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Diagonal earlobe creases and coronary artery disease

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DIAGONAL EARLOBE CREASES AND
CORONARY ARTERY DISEASE

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by

Sandra Jeanne Vollmer

1996

To: _____ Linda Simunek

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This thesis, written by Sandra J. Vollmer, and entitled Diagonal Earlobe Creases and Coronary Artery Disease, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this thesis and recommend that it be approved.

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I dedicate this thesis to both Fadi Al-Ghraoui and Hinda Greene. Without their understanding, patience, continuous support, and most of all love, the completion of this work would not have been possible.

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ABSTRACT OF THE THESIS

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by

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Florida International University, 1996

Miami, Florida

Professor Kathleen Blais, Major Professor

PURPOSE: The purpose of this study was to examine the relationship between the diagonal earlobe crease and the incidence of coronary artery disease.

PATIENTS AND METHODS: A descriptive, correlational, retrospective and concurrent approach was utilized in examining 61 patients, all with a cardiac catheterization within the last six months. All were examined for the presence of diagonal earlobe crease, presence of coronary artery disease, total blood cholesterol levels, age, sex, and past medical histories. Analyses included the Fischer's exact test, regression analysis, and multiple logistic regression analysis.

RESULTS: The mean age of all the subjects 70.3. Mean cholesterol level of all subjects= 199.68. A significant association between presence of earlobe creases and presence of coronary artery disease with P value <0.025. Gender (male) was the most predictive for the presence of CAD of the four covariates (including age, cholesterol, and ELC status), P<0.006. Earlobe status was the second most powerful predictor of CAD status, P=0.019. Neither age (P=0.40) nor cholesterol (P=0.16) were significant predictors of CAD status.

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ABSTRACT

CHAPTER 1
Introduction

According to the National Center for Health Statistics and the American Heart Association, cardiovascular disease (hypertension, coronary artery disease, stroke, and limited rheumatic heart disease) ranks as the number one killer in the United States. The current U.S. population is approximately 255 million, and nearly 59 million people have some form of cardiovascular disease (American Heart Association, 1994).

Cardiovascular diseases claimed 925,079 lives in the United States in 1992. In the same year, 42.1 % of all deaths were attributed to cardiovascular disease, or 1 of every 2.4 deaths. More than 2,500 Americans die every day from cardiovascular disease, most of whom are under the age of 65 years (American Heart Association, 1994).

Coronary artery disease and the associated risk factors have eluded health care professionals, anthropologists, and epidemiologists for decades. It was not until 1973 when physical findings were linked to coronary artery disease; the first being the diagonal earlobe crease (Appendix A) (Frank,1973). Before 1973, coronary artery disease was determined by the patient's history, familial history and laboratory studies.

The complexity of human beings and their interaction with the surrounding environment is reflected in the enormous array of information that may be obtained through the nursing process, which is a systematic method for organizing the change process within the nursing context. It enables the nurse to make a positive difference in the individual's ability to meet his or her daily health needs. The nursing process is composed of several phases. They are assessment, diagnosis, planning, implementing, and evaluating (Kozier, et al., 1993).

In the assessment phase of the nursing process, the nurse begins to establish a database which is applicable to the person's health status at a specific time (Kozier, et al., 1993). The Advanced Practice Nurse then continues this accumulation of information and begins to synthesize that information to make a diagnosis, and eventually a treatment plan. Assessment is not merely a random gathering of facts, but a purposeful process designed to provide a foundation on which to build a diagnosis of the individual's pathologic condition (Brill & Kilts, 1980). This database is obtained through the health history, comprehensive physical assessment, review of records, interview of support persons, review of literature, the ordering of appropriate tests and x-rays, and validation of the assessment data (Kozier, et al., 1993). Assessment, no matter how thorough, is never complete, since the individual and his environment are constantly changing.

During the diagnostic phase of the nursing process, the Advanced Practice Nurse utilizes the analyzed data to come up with a diagnosis and treatment plan. This is accomplished by comparing the data against standards, grouping data, identifying gaps or inconsistencies, determining the patient's health problems, risks, and strengths, and formulating diagnostic statements. Diagnosis requires both analysis and synthesis of the data acquired. Inductive and deductive reasoning, objectivity, critical thinking and decision making are all cognitive skills required for analysis and synthesis.

Accurate diagnosis of cardiovascular disease is dependent upon the accurate combination of findings discovered during the detailed cardiovascular evaluation (Harvey, 1988). This evaluation should include a careful and detailed history, physical examination, electrocardiogram, x-rays, and simple laboratory tests. This is referred to by Dr. Harvey (1988) as the "five finger" approach to effective and accurate clinical diagnosis. A careful and detailed history is the most important aspect of this

process, followed by the physical examination. Symptoms identified while taking the history provide a basis for the process of diagnosing a disease. Symptoms guide the focus and extent of the physical examination, and later, the laboratory investigations which will need to be performed. The Advanced Practice Nurse and physician utilizes this information to determine the most appropriate treatment in an attempt to restore the patient to the most optimal level of daily living.

Since the diagonal earlobe crease was first introduced as being an associated physical finding of coronary artery disease, multiple studies have substantiated this finding. Despite the correlation, the diagonal earlobe crease as a marker of coronary artery disease appears to be underutilized in the diagnostic process by both physicians and advanced practice nurses.

Assumptions

Coronary artery disease brings about anatomical changes.

Significance

Coronary artery disease is the number one killer of Americans according to the 1994 National Center for Health Statistics and the American Heart Association. Americans will pay an estimated $137.7 billion in 1995 for medical costs and disability from coronary artery disease. Early recognition of coronary artery disease risk factors and associated physical findings will enable the practitioner to implement coronary artery disease risk factor modification in an efficient and effective manner in efforts to limit morbidity and mortality from coronary artery disease.

Two roles of the Advanced Practice Nurse, as defined by the Florida Nurse Practice Act (1991), are the diagnosis of disease processes by physical assessment and the treatment of those diseases identified during that period. These roles include not only identification of illness through assessment and diagnostic testing and prescription for medications, but also include education on the disease process and

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treatment. The review of literature suggests the diagonal earlobe crease can be a contributing physical finding in helping to diagnose coronary artery disease. Early recognition of coronary artery disease risk factors will enable the Advanced Practice Nurse to implement risk factor modification in an expedient manner. If it can be demonstrated that diagonal earlobe creases are associated with CAD, health providers can make diagnosis earlier, before invasive diagnostic studies. This will then allow for aggressive risk factor modification and hopefully translate into an increased life expectancy in those patients with coronary artery disease. This will also help to decrease the costs associated with coronary artery disease.

Problem Statement

General Problem:

Is there a relationship between diagonal earlobe crease(s) and coronary artery disease in adult patients?

Specific Problems:

1. What is the difference in the percentage of coronary artery occlusion between those adult patients who present with bilateral earlobe creases as compared to those who have only unilateral earlobe crease?

2. To what extent is coronary artery disease present in those adult patients who have diagonal earlobe crease?

3. What is the relationship between ethnicity and diagonal earlobe creases in those adult patients with documented coronary artery disease?

Summary:

Cardiovascular disease ranks as the number one killer in the United States. It costs Americans an estimated $137.7 billion in 1995 for medical costs and disability from coronary artery disease. With the current trend in medicine to optimize the least expensive screening tools to diagnose diseases, the use of physical findings are

becoming crucial. One of the greatest tools the Advanced Practice Nurse has to work with is advanced physical assessment skills. Conclusions made from assessment enable nurses to educate their patients and the public about preventative health care.

If it can be shown that the earlobe crease, an easily identifiable physical finding, is associated with coronary artery disease, the nurse can educate the public about this physical finding, identifying associated coronary artery disease risk factors, and implement aggressive risk factor modification. This may result in increased life expectancy of those patients with suspected coronary artery disease, thus decreasing the costs incurred from this disease.

CHAPTER 2

REVIEW OF LITERATURE

Since the first study done in 1973 by Frank, a multitude of studies have been done to investigate the possible association between coronary artery disease and diagonal earlobe creases. This sign still remains controversial as a marker of coronary artery disease.

THEORIES OF AGING:

There are several theories of aging that may explain the possible correlation between diagonal earlobe creases and the incidence of coronary artery disease. These theories include the collagen theory, the crosslinkage theory and the free radical theory. Although no one theory proves the possible link between the diagonal earlobe crease and incidence of coronary artery disease, these theories should be further explored.

Collagen Theory

The collagen theory states that collagen is one of the most abundant forms of protein in the human body and is found in all connective tissues. It is the ground substance, holding our cells in place. It comprises 30-40 percent of body protein and undergoes modification of its elastic properties over time. As collagen becomes denser and replaces other components in the ground substance, cells have more difficulty acquiring nutrients and expelling wastes. This leads to a lack of elasticity in the vessel walls, which is the onset of arteriosclerosis, higher blood pressure, and many related problems. Bones also become brittle because of changes in the marrow collagen. The pattern of cross-linking and its role in impairing functional capacities justify its inclusion among primary physiological explanations of the aging process (Kyriazis, 1994).

Arteriosclerosis is the hardening, thickening, and loss of elasticity of the walls of the arteries. This results in degenerative areas in the vessel walls which rupture easily, giving way to a rough surface for blood to clot and cholesterol plaques to form. This can result in altered function of tissues and organs.

The ear is a very vascular area. If the ear is being supplied by sclerotic vessels, that area will have a diminished supply of nutrients and a higher level of waste products. This may lead to the elastic-tears which are manifested by the earlobe creasing seen by the naked eye. Since the vessels of the earlobe are smaller in diameter, it can be suggested that the earlobe is going to have visible changes before symptoms of coronary artery disease present.

Crosslinkage Theory

The crosslinkage theory states a chemical reaction produces irreparable, spontaneous damage to DNA and consequent cell death. This occurs when a crosslinking agent attaches itself to one strand of a DNA molecule. Usually, defense mechanisms excise the agent, together with the piece of the affected DNA, and the damage to the stand is repaired using the unaffected strand as the template. With aging, defense mechanisms are not able to excise the crosslinking agent before it attaches itself to the second DNA strand. The result is an abnormal parting of the two strands in mitosis, leading to an incomplete division and cell death. Accumulation leads to random, irreparable binding together of essential molecules in the cells. These range from DNA within the nucleus to macromolecules such as protein. The crosslinked network interferes with normal cell functioning and impedes intracellular transport. Irreversible aging of proteins, such as collagen, is responsible for the ultimate failure of tissues and organs (Kyriazis, 1994).

Collagen is the supporting structure for many organs, including the earlobes. It can be deduced from this theory that the failure of many organs will be visible in those

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structures supported by collagen, most likely those with the smallest vascularity first. Considering the earlobes are extremely vascular and supported by collagen, this area would be one of the first to show the beginning aging process, reflecting the beginning failure of the heart.

Free Radical Theory

The free radical theory states that free radicals are highly reactive cellular components derived from atoms or molecules in which unpaired electrons are seeking a mate. If they pair with an otherwise stable unit, another free radical is created and the process continues. Oxygen molecules most commonly generate free radicals, and the most vulnerable sites are the mitochondrial and microsomal membranes rich in unsaturated lipids. Lipid molecules are vulnerable to attack by free radicals, resulting in structural changes and malfunctions. Chemical and structural changes are progressive with a potential for a chain reaction in which free radicals generate other free radicals. Free radicals do not contain useful biological information and replace genetic order with randomness; thus faulty molecules and cellular debris accumulate in the nucleus and cytoplasm over a lifetime. They may contribute to the development of lipofuscin.

Lipofuscin, a free radical, is a pigmented material rich in lipids and proteins that accumulates in many organs with aging. It originates from a perioxidation of components of polyunsaturated acids located in mitochondrial membranes. They have some relationship to free radicals and the process of aging because the substance is associated with oxidation of unsaturated lipids. This accumulation interferes with the diffusion and transport of essential metabolites and information-bearing molecules in the cells. This may play a part in the aging process (Hendricks, 1994).

The free radical theory can be applied to coronary artery disease and earlobe creases because of the deposition of lipids and proteins which accumulates in many

organs as aging occurs. If this is the case, then this same deposition also occurs in the blood vessels, hence decreasing the circulation. A diminished blood supply to skin, especially the earlobes, will result in visible creasing, reflecting this diminished blood supply to the heart.

POSTULATIONS ABOUT THE FORMATION OF EARLOBE CREASE IN CORRELATION TO CORONARY ARTERY DISEASE

Multiple studies (Doering et al.1977, Kaukola et al.1979, Kristensen 1980, Shoenfeld et al. 1980, Merlob et al. 1981, Overfeld and Call 1983, Pasternac and Sami 1982, Kaukola 1982, Jarrett 1984, Dang 1984, Wagner et al. 1984, Blythe 1984, Peeples et al. 1985, Kirkham et al. 1989, Williams 1989, and Brown and Goldstein 1990) have been done in attempt to explain the physiological link between coronary artery disease and the diagonal earlobe crease.

<u>Presence of Earlobe Crease and Coronary Artery Disease in Adults</u>

Doering, Ruhsenberger, and Phillips (1977) are among the first to mention a possible explanation for the incidence of earlobe creases and coronary artery disease. They studied all patients (n=88) who were admitted to a medical intensive care unit and to a medical floor over a 10-week period of time. The ages of the patients ranged from 30-80. Identifying data included their age, sex, height, weight, blood pressure, smoking history, diabetes, and serum cholesterol level, as well as the presence of coronary heart disease and earlobe crease. They recorded the crease even if it was only unilateral. Fifty patients were in the heart disease group and 38 were in the control group. The systolic and diastolic blood pressures were measured twice on the day after admission and the means of the two readings were tabulated for data analysis, based on the Oregon Heart Association criteria. They were also categorized as obese if they were 30% over the ideal weight for a person of that height and sex. Using chi-square analysis, the two groups differed significantly with regard to their

age (t=2.68; p< 0.05) and weight (t=2.26; p< 0.05), smoking (x2= 5.24; p< 0.05) and the percentage of occurrence of earlobe creases (x2= 25.44; p< 0.001). The authors concluded that the earlobe creases do increase with age, and age alone does not account for the relationship between coronary heart disease and earlobe creases. Thus, the presence of the earlobe creases may be a useful diagnostic tool. They suggest that since both the incidence of earlobe creases and the incidence of coronary heart disease increase with age, they both may be related to changes occurring in the vascular system. Because the ear is such a vascular structure, these changes are manifested by creases and folds in the earlobe.

It is a well known fact the skin of older adults becomes flaky and scaly, and appears to hang loosely on the bony frame as a result of loss of elasticity, loss of underlying adipose tissue, and years of gravitational pull. Increased wrinkling is also apparent, especially in the sun-exposed areas such as the face and the earlobes. Sagging also contributes to the wrinkling which occurs, and is most apparent in the breasts, scrotum, under the chin, and in the earlobes (Seidel, Ball, Dains, & Benedict, 1991). The pinna increases in both length and width, the earlobes become elongated, and wrinkled (Malasanos, Barkauskas, Moss, & Stoltenberg-Allen, 1986).

Sanders T. Frank (1973) was the first to suggest an association between the diagonal earlobe crease and cardiovascular disease. He observed all patients 60 years old or younger. Out of 20 patients with positive earlobe crease, 19 had at least one or more risk factors of coronary artery disease. The risk factors taken into account and measured were elevated cholesterol, triglycerides, blood sugar, hypertension, cigarette smoking, and a family history of premature cardiovascular disease. On the basis of his observations, he suggested an association with the positive ear-lobe sign and premature cardiovascular disease.

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Lichstein, Chadda, Naik, and Gupta (1974) observed 531 patients who were admitted to a coronary care unit with acute myocardial infarction. Data collection included the absence or presence of the diagonal earlobe crease, hypertension, diabetes mellitus and smoking habits. There was a control group of 305 patients whom had been randomly selected with no clinical evidence of coronary heart disease. They found a statistically significant difference between the two groups (p<0.001). Forty-seven percent of the coronary artery group had positive earlobe crease, while only 30% of the control group had positive earlobe crease. Hypertension and diabetes mellitus had no significant statistical difference. Smoking was significantly higher as determined by chi square analysis (p<0.005) in those patients with a positive earlobe crease, as compared to those without the earlobe crease in the coronary artery group; there was no significant difference in the control group with and without the earlobe crease. The study concluded that the earlobe crease should be regarded as a coronary risk factor and used in the identification of patients at increased risk.

Kaukola, Manninen, Valle, and Halonen (1979) studied 286 randomly selected patients who had undergone coronary angiography to determine the cause of signs and symptoms of coronary heart disease or atypical chest pain. Two hundred patients had at least 50% stenosis in one of the main epicardial arteries and 86 were without significant stenosis. The two groups were of comparable age (range 26-66 years). The percentage of males in the coronary heart disease group was higher (63%) than in the non-coronary heart disease group (13%). Of the coronary heart disease group, 144/200 (72%) had the earlobe crease, while 18/86 (21%) of the non-coronary artery disease group had the crease (p<0.001). In the 50-59 year old group, 90% of the patients with coronary heart disease had triple vessel disease. In the group without any major coronary stenosis, six patients had a history of a myocardial infarction, and five of those six had the earlobe crease.

Multivariate analysis revealed that none of the traditionally known coronary risk factors (increased serum cholesterol and triglycerides, low HDL-cholesterol, hypertension, smoking, diabetes, and obesity) were associated with the earlobe crease. The validity of the observation depended on the comparison of the coronary heart disease group and the non-coronary heart disease group. The patients were divided into those with significant stenosis of the coronary arteries ($\geq 50\%$ stenosis of at least one of the major coronary arteries) and those with negligible or low grade stenosis ($\leq 50\%$). They concluded that because no other factor affected the patient selection, the association between the earlobe crease and coronary heart disease is not a spurious one. They referenced Rhoads et al. (1977) who reported that the Japanese have a low incidence of coronary heart disease, thereby, suggesting that there might be genetic influences involved in the cause and development of the earlobe crease. Conventional light microscopy had not revealed any specific tissue changes in the earlobe crease. Adams, Bayliss, Baker, Abdulla, and Hunter-Craig (1974) also noted similar lipid deposits in collagen tissue in the Achilles tendon and coronary arteries. They suggest that maybe the changes in collagen would provide a clue to the pathogenesis.

Kristensen (1980) examined patients with essential hypertension and normotensive controls who already had tissue typing and investigation for the atherosclerotic C3-F gene. Only those subjects with bilateral diagonal earlobe creases were considered. He found that 19/74 (25%) of the hypertensive males aged 23-71 and only 1/29 (3%) of the normotensive control males had the bilateral earlobe crease. The corresponding figures for the females are as follows: 5/51 (8%) and 2/26 (7%). Kristensen also compared age-matched hypertensive males with and without the earlobe creases. He showed that 13/19 (68%) of the crease-positive males had either angina (7), myocardial infarction (2), congestive heart insufficiency (3, [with

angina in 1]), strokes (3, [2 with angina]), or retinal thrombosis (1). In males without the earlobe creases, 2/15 (13%) had claudication (1 with angina), while the remainder had no vascular complications. The mean age group was 59±8 (±SD) and 58±8 years respectively.

Shoenfeld, Mor, Weinberger, Avidor, and Pinkas (1980) reported the prevalence of the earlobe crease in post-myocardial infarction patients. A total of 421 patients were examined consecutively who were admitted for the diagnosis of myocardial infarction on the basis of the clinical picture, electrocardiographic changes, and enzyme elevations. Data collected were age, sex, ethnic origin, location of the myocardial ischemia, the presence or absence of hypertension ($\geq$160/100 mm Hg), diabetes mellitus, hyperuricemia ($\geq$8 mg/dl), hypercholesterolemia ($\geq$250 mg/dl), cigarette smoking ($\geq$20/day), and hypertensive and diabetic retinopathies. The presence of the earlobe crease was also recorded in 421 patients (control group) consecutively admitted to the hospital for various reasons but without any past or present evidence of coronary heart disease, diabetes, or hypertension. Earlobe creases were examined while the clients were in both the supine and the seated position, and were noted to be either unilateral or bilateral.

The two groups (those with myocardial infarction and the control) were then matched for age, sex, and ethnic origin. The ethnic origin was determined by birth place of the patient or the parents. The division of the patients were determined according to the differences in habits (e.g., dietary) and the coronary risk factors. Statistical significance was determined by the chi-square test ($p<0.05$).

After the deaths of 12 subjects, earlobe tissue was obtained and analyzed. The incidence of the earlobe crease was statistically significant in those patients who died from myocardial infarction, in comparison to the control group (77% versus 40%). No statistically significant difference was noted between the incidence of the earlobe

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crease and the location of the myocardial ischemia or between the earlobe crease and sex. Significant correlations were noted between occurrence of the earlobe crease and hypertension ($p < 0.001$) and diabetic retinopathy ($p < 0.05$). No significant correlation was noted between the occurrence of the earlobe crease and hyperuricemia, hypercholesterolemia or hypertensive retinopathy. When the different coronary risk factors were analyzed in relation to other coronary risk factors (smoking, hypertension, diabetes, hypercholesterolemia, and hypertriglyceridemia) in the different age groups (38-50, 51-60, 61-70, and 71-80), a significant association was found with hypertension in two age groups only (38-50 and 61-70). There was also a statistically significant association between the earlobe crease and myocardial infarction ($p < 0.05$) in the 81-90 year old group and highly significant in all other age groups ($p < 0.005$).

Shoenfeld et al., also performed a histological analysis of the earlobe biopsies. The histological analysis showed that the earlobes with creases had significant tears in the elastic fibers but none in the earlobes without creases. Prearterial wall thickening was noted in four myocardial infarction patients (three had earlobe creases) and in two patients with the earlobe crease but without myocardial infarction. The authors speculated that a possible diminished blood supply to the earlobe, an extremely vascular area, may contribute to the elastic tears which become manifest as the early creasing seen by the naked eye.

Pasternac and Sami (1982) wrote about the predictive value of the earlobe crease sign in coronary artery disease. Their sample population included 340 patients consecutively admitted to the Montreal Heart Institute for coronary arteriography because of chest pain. All the patients' earlobes were examined prior to coronary arteriography, then the coronary risk factors were assessed (personal history of myocardial infarction, family history of myocardial infarction or sudden death before

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the age of 55, cigarette smoking, corneal arcus, age, systolic and diastolic pressures, and levels of cholesterol, triglycerides and glucose in fasting blood specimens). The coronary arteriography was considered abnormal if the lumen of any artery was narrowed by 30% or more. The severity of the blockages were then placed into categories of grade 1-3 (grade 1: 30-50% blockage in one or more of the main vessels, grade 2: narrowing greater than 50% in one or two main vessels, grade 3: narrowing greater than 50% in three main vessels). Chi-square and t-test analysis was done. The positive predictive value was 91.1% for coronary artery disease and earlobe crease and 60.5% for those without this sign (the difference was significant at p<0.001); the negative predictive value was 39.5%. The positive predictive value was higher (95.7%) when considered separately, and in women was lower at 66.7%. Earlobe crease sign was more common in those patients with grade 3 coronary artery disease.

Coronary artery disease was significantly more common in patients with the earlobe crease sign in all age groups except for those 60 years of age. In patients younger than 34.5 years, the earlobe crease was not observed in those with normal coronary arteries but was observed in those with coronary artery disease (27.7%). Posternac and Sami showed that the earlobe crease has a high predictive value for coronary artery disease, but that its absence does not rule out such disease.

Kaukola (1982) wrote about the diagonal earlobe crease, heredity and coronary heart disease. He studied 41 males with a history of previous myocardial infarctions and their 134 first-degree relatives. They were studied for 6-25 months after having survived a myocardial infarction. Their first-degree relatives included 5 fathers (ages 61-70), 11 mothers (ages 52-72), 45 brothers (ages 25-60), 26 sisters (ages 23-63), 22 sons (ages 11-26), and 25 daughters (ages 9-25).

Kaukola notes that with increasing age, earlobe crease becomes general but that a positive correlation between the earlobe crease and coronary heart disease is maintained. The earlobe crease is also further correlated with increasing severity of coronary atherosclerosis, which also increases with age. He states that it should also be noted that the earlobe crease may be present without demonstrable ischemic heart disease. Among the healthy brothers of the myocardial infarction patients, both with and without the earlobe crease, the earlobe crease was found at a similar rate. In contrast, the earlobe crease was found at a higher incidence in the healthy sisters of the myocardial infarction patients. The mothers of these patients had died of myocardial infarction more frequently than the mothers of myocardial infarction patients without the earlobe crease. He concluded that the results of the study tend to support that the earlobe crease is correlated with coronary heart disease, rather than earlobe crease and heredity.

Dang (1984) discussed a possible relationship between the earlobe crease and the chromosome 11. It is reported that external ear malformations have been associated with trisomy 11 and that familial earlobe creases are associated with hallux syndactyly and ulnar polydactyly. During embryogenesis, the shape of the pinnae results from the intricate folding of cartilaginous tubercles of brachial arches. They are innervated by C2, C3, and cranial nerves V, VII, IX, and X. A body surface map and the viscera on the auricle had been proposed in an attempt to explain ear acupuncture. The earlobe crease points to the area on the pinnae which corresponds to the heart, according to a somatotopic acupuncture map.

Blythe (1985) discussed the correlation between earlobe creases, ear-canal hair, and coronary artery disease. He accepts that there is a statistical correlation between earlobe creases, ear-canal hair, and coronary artery disease. He believes the significance is statistical only and not predictive.

Kirkham, Murrells, Melcher, and Morrison (1989) examined 303 consecutive coroner's necropsies of patients who died from cardiovascular disease. The earlobes were classified as soldered, attached, or free. The presence or absence of the earlobe crease in one or both ears was recorded. In addition, the age, height, and sex of the deceased were also recorded. The mean (SD) age of the group was 72.2 (14.7). The incidence of the earlobe creases in those aged ≥ 55 (191/260) was significantly higher than in the younger subjects (11/28) (74% v 39%, p<0.001, 95% confidence interval for the difference in proportions 17% to 52%). The incidence of creases in males and females was similar [123/171 (72%) v 88/132 (67%), 95% confidence interval for the difference in proportions-5% to 16%]. Thirty-five percent (47/211) had a history of cardiovascular disease, as compared to 17% (16/92) of those without.

They concluded there was a strong association between earlobe creases and a cardiovascular cause of death in men and women after controlling for age, height, and diabetes. They did not find a correlation between the earlobe creases in diabetic women and the risk for cardiovascular cause of death. They also found that the presence of the combination of a previous history of cardiovascular disease and earlobe creases was not as strongly associated with cardiovascular causes of death as the presence of the earlobe crease alone. This suggests that cardiovascular disease was underdiagnosed in that population. Their final conclusion is that the diagonal earlobe crease is associated with cardiovascular causes of death.

Kenny (1989) discussed the idea that the earlobe crease points to an area of the pinna which corresponds to the heart in the acupuncture map. He points out that the earlobe crease may be associated with the heart on the acupuncture map and may also be associated with sleep apnea, but it is more useful for the clinician to know that old people with wrinkles are more likely to have coronary artery disease.

Cheng (1992) discussed the literature which has been written to date about the different theories which have been used to explain the occurrence of the earlobe crease. He notes that age is a major confounding variable. He states that although the earlobe crease has not been proven to be clearly associated with coronary artery disease, this does not exclude it from being used in the evaluation of coronary artery disease risk factors.

Cheng also looked at the acupuncture theory of Dang (1984) cited by Elliot and Karrison (1991). He points out that the area of the earlobe where creases are found is nowhere near the "heart" point on the acupuncture map. He also looked at the theory of macrophage receptors which was proposed by Sapira (1991). According to this theory, if the aging body can no longer maintain earlobe collagen, then one can assume that it cannot maintain the chemically similar macrophage receptor. He concludes that this will lead to decreased macrophage activity, which controls the size of atheromas, and might account for the correlation between earlobe creases and coronary artery disease.

Presence of Earlobe Crease in Infants

Merlob, Amir, and Reisner (1981) looked at the incidence of the ear crease in newborn infants (n=1,039) and in older children (n=685). The data collected on each infant included the presence or absence of the ear crease, any other minor or major malformations, family history of cardiovascular disease, and any other known risk factors. The diagonal earlobe crease was noted in 48 newborns (4.6% incidence). All of the infants were free of congenital deformities and all were full-term. The infants were re-examined just prior to discharge (usually days 3-4), and ear creases were present in only 6 infants. Of those six infants, there was no family history of coronary

artery disease or other risk factors. They were not able to find a correlation between the diagonal earlobe crease in infants/children and a family history of coronary artery disease. The earlobe crease appears to develop later in life.

<u>Presence of Earlobe Crease in Culturally Diverse Groups</u>

Rhoads and Yano (1977) studied 1,237 Japanese-American men and found no relationship between the prevalence of coronary heart disease (angina, coronary insufficiency, and myocardial infarction) or myocardial infarction and earlobe crease. An earlobe crease was found in 30% of the 71 men with coronary heart disease of any type, in 22% of the 37 men with myocardial infarction, and in 32% of the men without coronary heart disease. They correlated earlobe creases slightly to blood pressure and definitely to obesity. They concluded that the lack of rigorous study design in the case-control studies, their considerable variation in results, and their own negative findings in a population-based study leave substantial question about a real association between earlobe crease and coronary heart disease.

Fisher and Sievers (1980) discussed the incidence of the diagonal earlobe crease and obesity. They examined 200 consecutive full-heritage southwest American Indian adult patients (106 men, 94 women) whom had been admitted to the hospital. The patients' earlobes were examined in the sitting position and were done without prior knowledge of the medical history. The diagonal earlobe crease was noted in 71% of the men (n=56) and 48% of the women (n=58) over the age of 50 years. It was noted that 17 out of 114 patients 50 years or older, had evidence of coronary heart disease, as manifested by angina pectoris, myocardial infarction, or ECG evidence of myocardial ischemia. There was no significant association between the remaining 97 patients 50 years or older without coronary heart disease and the diagonal earlobe crease. Among an additional 16 patients (twelve men, four women) with documented acute myocardial infarction, a crease was present in only 42% of the

men (mean age 54 years) and 25% of the women (mean age 59 years), frequencies similar to the rates for the Indians hospitalized without coronary heart disease when controlled for age and sex. The authors suggested that a study be done on Mexican-Americans because many of them have considerable Indian heritage.

Petrakis and Koo (1980) discussed the association of the diagonal earlobe crease and coronary artery disease in regards to the prevalence in ethnic and racial groups. They looked at 1,871 "mug-shot" files (front and side view), maintained by a police department for the frequency of earlobe creases by age and race. The study was confined to males of White, Black, Chinese, Latin-American, and Hawaiian-Samoan racial and ethnic groups. The authors found an age-related increase in the frequency of earlobe creases in White, Black, and Latin-American groups, but no increase among the Chinese. This suggests a racial variation in the frequency of this trait.

Overfield and Call (1983) examined 324 healthy adults from three different racial backgrounds: southwestern Alaskan Eskimos (n=70), Navajos (n=167), and Whites (n=87). They looked at age, race, and earlobe shape. There were noted to be three different types of earlobes: free lobes, attached lobes, and soldered lobes. Freelobes are attached only to the ear, not to the side of the face in front of and below the ear. Attached lobes blend into the back of the check; and soldered lobes are an extreme version of the attached form. They found that earlobe creases developed with age (p<0.005) in both the white and Navajo sample populations. By the fifth decade of life, 50% of the Whites had earlobe creases. This percentage was equaled by the Navajo population until the sixth decade. Eighty percent of the Whites had the earlobe crease in the sixth decade, as compared to the 69 per cent in the Navajo population. There was no significant difference in the incidence of creasing by race.

Five to eleven percent of the attached earlobes were creased, 34-35% of the free earlobes were creased, and none of the soldered lobes were creased. In all the whites who were over the age of 50 years, 43% of the attached lobes and 73% of the free lobes were creased. In comparison, in the Navajos of the same age group 33% of the attached lobes and 52% of the free lobes were creased. The researcher concluded that the racial differences in earlobe shape and the difference in the creasing ability of the earlobe shape should be considered an important variable in the study of earlobe creases. They state that the earlobe crease, until shown otherwise, should be considered more a curiosity than a warning sign of anything but the passage of time.

Christiansen, Mathiesen, Andersen, and Calberg (1975) report that they observed all patients admitted to both a medical and a surgical floor. There were 203 women and 320 men, the mean age of the two groups was 69.5 ± 7.5 (S.D.) and 68.8 ± 10.5 (S.D.) years, not differing significantly. All the patients were observed for diagonal earlobe crease, acute myocardial infarction, coronary heart disease, arterial hypertension, smoking habits and diabetes mellitus. They found that the earlobe crease was more prevalent in the patients with coronary heart disease than in the controls as the ages of the subjects increased. There was a statistically significant difference in the group of 50-59 years old ($p<0.001$). There was also a higher statistical significance between earlobe crease and coronary heart disease than between coronary heart disease and other risk factors such as hypertension, diabetes and smoking. They concluded that the presence of the earlobe crease is suggestive of coronary heart disease.

Anderson, Christiansen, and Jensen (1976) studied 101 patients (45 women and 56 men) with diabetes mellitus and examined them for the presence or absence of the earlobe crease and/or diabetic retinopathy. None of the patients were below the age of 30. They noted that 51.4% of the patients with retinal angiopathy had the

diagonal earlobe crease. In comparison, only 7.6% of the patients with normal retinal vessels had the earlobe crease - a significant lower frequency (p<0.0005). They concluded that the diagonal earlobe crease is positively correlated to diabetic retinopathy.

Lichstein, Chapman, Gupta, Chadda, Smith, Schwartz, and Naik (1976) examined the earlobe crease and compared it to the degree of sclerosis and the degree of coronary artery occlusion noted at postmortem examination. A total of 113 patients, 40 years or older, were examined postmortem. The amount of sclerosis was graded from 0 to 4, with 0 being no occlusion, 1 was occlusion up to 25%, 2 indicated 50% occlusion, 3 was 75% occlusion, and 4 indicated 100% occlusion. Thirty-two patients had absent ear creases, 22 had unilateral ear crease, and 59 had bilateral ear creases. The mean sclerotic score was 7.60 ± 0.39 (SEM) for those with bilateral ear crease, 6.75 ± 0.64 (SEM) for those with unilateral ear crease, and 6.03 ± 0.53 (SEM) for those with no ear crease. When corrected for age, a statistically significant difference (p< 0.05) existed between the adjusted mean sclerotic scores of the no ear-crease group and the bilateral ear-crease group. There was no significant difference between the patients' sex and ear crease status (p<0.005).

They found the greatest degree of occlusion was those with bilateral ear crease (2.20 ± 0.32 SEM), less in those with unilateral ear crease (2.08 ± 0.53 SEM), and the lowest in those without the ear-crease (1.31 ± 0.44). They concluded that there is a statistically significant difference (p<0.001) in the amount of sclerosis of the coronary arteries in no earlobe crease group as compared to the bilateral earlobe crease group.

Frank (1977) noted that two men (ages 53 and 51 years) had classic angina, positive stress tests and the earlobe crease. Neither patient was hypertensive or

diabetic. Both had normal coronary angiograms. He suggested that this might represent cardiac small-vessel disease.

Moncada, Rutz, Rodriguez, and Leiva (1979) stated a possible association between earlobe crease and vascular disease. They studied 300 healthy individuals and recorded the presence or absence of diagonal earlobe crease, certain risk factors for vascular disease sought by fundoscopy, measurement of blood-pressure and fasting blood glucose, cholesterol, and triglycerides, and electrocardiography. The results suggested that people with high blood pressure, abnormal fundoscopic examination, or signs of ischemia on electrocardiogram are more likely to have the diagonal earlobe crease. They suggested that healthcare professionals screening the general population should look for the earlobe crease as a sign for vascular disease.

Wiedemann (1979) discussed that the diagonal earlobe crease, sometimes referred to as Frank's sign, is an acquired feature of the earlobe found in older age groups. He states that it is important to distinguish it from the congenital slit-like indentations of the earlobes (so called Kerbenohr) which are present at birth. These congenital, diagonal earlobe creases are a frequent and very characteristic symptom in Beckwith's syndrome or "electromyogram" syndrome, but they also exist, although rarely, in healthy children and adults.

Elliot (1983) examined 1,000 hospitalized patients for the presence or absence of the diagonal earlobe crease and then evaluated them for coronary artery disease. Two patients had severe coronary artery disease as proved by autopsy, 148 had coronary angiography showing greater than 75% luminal narrowing of at least one of the major coronary arteries, 226 had had myocardial infarction, six had a history of classic angina, four had other evidence of coronary artery disease (positive stress test, cardiac catheterization for which results were not available). There was noted to be an increased frequency of the earlobe crease with increasing age (chi-square 274,

p<0.00001). When the data of the earlobe crease was subdivided according to sex and race, it suggested that the earlobe crease is more frequently seen in white males (p<0.001 for sex, p<0.05 for race). He noted that the conclusion is probably not tenable because of the excessive number of young black women in the study population. When those were removed from the analysis, the p values decreased to <0.02 and 0.05 for sex and race respectively. The occurrence of coronary artery disease and the earlobe crease in all 1,000 patients was 331 (p<0.00001). Earlobe crease and age were analyzed and showed an association between coronary artery disease and the earlobe crease.

There was also 205 patients of the same study population who underwent coronary angiography and who were analyzed separately. Coronary artery disease and the earlobe crease were seen together in 121 patients and 39 patients had neither. Eighteen had an earlobe crease but no detectable coronary artery disease; 27 had coronary artery disease but no earlobe crease. The chi-square value for this analysis was 47 (p<0.00001), again signifying a relationship between the earlobe crease and coronary artery disease.

Elliot concluded that the data would suggest the earlobe crease is a strong risk factor for coronary artery disease in a general medical population, and a stronger prognostic factor in patients undergoing cardiac catheterization. It should be considered a risk factor or physical marker, rather than a diagnostic test because of the sensitivity factor of only 60% and selectivity of 65%. Therefore, the patient with the earlobe crease is at risk for the diagnosis of coronary artery disease but does not necessarily *have* coronary artery disease.

Ishii, Asuwa, Masuda, Ishikawa, Shimada, and Takemoto (1990) examined the association between earlobe creases and coronary and aortic atherosclerosis in 100 autopsied men ranging in age 50-79 years. They had died of vascular diseases or

related conditions and were studied in conjunction with blood pressure and serum cholesterol levels. Multivariate regression analyses demonstrated that the degree of earlobe crease was dependent on the extent of coronary and aortic atherosclerosis, but was independent of age. The degree of aortic atherosclerosis was dependent not only on the appearance of the earlobe crease and cholesterol level, but on age. The authors concluded that the earlobe crease provides a significant external marker for atherosclerosis and may reflect risk factors, such as cholesterol. They also concluded that an association between earlobe crease and atherosclerosis may exist in all ethnic groups, including Orientals.

Tranchesi, Barbosa, Albuquerque, Caramelli, Gebara, dos Santos Filho, Nakano, Bellotti, and Pileggi (1992) examined the diagonal earlobe crease as a marker of the presence and extent of coronary atherosclerosis. They examined 1,424 patients (760 men, 664 women, aged 30-80 years) for the presence of earlobe crease. The patients were then divided into two groups: group I control- 1,086 consecutive patients who denied symptoms of myocardial ischemia and were admitted to a general hospital for other reasons; group II coronary artery disease- 338 patients with documented coronary artery disease (presence of >70% documented coronary artery stenosis).

Earlobe crease was present in 304 patients (28%) in group I and 220 (65%) in group II ($p<0.0001$). The groups were stratified in age groups to isolate the influence of age because the incidence of earlobe creases increased with age ($p<0.0001$ for both groups). The association remained statistically significant in all decades, except for patients aged >70 years ($p=0.070$). A direct adjustment of the earlobe crease was performed to remove the confounding effect of different age and sex distributions between the groups. When adjusted for age and sex, the prevalence of earlobe creases was still 58% higher in patients with coronary artery disease than in the control group

(p<0.001). The presence of the earlobe crease was also related to the severity of the coronary luminal narrowing (p=0.015). The sensitivity of the sign observed for the diagnosis of coronary artery disease was 65%, the specificity 72%, the positive predictive value 42%, and the negative predictive value 87%.

Elliott and Karrison (1991) performed a prospective, observational study on 108 patients in four cohorts (each matched for age, sex, and race, but differing in the presence or absence of both a diagonal earlobe crease and coronary artery disease). Their results suggest that a diagonal earlobe crease is associated with increased all-cause and cardiac morbidity and mortality. They suggest that those patients with earlobe creases may be at higher risk for coronary events, and might need to be cautioned to control risk factors.

Schneiderman (1993) discussed that the earlobe crease is semiotic. He points out that the point is controversial as whether or not to use this sign as a predictor of coronary disease. The earlobe crease is a sign indicating increased prevalence, rather than mechanism, which may be applied to populations but not to individuals. He states that there has not been an ideal study done to test the association and hopes that future investigations will settle the issue.

Mehta and Hamby (1974) describe their research on 211 patients admitted for coronary angiography. All the patients were examined for the presence or absence of the diagonal earlobe crease. It was noted that 159 patients had coronary artery disease, of whom 89 had a diagonal earlobe crease. Fifty-two patients had normal coronary arteries, yet 26 had the earlobe crease. They found an increasing incidence of earlobe creases with increasing chronological age. The earlobe crease was present in 65% of the patients over 55 and in 34% of the patients under age 55. They concluded that the earlobe crease is not related to coronary artery disease but does increase with age.

Gral and Thornburg (1983) examined 244 residents (220 male, 14 female) of a nursing home and a hospital based home care program. The residents ranged from 24-99 years old (mean 66) and all were examined for the presence or absence of earlobe creases and their correlation with cardiovascular disease. Either unilateral or bilateral earlobe creases were found in 119 residents (55 unilateral, 64 bilateral), or 50.85%. One hundred forty-two residents had one or more forms of cardiovascular disease, 12 had peripheral vascular disease, 20 had coronary artery disease, 45 had cerebrovascular disease, 48 had atherosclerotic heart disease and/or hypertension, and 17 had "other" cardiovascular diseases (mostly congestive heart failure). Seventy-three of them (51.4%) had earlobe crease(s). The incidence of the earlobe crease was 50% among the rest of the 92 residents, whom had no apparent cardiovascular disease. The authors concluded that earlobe creases might be more significant in the diagnosis of coronary artery disease in a younger patient population. They also state that the earlobe creases may occur as part of the skin aging process.

Brady, Zive, Goldberg, Gore, and Dalen (1987) did a prospective study of 261 consecutive men undergoing coronary arteriography and evaluated the association of earlobe creases with the presence and extent of coronary artery disease. An earlobe crease was detected in 67% of their population. The presence of coronary artery disease in men with (n=175) an earlobe crease was 85% and those without (n=86) an earlobe crease was also 85%. They also examined the age-specific prevalence rates of coronary artery disease in men with and without the earlobe crease and found no significant differences in those rates. They concluded that the reported association between earlobe crease and coronary artery disease is related to the increased prevalence of earlobe creases and coronary artery disease with age.

It was originally mentioned by Dr. Frank (1973) that there might be an association between the earlobe crease and coronary artery disease. Since that time,

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several researchers have explored this possible relationship. Some researchers, such as Doering, et al. (1977) and Blythe (1985) suggest that the earlobe crease is only associated to heart disease because of the vascular changes which occur during the aging process. Other authors, such as Elliot (1983), suggested that the earlobe crease was a strong risk factor for coronary artery disease.

Although several theories have been linked to earlobe creases and heart disease, no one theory proves the relationship. This research will examine that possible relationship between earlobe creases and the incidence of coronary artery disease in those patients who have had a cardiac catheterization within the last six months.

Purpose

The purpose of this study is to examine the relationship between the diagonal earlobe crease and the incidence of coronary artery disease.

Operational Definitions

Coronary artery disease- coronary artery luminal narrowing of at least 50% in one major epicardial coronary artery as documented on coronary angiography.

Coronary angiography- 1. radiography of vessels after the injection of a radiopaque material. 2. description of the blood vessels or lymphatics (Stedman's, 1976).

Diagonal earlobe crease-crease which runs from the lower pole of the external meatus, diagonally backwards to the edge of the lobe at approximately 45 degrees, either unilateral or bilateral (Kirkham, et al., 1989).

Unilateral earlobe crease- Diagonal earlobe crease present in only one ear.

Bilateral earlobe crease- Diagonal earlobe crease present in both earlobes.

Adult patient- 50-90 year old patient who had a cardiac catheterization within the last six months.

Chapter 3

METHODOLOGY

This chapter discusses the design approach which was utilized and the setting in which the research took place. In addition, the sample subjects, the sampling method, how the protection of human subjects was maintained, and the data collection procedures will be covered.

Design and Setting

A descriptive and correlational approach was used in this study. The sample body consisted of 61 subjects, either with or without coronary artery disease as documented by coronary angiography, who had been admitted to a 140-bed teaching hospital in a metropolitan area in Southeastern Florida for coronary angiography.

Sample and Sampling Method

The subjects for this research was a convenience sample of patients who were admitted for coronary angiography, with documented coronary artery disease or those without any known coronary artery disease. Coronary artery disease, as defined in this dataset, was the coronary artery luminal narrowing of at least 50% as documented on coronary angiography in one major epicardial coronary artery.

The criteria for inclusion for this study were as follows: adult subjects ages 50-90 years, either with or without coronary artery disease as documented by cardiac catheterization performed within the last six months at the Southeastern Florida hospital. These subjects had to be able to read, write, speak, and understand English. Exclusion from the study was as follows: 1) subjects who were younger than 50 years or older than 90 years; 2) subjects who were not stable enough to have a full physical examination or cardiac catheterization; 3) subjects who preferred not to participate in the study.

Potential subjects were identified with the assistance of the cardiologist and the cardiac catheterization laboratory staff from a list of the patients who had a cardiac catheterization within the last six months. The principal investigator reviewed each patient's medical record to determine if the patient met the study criteria. Those subjects who met the criteria were approached either by telephone, or in their hospital room by the principal investigator who introduced herself by name and position, explained the purpose of the study, and invited the subject to participate in the study.

Protection of Human Subjects

The proposed research had been reviewed and accepted by both the University Research Council at Florida International University and the Research Committee at the Southeastern Florida hospital.

All subjects read and signed an informed consent form prior to the study (Appendix B). The consent form listed exactly what was expected of the participants. The names of the subjects were known only to the principal investigator. Verbal and written information and introductions indicated: 1) all the data was handled only by the principal investigator, the faculty supervisor, and the statistician; 2) all the subjects were identified by their medical record number and subsequent data analysis was performed using this medical record number only; 3) findings were reported in terms of grouped data only.

The participants were assured that their decision to participate or not participate in no way affected their health care. Participants were informed in writing of the right to withdraw from the study at any time. There were no foreseeable risks to subjects who participated in this study.

The subjects were told they could obtain the results of the study once the project was completed, by contacting the principle investigator.

Data Collection Procedures

Each subject who expressed interest in participating in the study was given a consent form which described the study. The principle investigator allowed time for the client to read the consent and answered any questions. Those subjects who agreed to participate, then signed the consent form. The following information was obtained by the investigator on all subjects by reviewing each medical record: age, sex, ethnic origin, previously known coronary artery disease risk factors, degree of coronary artery occlusion as determined by coronary angiography, total blood cholesterol. They were then examined in the seated position for the presence/absence of diagonal earlobe crease(s).

Analysis of the Data

The data was analyzed utilizing the following methods: frequency, standard deviation, Fisher's exact test, determination of sensitivity and specificity utilizing the Instat program, regression analysis, multiple logistic regression, and linear regression analysis. Frequency was used to organize the data so that general trends could be observed and the mean was used to determine the central tendency. Standard deviation provides the degree of variability. The Fisher's exact test was selected because it is used when the total N is less than 30 or when there are cells with a value of 0. The Fisher's exact test is a statistical procedure used to test the significance of the difference in proportions, used when the sample size is small or cells in the contingency table have no observations (Polit & Hungler, 1995).

Sensitivity and specificity was determined to show if this sign truly predicts the disease of the person. Sensitivity is defined as the proportion of those who truly have the characteristic that are correctly classified as having it by the measurement technique. Specificity is defined as the proportion of those who truly do not have the characteristic that are correctly classified as not having it by the measurement technique (Kelsey, Thompson, and Evans, 1986).

Regression analysis and multiple logistic regression analysis was used to compare the dependent (CAD and earlobe crease) and independent (age, sex, cholesterol, and race) variables. Regression is a statistical procedure for predicting values of a dependent variable based on the values of one or more independent variables. Multiple logistic regression analysis uses maximum likelihood estimation for analyzing relationships between dependent variables and categorical dependent variables. Linear regression was utilized to correlate between two variables, to try to determine the accuracy of the sign when more than one variable is included (Polit and Hungler, 1995).

Chapter 4

Data Analysis

The data collected to examine the research questions and hypotheses are discussed in this chapter. Each research question will be considered individually. Descriptive data including frequencies, means, standard deviations, multiple regression, and statistical significance (P values) are reported. Tables summarizing the data are presented.

Sample Characteristics.

The convenience sample consisted of 61 subjects (26 females/35 males) from a Southeastern Florida hospital, all having cardiac catheterization within the last 6 months at the time of the study (Table 1).

Table 1: Frequency Distribution of Sample by Gender
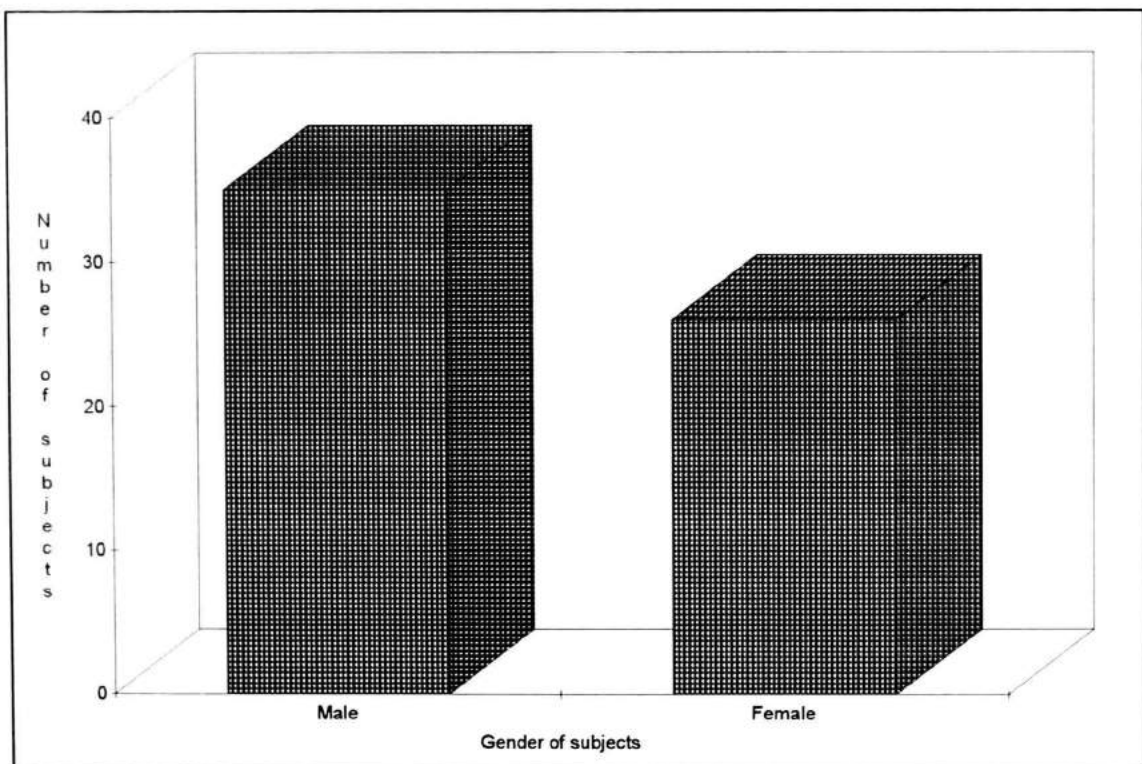
The mean age of the 61 subjects was 70.3 $\pm$ 8.7, with a range of 50-87 (see Table 2). The mean age of females was 71.4 $\pm$ 9.5 with a range of 50-87. The mean age of males is 69.2 $\pm$ 7.8, with a range of 50-87. Unpaired t-test, the mean difference was - 1.3, P value 0.48. There was no statistical difference in the age of male and female subjects.

Table 2: Frequency Distribution of Ages of Subjects
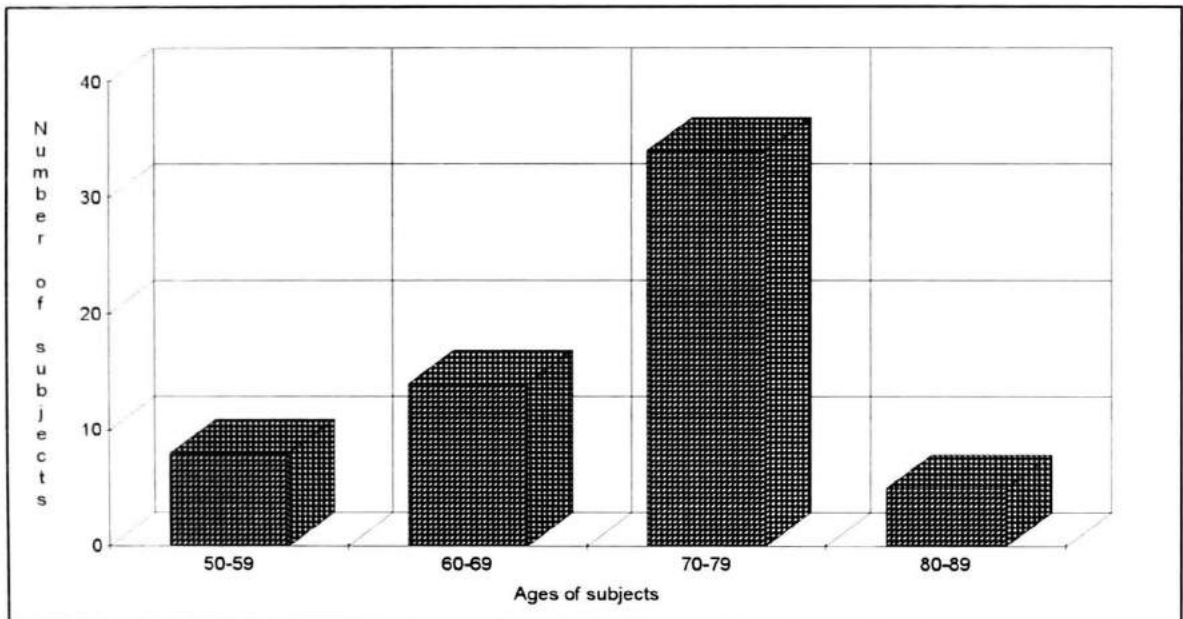
The subjects were all White, except for one African-American female. Mean cholesterol of all the subjects was 199.68 (SD $\pm$ 51.82) (see Table 3).

Table 3: Frequency Distribution of Subjects Serum Cholesterol Levels
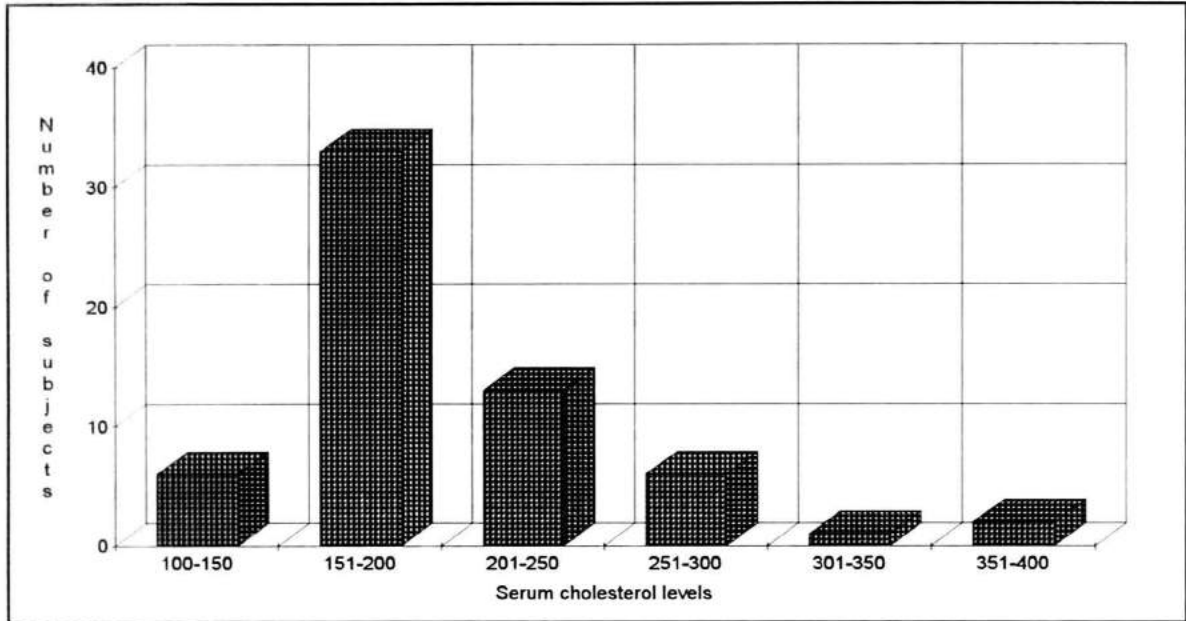
Research Questions:

1. What is the difference in the percentage of coronary artery occlusion between those adult patients who present with bilateral earlobe crease as compared to those who have unilateral earlobe creases?

To address this question, the Fisher's exact test was utilized to analyze the data. There was a significant association between presence of earlobe creases and presence of coronary artery disease with a two-sided P value <0.025 (see Table 4), odds ratio of 10.000, 95% confidence interval (1.579 to 63.345) using the approximation of Woolf. There is a strong association between earlobe creases and coronary artery disease based on this statistical analysis. However, there was only one subject who presented with only unilateral earlobe crease and had a normal heart catheterization.

To explore the contributions of the various variables to the presence or absence of CAD by angiography, regression analysis was done to "adjust" for the presence of each of the other variables. Both multiple logistic regression analysis and linear regression analysis were applied. The results of the multiple logistic regression showed that earlobe creases were independent of age (see Table 4). Cholesterol added nothing, whether factored in with or without gender or age.

Table 4. Logistic regression (logit) analysis for the presence of coronary artery disease in comparison with the four covariates.

N=61	Age	Gender	Cholesterol	ELC
Estimate	0.0777133	44.265	0.0157926	31.69465

Dependent variable: CAD 50%, N with >50% CAD=52, N with <50% CAD=9

Final loss: 4.76947434   R= .61509   Variance explained: .37834%

2. To what extent is coronary artery disease present in those adult subjects who have diagonal earlobe crease?

The presence or absence of the earlobe crease in relation to the degree of coronary occlusion was also examined (see Table 5 and 6). Those subjects with a higher degree of coronary occlusion had a significantly higher percentage of having the earlobe crease.

Table 5. Incidence of CAD and Earlobe crease using Fisher's Exact Test.

	With Earlobe Crease	Without Earlobe Crease	Total
Without CAD	5	3	8
	(8%)	(5%)	(13%)
With CAD	50	3	53
	(82%)	(5%)	(87%)
Total	55	6	61
	(90%)	(10%)	(100%)

Note: p<0.0254

Table 6. Degree of CAD with relation to Presence/Absence of ELC.

	<50%	50-74%	>75%
Earlobe Crease Present	8	5	42
Earlobe Crease Absent	3	0	3

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Forty-five (68.9%) subjects had occlusion greater than 75% (see Table 7).

Table 7: Frequency Distribution of Degree of Coronary Occlusion
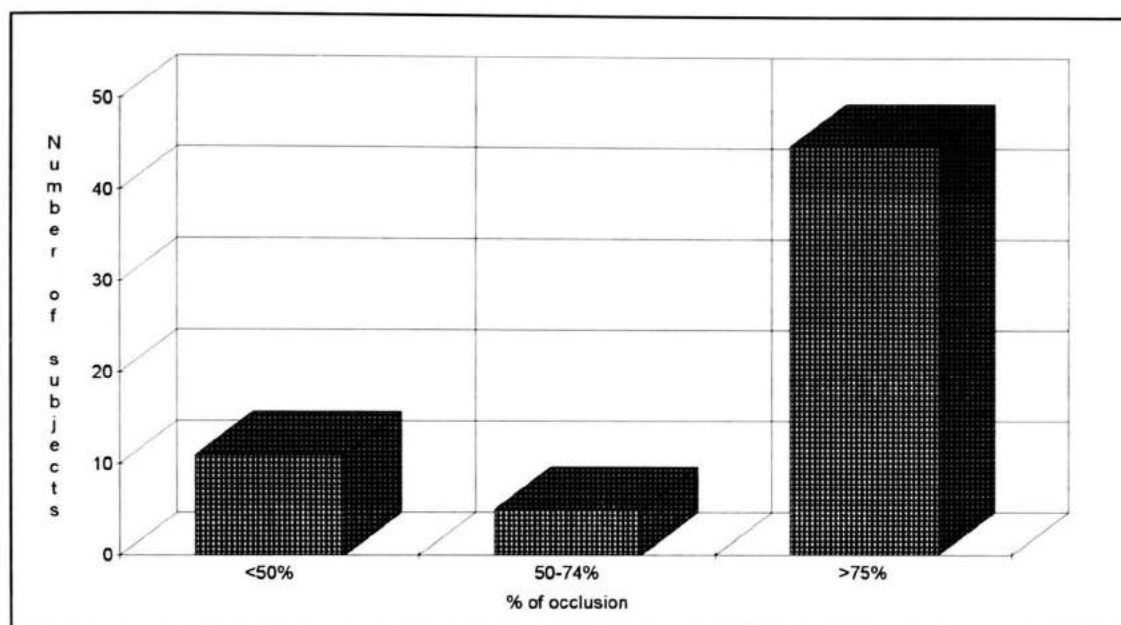
Note: p < 0.10

Linear regression analysis showed gender to be the most predictive for the presence of coronary artery disease (used as a categorical variable: present if one artery demonstrated ≥ 50% luminal narrowing) of the four covariates (including age, cholesterol, and ELC status), with a beta of 0.365, P< 0.006 (see Table 8). Earlobe status was the second most powerful predictor of CAD status, with a beta of 0.287, P=0.019 (see Table 9). Neither age (β=0.100, P=0.40) nor cholesterol (β=0.182, P=0.16) were significant predictors of CAD status in this dataset.

Table 8. Linear regression analysis for the presence of coronary artery disease in comparison with the four covariates.

Variable	Beta In	Partial Cor.	Semipartial Cor.	Tolerance	R-square	t (57)	p-level
Age	0.1008741	0.111514	0.0987089	0.9575311	0.0424689	0.840494	0.4041458
Gender	0.3648981	0.3557312	0.3345159	0.8404082	0.15955919	2.849365	0.0061024
Cholesterol	0.1824697	0.1865169	0.1668485	0.8351091	0.1638909	1.429595	0.1608557
ELC	0.28735	0.3075368	0.2840449	0.9771281	0.0228718	2.41851	0.0187964

3. What is the incidence of diagonal earlobe creases in those adult subjects from different ethnic origins with documented coronary artery disease?

This question could not be answered because in this dataset, there was only one subject who was from a different ethnic origin other than White, and that was a female who was of African-American origin.

Summary:

The statistical analysis indicates that in this dataset, earlobe creases were a significant predictor and correlate of the presence of coronary artery disease as documented by cardiac catheterization, and that this association was independent of the effect of age or serum cholesterol. The sensitivity of this study was analyzed to be 94.3%. However, the specificity was only 62.5% (true positive 50 subjects, false positive 5, false negative 3, and true negative 3) (see Table 9), reflecting the low number of negative heart catheterizations.

Table 9. Disease state of CAD.

Test Result of Earlobe Crease	CAD Present	CAD Absent
Positive	A (True Positive)	B (False Positive)
	50	5
Negative	C (False Negative)	D (True Negative)
	3	3

It must be noted that all participants had some percentage of coronary artery occlusion.

CHAPTER 5

DISCUSSION OF THE FINDINGS, CONCLUSIONS, IMPLICATIONS, LIMITATIONS, AND RECOMMENDATIONS

In this study, the first question in regards to the difference between unilateral or bilateral earlobe creases with coronary artery disease. There was only one patient who presented with unilateral earlobe crease, noted to be in the right ear, and who had normal coronary arteries. It is suggested by Elliott (1993) that the earlobe crease forms in the right ear first, which may be the case in this patient. All the other patients had bilateral earlobe creases.

One of the most interesting findings of this study was that gender was the most predictive for coronary artery disease of the four covariables (including age, cholesterol, and ELC status). This finding is consistent with the findings of Kristensen (1980), Pasternac and Sami (1982), Wagner et al.(1984), and Fisher and Sievers (1980), who found that the diagonal earlobe crease was more prevalent in males than females. It has been suggested before that coronary artery disease is correlated with gender. But from the results of this study and of those previously cited, a possible correlation between coronary artery disease and earlobe crease may exist.

Traditional diagnosis of coronary artery disease often requires sophisticated testing which increases the costs incurred in medicine. In this dataset, the presence of the earlobe crease was the second most powerful predictor of CAD status. This by no means gives a direct cause and effect, but rather serves as an additional physical finding which the nurse practitioner and physician can utilize in the diagnosis of coronary artery disease.

Many studies, such as Brady et al. (1987), and Cheng (1992), have criticized many reports on coronary disease associated with earlobe creases, stating that they

may simply be a marker for age. Although it is a well documented fact that age is an important predictor for morbidity and mortality, these results show that the earlobe crease was independent of age, whether or not gender was included in the analysis.

When examining the association of earlobe crease in subjects of different ethnic origins and CAD, all of the patients in this dataset were white, except for one subject who was black. This may be due to the low percentage of African American patients seen at the Southeastern Florida hospital and the actual demographics of the hospital. This research question could not be answered by this study.

In view of the rising cost of healthcare and the need to reduce that cost for the patient and the healthcare provider, the use of the earlobe crease may be viewed as an additional physical finding for the detection of possible coronary artery disease. It is recommended that once the earlobe crease is observed, risk factor identification and aggressive modification should be implemented. Cardiac risk factors need to be reviewed with the patient and the family, including informing them of the simple identification of the earlobe crease. This simple identification of the earlobe crease to the general public could enhance the awareness of possible coronary artery disease. This increased awareness will hopefully get those patients who otherwise would not have sought medical care and education to have a full physical examination, coronary artery disease risk factor identification and modification.

Limitations

The limitations of this study include: 1) the number of patients was small, limiting statistical power; 2) very few patients did not have coronary artery disease (<75% occlusion) by catheterization; 3) a small number of patients did not have earlobe creases, thus limiting the specificity of this finding; 4) other traditional coronary risk factors (including hypertension, diabetes, obesity, etc) were not entered into the regression equations; 5) because the subjects in this study were a limited,

convenience sample, the study cannot be generalized to other groups; 6) there were time constraints which needed to be observed; 7) the lack of a culturally diverse study population, and 8) although the analysis showed a possible correlation between earlobe creases and coronary artery disease, it cannot be concluded that all patients with earlobe creases have coronary artery disease. This is related to the limited number of negative heart catheterizations in this dataset.

Recommendations

Recommendations for further studies include doing a prospective, randomized study with a larger population, with greater ethnic diversity represented, looking at the incidence of earlobe crease in patients undergoing cardiac catheterization. It would be interesting to look at those patients who must have a cardiac catheterization routinely before a major procedure is done (ie., organ transplant, vascular surgery) and who present without any cardiac risk factors. It might also prove to be helpful to do a longitudinal study of patients with a positive family history and follow them until the 3rd quartile of life for the detection of earlobe creases. Another recommendation would be to look at the tropical areas of the world to see if the long term effects of sun exposure has any influence on the development of the earlobe crease.

To truly determine a relationship between earlobe creases and coronary artery disease, one needs to look at all of the findings which have been suggested to date which might correlate with CAD (height, obesity, male-patterned baldness, ear-canal hair, arcus senilis, ApoA-1, atherosclerotic C3-F gene, chromosome 11, sleep apnea, alcohol use, stress) and all the risk factors which are known to contribute to CAD (age, sex, race, cholesterol level, cigarette smoking, diabetes, hypertension, family history). If this actually could be set up, the possibility of measuring all these variables on every patient would be very difficult at best and extremely costly. The control group would need to be free of any of the above possible findings. Another study

might look at both parents to see the incidence of heart disease and earlobe creases and its potential effect on the patient.

In conclusion, heart disease is rising every year as determined by the American Heart Association (1994). In view of rising health care costs, more cost effective measures must be utilized to assist in the diagnosis of coronary artery disease. If the diagonal earlobe crease can be shown to be a predictive sign of heart disease, it can then be used as an additional physical finding in the assessment of patients.

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Appendix A

Diagonal earlobe crease.

Appendix B

INFORMED CONSENT
Diagonal Earlobe Creases and Coronary Artery Disease

You are invited to participate in the research study as described below.

A descriptive, correlational, retrospective, and concurrent approach will be utilized in examining the possible relationship between diagonal earlobe creases and coronary artery disease.

PURPOSE OF THE RESEARCH AND BACKGROUND INFORMATION

Cardiovascular disease (hypertension, coronary artery disease, stroke, and rheumatic heart disease) ranks as America's number one killer according to the National Center for Health Statistics and the American Heart Association. Coronary artery disease and the associated risk factors have eluded health care professionals, anthropologists, and epidemiologists for decades. It was not until 1973 when physical findings were linked to coronary artery disease-the first being the diagonal earlobe crease. Since the diagonal earlobe crease was first introduced as being a possible associated physical finding, multiple studies have been done to substantiate this finding.

The purpose of this study is to examine the relationship between the diagonal earlobe crease and the incidence of coronary artery disease.

A total of at least 60 post-cardiac catheterization patients from the Cleveland Clinic Hospital will utilized in this study. All the patients will have had a cardiac catheterization within the last six months.

If you agree to participate in this research study, the following procedures will be followed:

* You will be asked to read and sign this consent form after all of your questions have been answered.

* You will be placed into one of two groups listed above-depending upon the results of your cardiac catheterization.

* Your earlobes will be examined for the presence or absence of the diagonal earlobe crease-it will be noted if the crease occurs in one or both of your earlobes.

* Your total blood cholesterol will be noted from your admission blood work.

RISKS:

* There are no risks to you in having your earlobes examined.

BENEFITS:

* The potential benefit of participation in this study is assisting to add to the research in regards to coronary artery disease, and gaining knowledge about coronary artery disease. The knowledge gained from your participation may help others.

ALTERNATIVES:

* This study is for data-collection only. If you choose not to participate in this study, you will still receive the highest standard of care practiced in this hospital.

CONFIDENTIALITY:

* Confidentiality of your records will be maintained; however, the Food and Drug Administration, the thesis committee members (Dr. Kathleen Blais-FIU (Florida International Univeristy)-Nursing, Dr. Howard Bush, MD-Cleveland Clinic Florida, and Dr. Divina Grossman-FIU-Nursing), and the Institutional Review Boards for both Cleveland Clinic Florida and FIU may review your medical records in order to accurately review and report information for this study.

COST/COMPENSATION:

* You will not be compensated for participation in this study.

RESEARCH-RELATED INJURIES:

* If physical injury occurs due to involvement in research, medical treatment is available, but you or your insurance company must pay the cost of treatment. Compensation for lost wages, direct or indirect losses is not available from the Cleveland Clinic Florida. Further information about compensation is available from the Cleveland Clinic Florida's Office of the Institutional Review Board (305) 978-5763.

QUESTIONS ABOUT RESEARCH:

* If you have any questions about the research or develop a research-related problem, you should first contact Sandy Vollmer, RN at: (305) 568-7520 (work), or (305) 631-4941 (beeper). During non-business hours you should contact Dr. Howard Bush at (305) 978-5000. If you have any questions about your right as a research-related subject, you should contact the Cleveland Clinic Florida's Office of the Institutional Review Board (305) 978-5763.

VOLUNTARY PARTICIPATION:

* Your participation in this study is voluntary. Your refusal to participate will not prejudice your future treatment or benefits here at the Cleveland Clinic Hospital. You are free to discontinue participation in the study at any time without fear of penalty or loss of medical care.

Your signature below indicates that you agree to participate in this study. You will be given a copy of this signed consent form.

_____   _____
Subject Signature   Date   Time

_____   _____
Signature of Investigator   Date   Time

_____   _____
Witness   Date   Time