean specificity of the three student groups are higher than what physicians in earlier CBE performance studies (50%) and other second and first year medical students (62-68%) showed using MammaCare® models and similar methods.[17, 21] Because both positive predictive value and specificity have included in their equations false positive detections, these two results can be explained by the higher number of false positive detections made by the MS II students.

False Positive Rate

Although not significant, MS II students, on average, reported twice as many false positive detections than MS I and PA I students. This large number of false positive detections negatively affects their positive predictive value, meaning what they say is a cancerous breast lump truly is a cancerous breast lump, and their overall specificity. In a clinical setting, this would really impact a patient who would then need diagnostic measures (mammogram, biopsy, aspiration), and of course, the emotional aspect of the patient wondering if in fact their breast lump is cancerous. In 1998 economy, it was found that for every $100 spent for screening, an additional $33 was spent to evaluate the false positive result.[25] One explanation for the increased false positive rate could be that MS II students have a sense of false security regarding their palpatory skills. Besides believing they have well developed palpatory skills, many may have felt an underlying pressure to palpate for anything, even if it wasn't significant. Another possible explanation for this finding could be that MS II students do have well developed palpating skills, and while picking up subtle changes found in the breast models, they had a hard time categorizing the change as a suspicious breast lump or a benign change. Perhaps the other students did not feel the subtle changes and only marked lumps that were distinct. With well developed palpatory skills, a lot of information is inputted, but the well trained osteopath can sort thought it and interpret what is real and not. R.P. Baker, D.O. was a practicing pathologist in the 1930's who described what may be learned through palpation of the breast. He described that if the lump feels encapsulated and sharply circumscribed, and is movable within the tissues immediately surrounding it, it must be a cyst or fibroadenoma. Cancer, he described, is an infiltrating growth that results in an indefiniteness of outline. He also explained that benign growths do not invade the pectoral fascia, and thus are always freely movable on the fascia. Cancer on the other hand can invade the pectoral fascia, will become fixed to the fascia and will not move upon it.[26]

Tumor Characteristics

The ease or difficulty of detection is affected by the tumor size, firmness and location. The easiest tumors to detect are those that are large, firm and near the surface; the most difficult to find tumors are small, soft, and deep within the breast tissue.[10] Sensitivity in all three groups declined with size of the lump. This is also true for many clinical studies that have been done. One example is a study that assessed CBE sensitivity among women in a managed care organization's Breast Cancer Screening Program (BCSP).[27] They found only 17% sensitivity for tumors $\leq$ 5mm and 58% for tumors $\geq$21 mm. Second year medical students had the highest mean sensitivity for the smallest breast lump, and although the difference between the three groups was not significant statistically, it could potentially be clinically significant because the small lumps used in these models are the size that are goal for screening.[17] Prognosis generally follows cancer size at the time of diagnosis, so it is important to determine the accuracy of CBE for small cancers 20 mm or less.[12] Sensitivities for both PA I and MS II students were lowered as density of the lump decreased. However, MS I students had a higher mean sensitivity for soft breast lumps (58%) than medium (54%). This can be explained by the limitations in the grading system that will be discussed later. There is little known about the possible relationship between tumor pathology and tumor density; it may be impossible to palpate some malignancies, regardless of their size.[10]

Training on CBE proficiency

A majority of the student groups believed they did not have adequate CBE training. This result is not uncommon. In a study of medical students, 83% of fourth-year students reported needing additional training in CBE.[19] In another study, satisfaction of second year medical students' education with CBE was minimal, while interest in learning CBE was high.[21] In a study done on physicians,[16] approximately one third stated that their training in CBE was not adequate: 36% stated that their medical school training was inadequate and 35% stated that residency was so. Furthermore, 84% of the physicians reported that they felt at least some need to improve their abilities in breast lump detection.[16]

Limitations

One of the limitations of this study was scoring of the students. In previous studies,[16, 17] all study participants were observed, and the research assistant verified all findings. The scoring would not affect how many breast lumps the students found, or how many false positive detections there were for each breast model, but it would affect which breast lump was detected. Scoring became a problem whenever there were two breast lumps in one quadrant side by side of each other, and the student marked only one X in that quadrant. Which breast lump did the student really detect, breast lump one or two? To address this problem, the student's marked X was looked to see if it was close in proximity to either lump and called whatever was closest. However, if the marked X was in the middle of the two lumps, the lump number was randomly chosen, and that number was used consistently for others who did the same. Scoring might explain why breast lump one in Breast Model D was found more often than breast lump two in Breast Model D, which theoretically is a simpler breast lump to find. In previous studies,[16, 17] lump number five (3 mm, deep depth, soft) in Breast Model A had been the most difficult lump to find. One explanation could be that the students were not truly finding AL5, but feeling nodular background tissue. There was a non-suspicious fibrous nodular lump located about an inch below AL5. With the scoring model chosen, it was impossible to know if the students marking near AL5 was really AL5, or the non-suspicious nodular lump that was in the correct quadrant, and a similar pattern as the model template.

One comment made by one student after the testing session, was that they would have done better had they felt a true breast lump in one of the models at the beginning because then they would know what exactly they were looking for. The MammaCare® instructor's manual actually states that testing should begin by using either Breast Model C or D first and participants should never palpate Breast Model F (no breast lumps) first because students should be allowed to experience success in finding a breast lump. However, several studies[16, 17, 21] using the MammaCare® models determined the initial order of presentation randomly. Logistically, it would be difficult to have every participant start with either breast model first. This limitation could also be considered a strength because to have each student start randomly would prevent bias.

Another limitation to this study was the short period of time to recruit students. When I rotated back into the fellowship, physician assistant students had two weeks left of their curriculum. Second year medical school classes had ended and they were beginning their board review month and stress levels among these students were high, so I attempted to recruit them when Step One boards were over. This left two weeks before all students left to begin their third year rotations, and conscientious efforts were made to solicit a random sample of students. There was only a week to recruit incoming first year medical students to participate before class work began. Their schedules were filled with orientation, but again efforts to solicit a random sample of students was pursued. The short recruitment time and students' schedules lead to a small sample size.

One potential limitation was lack of seriousness among some of the second year medical students regarding the project. I have been their pre-doctoral fellow the last two years which means I have developed a relationship with many of them, counseling and tutoring many of them about classroom work. I may not have held an authoritative position with the MS II students as I might have had with the physician assistant students and the incoming first year medical students who did not know me. From previous studies,[16] duration of time was positively correlated with higher sensitivities. From a general observation of the MS II students, fewer spent the entire allotted time palpating the breast models. Again, this could be due to the lack of seriousness of the project, or higher estimated level of confidence in their abilities to detect a breast lump.

Another potential limitation was the authenticity of the silicone breast models. The breast models used were studied carefully, evaluated thoroughly and were developed over a number of years.[28] In Fletcher's study,[16] 80% of the physicians reported that the models were easier to examine; but also the majority of physicians stated that the models were lifelike. Furthermore, it may be much easier to palpate the models than real women's breast because the models are in the supine position and they can not move or respond to pain. This potential aspect of the models is represented by the increased sensitivity (57-59%) compared to data presented by the National Breast and Cervical Cancer Early Detection Program (NBCCEDP) which published values for CBE on real women as 58.8% sensitivity and 93.4% specificity.[14]

Conclusion

Although there was no statistical significant difference between MS II, MS I, and PA I students in regards to efficacy of CBE, there were some trends. MS II students had a higher mean sensitivity, and found the smallest (3mm) and deeper lumps more often than the other student groups. This could be significant clinically to many women who have invasive breast cancer that is hard to find.

Future longitudinal studies looking at incoming first year students and following them through their education and studying their attitudes and performance on CBE would be beneficial. Because preventive medicine is one of the key stones of osteopathic philosophy, another interesting study would be study whether osteopathic physicians perform more CBE in their practice than their allopathic counterparts.

APPENDIX A:

ONE PAGE SELF-RESPONSE QUESTIONNAIRE

Questionnaire

For each item, please check the item that best represents you.

Gender: ☐ Male ☐ Female

Student Status: ☐ Medical Student ☐ Physician
Assistant Student

Graduation Year: ☐ 2009 ☐ 2010 ☐ 2011

Do you have prior palpatory experience, for example but not limited to: chiropractic, massage, physical therapy? ☐ Yes ☐ No

Have you had formal training in clinical breast examination? ☐ Yes ☐ No

If yes to the above, were breast models used during instruction? ☐ Yes ☐ No

During your lifetime, how many breast lumps have you felt:

A. on a real person?
☐ None ☐ 1-2 ☐ 3-4 ☐ 5 or more

B. on breast models (from training exercises)?
☐ None ☐ 1-2 ☐ 3-4 ☐ 5 or more

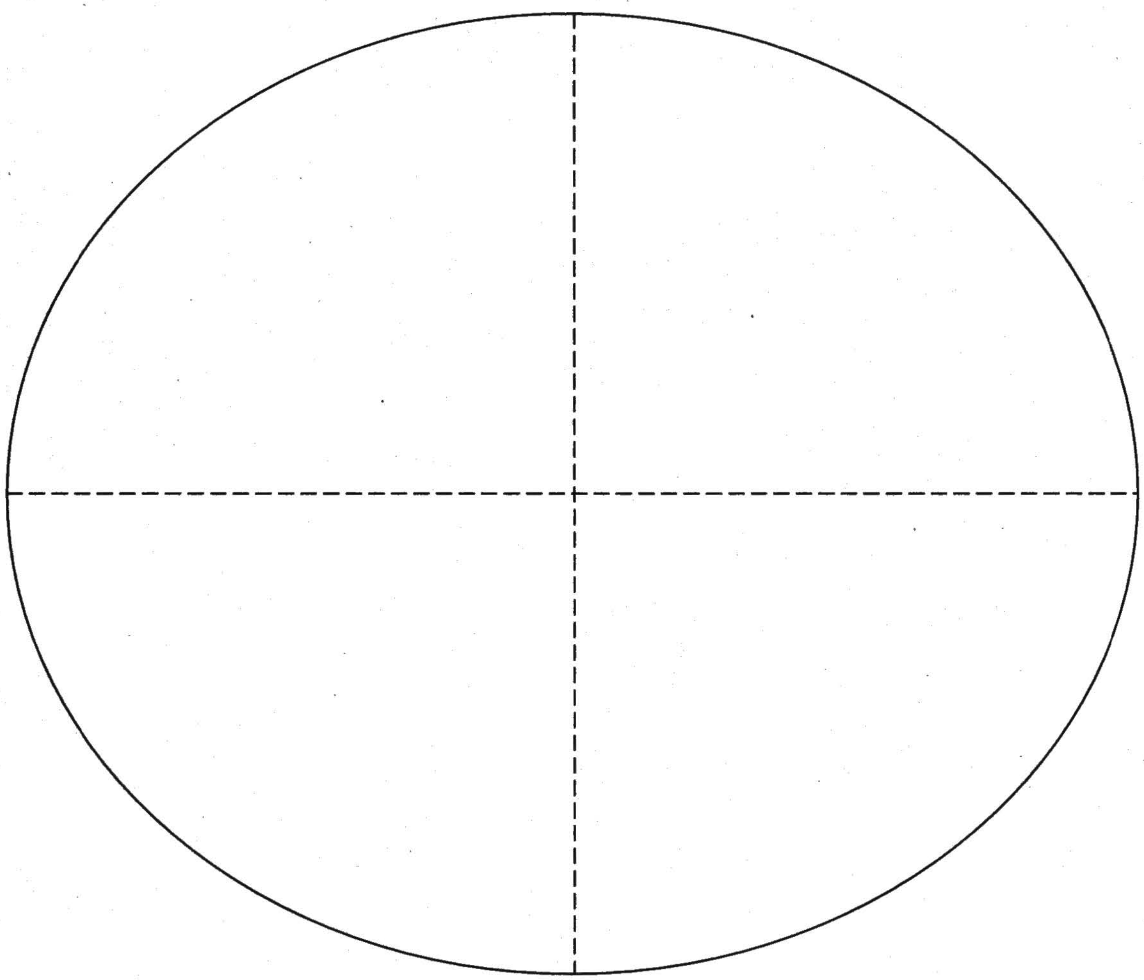
For each item, please circle the one number that best represents your opinion:

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I feel I have had adequate training in clinical breast exams.	1	2	3	4	5
I am confident in my abilities to detect a cancerous breast lump.	1	2	3	4	5

ID # __________

APPENDIX B: BREAST WORKSHEET

TOP



BOTTOM

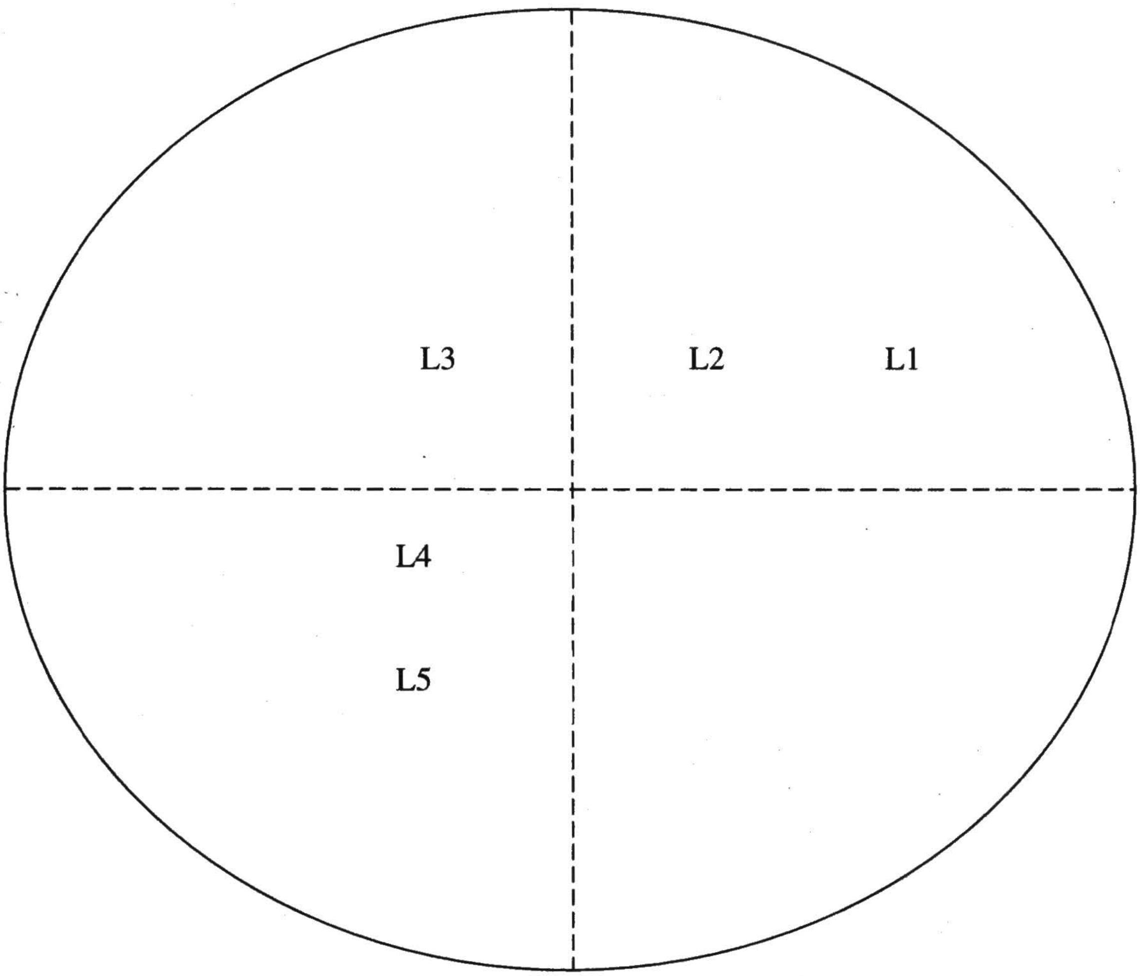
APPENDIX C:

CHART OF DIMENSIONS OF EACH BREAST LUMP

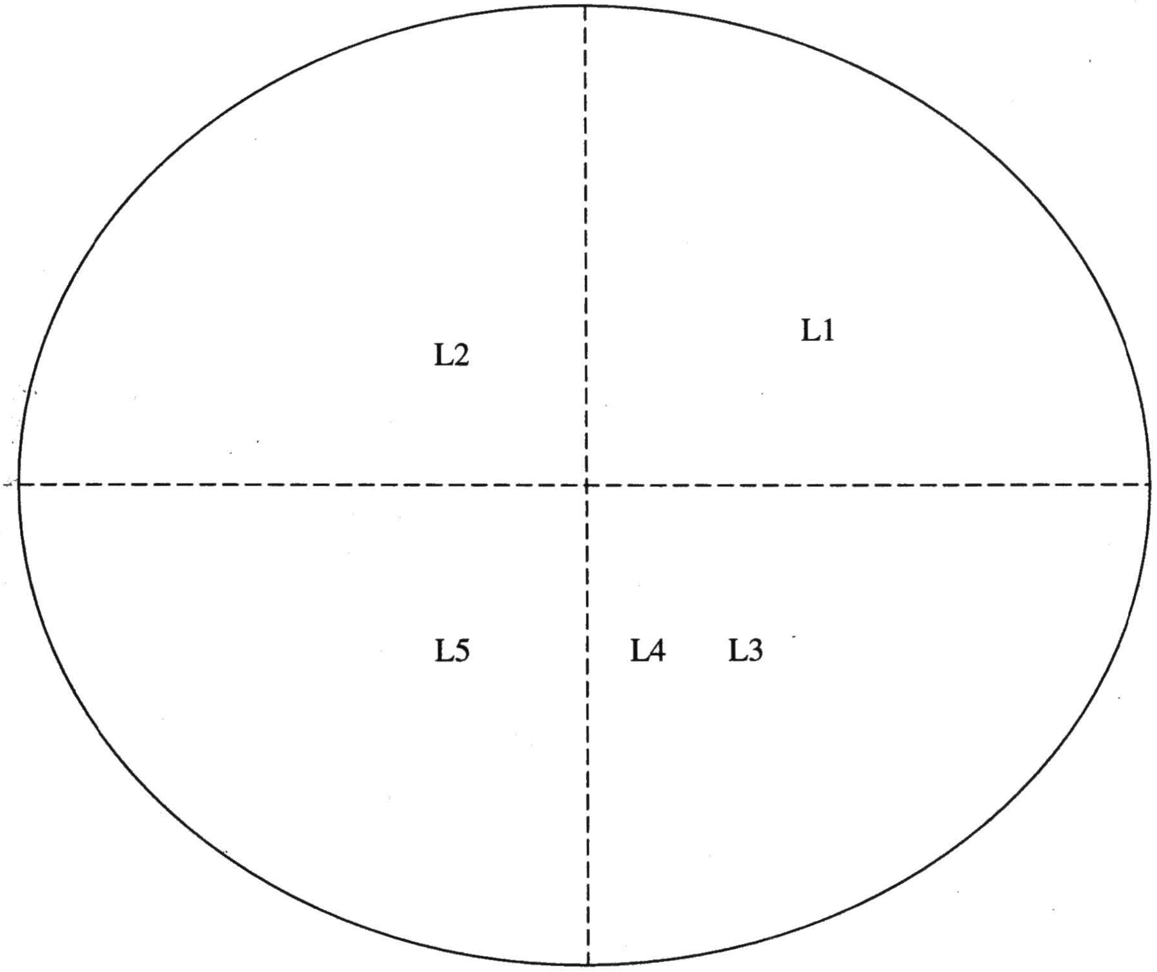
Size	Hardness	Depth
3 mm	20 (durometers): Soft	Medium (M)
5 mm	40 (durometers): Medium	Deep (D)
10 mm	60 (durometers): Hard	

	Breast A	Breast B	Breast C	Breast D	Breast E
L1	10mm 20 M	5mm 60 M	10mm 20 D	3mm 20 M	3mm 40 D
L2	3mm 60 M	10mm 60 M	3mm 40 M	10mm 60 D	
L3	5mm 40 M	10mm 40 M	5mm 60 D	5mm 40 D	
L4	10mm 40 D	5mm 20 D	5mm 20 M		
L5	3mm 20 D	3mm 60 D			

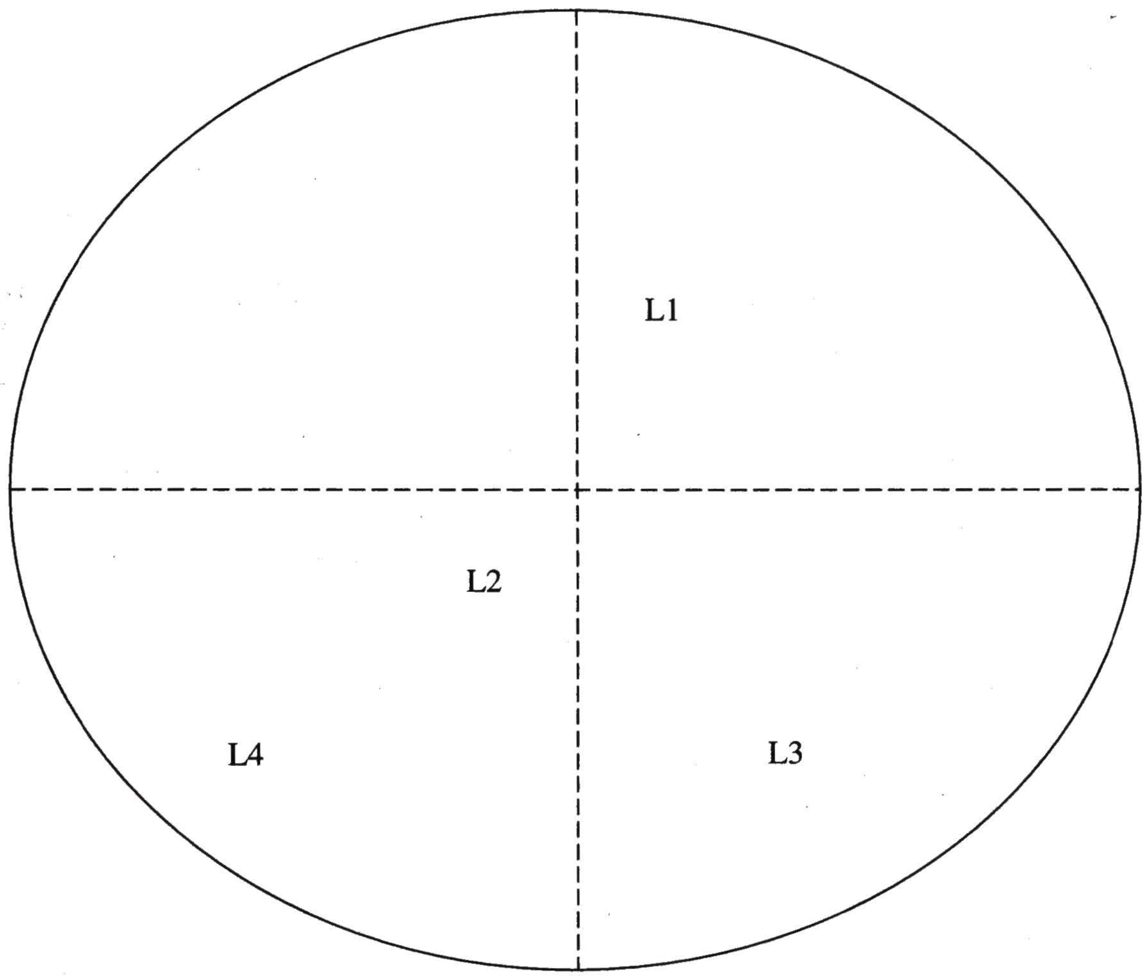
APPENDIX D: TEMPLATE OF BREAST MODEL A



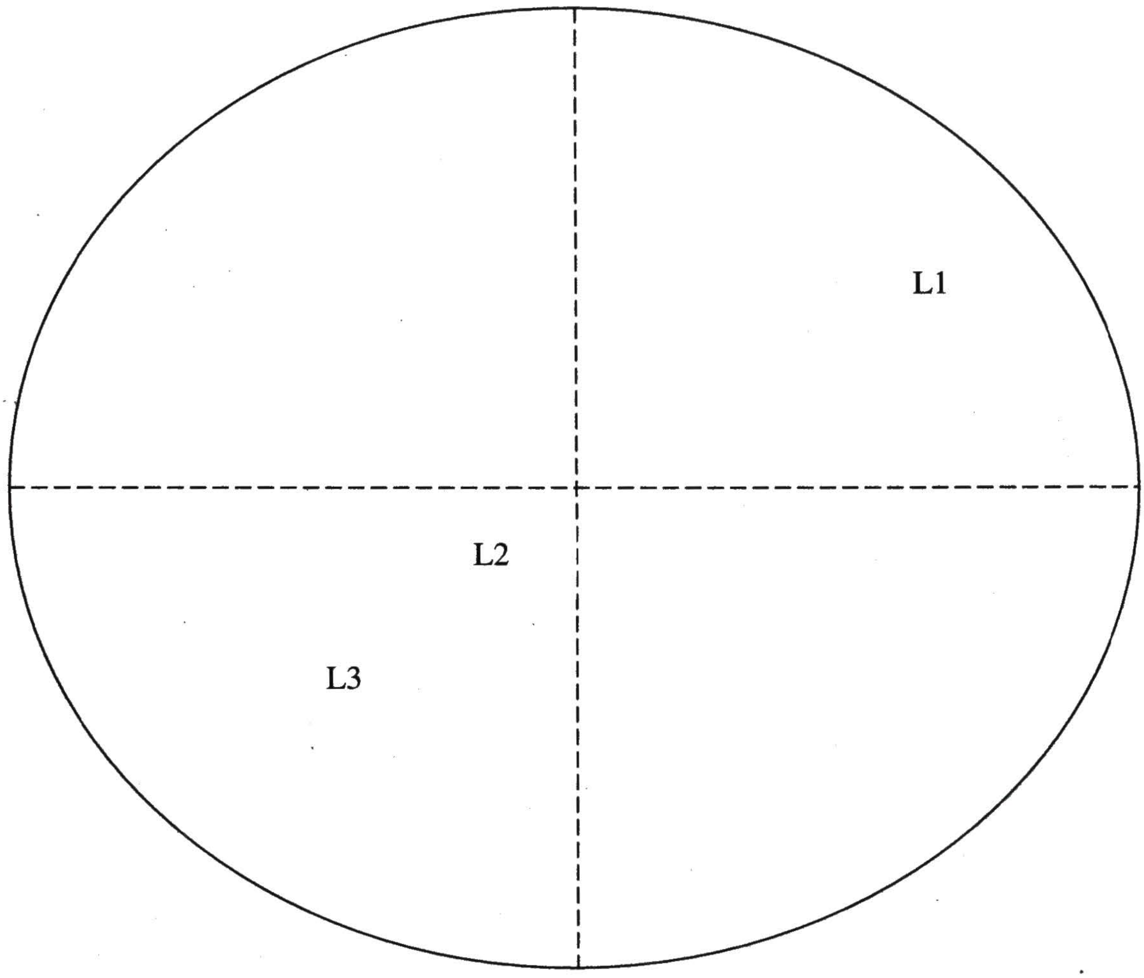
APPENDIX E: TEMPLATE OF BREAST MODEL B



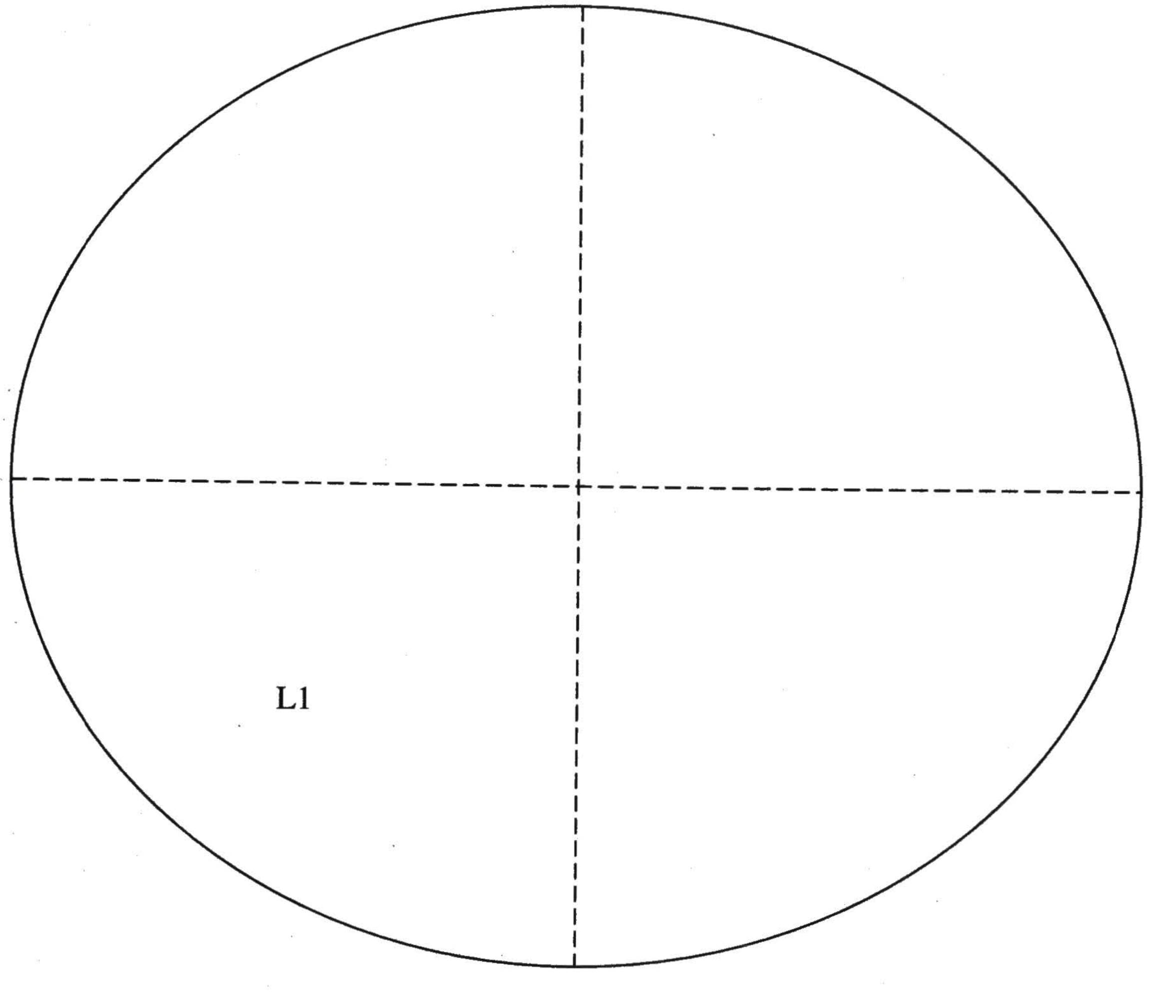
APPENDIX F: TEMPLATE OF BREAST MODEL C



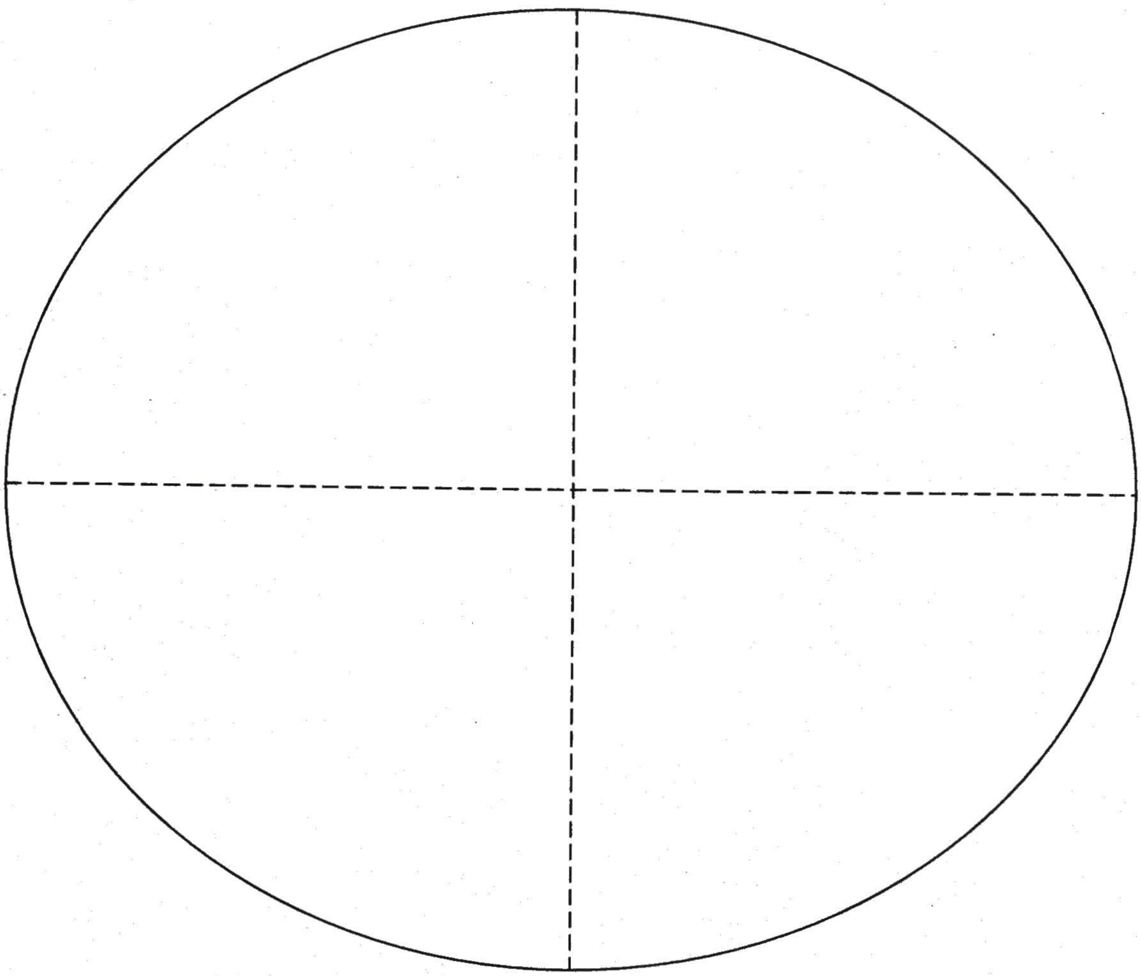
APPENDIX G: TEMPLATE OF BREAST MODEL D



APPENDIX H: TEMPLATE OF BREAST MODEL E



APPENDIX I: TEMPLATE OF BREAST MODEL F



BIBLIOGRAPHY

1. Ward R, ed. *Foundations for Osteopathic Medicine.* 2nd ed. Philadelphia: Lippincott Williams & Wilkins; 1997.

2. Lippincott H. Knowing, seeing, thinking feeling fingers. *Cranial Academy News Letter.* 1962;15:1,3.

3. Frymann V. Palpation- its study in the workshop. *Academy of Applied Osteopathy Yearbook.* 1963:16-30.

4. Burns L. The teaching of osteopathic skill. *JAOA.* 1946;46:217-219.

5. Allen PV, Stinson J. The development of palpation. *JAOA.* 1941;40:207-210.

6. Beal M. Louisa burns memorial lecture: Perception through palpation. *JAOA.* 1989;10:1334-1352.

7. Beal M. Osteopathic basics. *JAOA.* 1980;79:456-459.

8. Nicholas A. Palpation in osteopathic medicine. *Osteopathic Annals.* 1978;6:304-310.

9. Smith, RA, Saslow D, Sawyer, KA, et al. American cancer society guidelines for breast cancer screening: Update 2003. *CA Cancer J Clin.* 2003;53:141-169.

10. McDonald S, Saslow D, Alciati MH. Performance and reporting of clinical breast examination: A review of the literature. *CA Cancer J Clin.* 2004;54:345-361.

11. Saslow D, Hannan J, Osuch J, et al. Clinical breast examination: Practical recommendations for optimizing performance and reporting. *CA Cancer J Clin.* 2004;54:327-344.

12. Barton MB, Harris R, Fletcher SW. Does this patient have breast cancer? the screening clinical breast examination: Should it be done? how? *JAMA.* 1999;282:1270-1280.

13. Bancej C, Decker K, Chiarelli A, et al. Contribution of clinical breast examination to mammography screening in the early detection of breast cancer. *J Med Screen.* 2003;10:16-21.

14. Bobo JK, Lee NC, Thames SF. Findings from 752 081 clinical breast examinations reported to a national screening program from 1995 through 1998. *JNCI.* 2000;92:971-976.

15. Baines C. Screening for breast cancer: How useful are clinical breast examination? *JNCI.* 2000;92:958-959.

16. Fletcher SW, O'Malley MS, Bunce LA. Physicians' abilities to detect lumps in silicone breast models. *JAMA.* 1985;253:2224-2228.

17. Fletcher SW, O'Malley MS, Pilgrim CA, Gonzalez JJ. How do women compare with internal medicine residents in breast lump detection? *J Gen Intern Med.* 1989;4:277-283.

18. Hamann C, Volkan K, Fishman MB, Silvestri RC, Simon SR, Fletcher SW. How well do second-year students learn physical diagnosis? observational study of an objective structured clinical examination (OSCE). *BMC Med Educ.* 2002;2.

19. Kann P, Lane D. Breast cancer screening knowledge and skills of students upon entering and exiting a medical school. *Acad Med.* 1998;73:904-906.

20. Barrett SV, Zapaka J, Mazor K, Luckman R. Assessing third-year medical students breast cancer screening skills. *Acad Med.* 2002;77:905-910.

21. Lee K, Dunlop D, Dolan N. Do clinical breast examination skills improve during medical school? *Acad Med.* 1998;73:1013-1019.

22. Pilgrim C, Lannon C, Harris RP, Cogburn W, Fletcher SW. Improving clinical breast examination training in a medical school: A randomized controlled trial. *J Gen Intern Med.* 1993;8:685-688.

23. Fletcher SW, Morgan TM, O'Malley MS, Earp JA, Degnan D. Is breast self-examination predicted by knowledge, attitudes, beliefs, or sociodemographic characteristics? *Am J Prev Med.* 1989;5:207-215.

24. Powell HS, Bridge J, Eskesen S, Estrada F, Laya M. Medical students' self-reported experiences performing pelvic, breast, and male genital examinations and the influence of student gender and physician supervision. *Acad Med.* 2006;81:286-189.

25. Elmore JG, Barton MB, Moceri VM, Polk S, Arena PJ, Fletcher SW. Ten-year risk of false-positive screening mammograms and clinical breast examinations. *N Engl J Med.* 1998;338:1089-1096.

26. Baker R. That lump in the breast: Some questions and answers. *JAOA.* 1938;37:535-536.

27. Oestreicher N, White E, Lehman CD, et al. Predictors of sensitivity of clinical breast examination (CBE). *Breast Cancer Research and Treatment.* 2002;76:73-81.

28. Pennypacker HS, Bloom HS, Criswell EL. Toward an effective technology of instruction in breast self examination. *Int J Ment Health.* 1982;11:98-116.