

# Carpal Tunnel Syndrome in Women Undergoing Reduction Mammoplasty

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Women with mammary hypertrophy who present for reduction mammoplasty have several well-described musculoskeletal complaints, but a high prevalence of carpal tunnel syndrome has not been reported. We identified 151 patients from a plastic surgery practice who underwent reduction mammoplasty from 1994 to 1996. To this group we added a convenience sample of 64 women volunteers with relatively smaller breasts (brassiere cup size B or smaller). We questioned the entire group about specific symptoms and examined them using standard provocative tests. Carpal tunnel syndrome was defined as the coexistence of symptoms and at least two physical examination findings. We examined its association with breast size, age, race, and body mass index. Stepwise logistic regression was used to determine which physical characteristics were predictive of the condition. Carpal tunnel syndrome was found in 30 patients (19.9 percent) (95 percent confidence interval, 13.8 to 27.1) and in none of the women in the convenience sample. Breast size and, to a lesser degree, body mass index were found to be highly significant predictors of carpal tunnel syndrome. After controlling for breast size, race was also significant. Breast size displayed an independent risk ratio of 6.67 when comparing the upper quartile of size to the lower quartiles. There is a markedly higher prevalence of carpal tunnel syndrome in women who present for reduction mammoplasty than in those with smaller breasts. Breast size was a significant predictor of carpal tunnel syndrome. (*Plast. Reconstr. Surg.* 105: 1314, 2000.)

Women with mammary hypertrophy have several well-described musculoskeletal complaints, including back pain, shoulder grooving from bra straps, headache, and neck pain.<sup>1-7</sup> Little has been reported on upper-extremity neurologic symptoms caused by excessive breast size: two articles reported ulnar nerve paresthesias in approximately 15 percent of their patients and one group reported symptoms of hand numbness or pain in 22.6 per-

cent of their patients.<sup>8-10</sup> It has been our experience that upper-extremity neurologic symptoms in women with mammary hypertrophy occur much more frequently than reported. The distribution of symptoms is mostly along the median nerve, as in carpal tunnel syndrome.

## METHODS

All women who presented to a solo plastic surgery practice in Tuscaloosa County, Alabama, for reduction mammoplasty from January of 1994 to June of 1996 were evaluated for inclusion in the study. The racial composition of the patient group was compared with the demographic composition of Tuscaloosa County as reported in 1997 data from the U.S. Bureau of the Census. Of the 169 women who presented for reduction mammoplasty, two were excluded for having undergone previous shoulder surgery involving the brachial plexus. Three women were excluded for having significant osteoarthritis in the cervical spine or wrists, which precluded their undergoing provocative testing for carpal tunnel syndrome. In addition, 13 women were excluded because of either incomplete testing or incomplete historical data.

Physical characteristics were determined, including age, race, body mass index, and breast size. Body mass index was calculated as the weight in kilograms divided by the square of the height in meters. Breast size was measured in centimeters from sternal notch to each nipple, with the patient sitting and unclothed; the average of both breasts was used in our analy-

ses. The mean and range for age, breast size, and body mass index were calculated.

The 151 patients enrolled in the study were interviewed for symptoms of carpal tunnel syndrome and were administered Tinel, Phalen, and Reverse-Phalen tests during their physical examination. The interview and examination occurred before they underwent reduction mammoplasty. Positive symptoms were defined as pain, weakness, numbness, tingling, or burning along the radial palm or the first three fingers. In the Tinel test, the examiner tapped over the carpal tunnel at the wrist. In the Phalen test, the subject held her wrists maximally flexed for 60 seconds, and in the Reverse-Phalen test, the wrists were held maximally extended for 60 seconds. A positive result was recorded if there was any tingling or paresthesia in the radial palm or in the first three fingers. We designated those women who had both symptoms and at least two positive physical examination findings as having carpal tunnel syndrome. The prevalence was determined for each physical characteristic (breast size, body mass index, age, and race). Confidence intervals were determined using a standard statistical formula.<sup>11</sup>

A convenience sample of women volunteers with brassiere cup size B or smaller was drawn from the staffs of several hospitals in the Tuscaloosa area. The volunteers were not randomly selected. The same physical characteristics were determined as for the patient group. The volunteers were interviewed for symptoms of carpal tunnel syndrome and were tested in the same manner as the patients. The same interviewers were used as for the patient group. None of the volunteers had a history of either shoulder surgery or osteoarthritis. Carpal tunnel syndrome was defined in the same way as for the patients.

Because the volunteers were not randomly selected and because the patient and volunteer groups differed significantly, direct comparisons could not be made. Instead, a combined group of both the relatively large-breasted patients and relatively small-breasted volunteers was used to test the association of carpal tunnel syndrome with the various physical characteristics. Body mass index was categorized into normal (less than 25.0 kg/m<sup>2</sup>), overweight (25.0 kg/m<sup>2</sup> to 29.9 kg/m<sup>2</sup>), and obese (greater than 30.0 kg/m<sup>2</sup>), according to the 1998 National Heart, Lung, and Blood Institute criteria.<sup>12</sup> Breast size was divided into the quartiles

observed in the study (less than 23.0 cm, 23.1 cm to 30.0 cm, 30.1 cm to 35.0 cm, and greater than 35.0 cm). Age was treated as a continuous variable. Logistic regression analysis was used in a stepwise fashion to determine predictors of carpal tunnel syndrome. The statistical package used was Statistical Package for the Social Sciences (release 4.1 for IBM VM/CMS).

## RESULTS

The characteristics of the patient and volunteer groups are listed in Table I. The patient ages ranged from 13 to 64 years, with a mean of 32.8 years. Almost all patients were either Caucasian (89 patients, 58.9 percent) or African-American (61 patients, 40.4 percent). One patient was Hispanic. There was a higher proportion of Caucasians in the volunteer sample. Tuscaloosa County is mostly urban (71 percent) and contains a population of approximately 160,760, with 71 percent Caucasian, 28 percent African-American, and 1 percent other.<sup>13</sup> This racial composition is similar to that of our patient group, although African-Americans were somewhat overrepresented.

Body mass index in the patients ranged from 20.8 kg/m<sup>2</sup> to 54.2 kg/m<sup>2</sup>, with a mean of 33.5 kg/m<sup>2</sup>. The average of breast sizes in individual patients ranged from 24.8 cm to 47.5 cm, with a mean of 34.1 cm. These characteristics are similar to those of patients in other series of women undergoing reduction mammoplasty.<sup>9,10,14,15</sup>

The distribution of carpal tunnel symptoms and physical examination findings among patients and volunteers is listed in Table II. Of the 151 women who presented for reduction mammoplasty, neurologic symptoms of carpal tunnel syndrome were reported by 129 (85.4

TABLE I  
Characteristics of Patients and Volunteers

	Patients (n = 151)	Volunteers (n = 64)
Race		
Caucasian	89 (58.9%)	56 (87.5%)
African-American	61 (40.4%)	8 (12.5%)
Other	1	0
Age (years)		
Mean ± SD	32.8 ± 11.2	39.1 ± 12.3
Range	13-64	15-60
Breast size (cm)		
Mean ± SD	34.1 ± 5.0	20.4 ± 2.4
Range	24.8-47.5	14.0-24.5
Body mass index (kg/m <sup>2</sup> )		
Mean ± SD	33.5 ± 7.0	24.4 ± 3.9
Range	20.8-54.2	17.7-33.7

TABLE II

Distribution of Patients and Volunteers with Combinations of Carpal Tunnel Symptoms and Physical Examination Findings

	Patients ( <i>n</i> = 151)	Volunteers ( <i>n</i> = 64)
Carpal tunnel symptoms	129 (85.4%)	3 (4.7%)
At least two physical examination findings	32 (21.2%)	2 (3.1%)
At least two physical examination findings and symptoms for carpal tunnel syndrome	30 (19.9%)	0 (0.0%)
Symptoms and no physical examination findings	25 (16.6%)	2 (3.1%)
At least two physical examination findings and no symptoms	2 (1.3%)	9 (14.1%)

percent). Three had symptoms that were not in the distribution of the median nerve. Three women in the volunteer group (4.7 percent) reported neurologic symptoms of carpal tunnel syndrome. Eight of the volunteers had symptoms that were not in the distribution of the median nerve. Two patients and nine volunteers who had two or more physical examination findings of carpal tunnel syndrome did not have related symptoms. There were 30 patients (19.9 percent, 95 percent confidence intervals, 13.8 to 27.1 percent) who met our criteria for carpal tunnel syndrome: two or more positive physical examination findings in addition to neurologic symptoms along the distribution of the median nerve. None of the volunteers met the criteria.

Table III lists the prevalence of carpal tunnel syndrome according to age, race, body mass index, and breast size in the combined group of patients and volunteers. Body mass index and breast size were characteristics significantly associated with carpal tunnel syndrome ( $p = 0.015$  and  $p < 0.001$ , respectively). The mean age of those without carpal tunnel syndrome

was 34.4 years, compared with 36.5 years for those with carpal tunnel syndrome ( $p = 0.37$ ). The difference in prevalence between the races was not significant ( $p = 0.56$ ). In a multivariate analysis adjusting for age, race, body mass index, and breast size of the combined patient and volunteer groups, only breast size and race were significant predictors of carpal tunnel syndrome ( $p = 0.003$  and  $p = 0.04$ , respectively). The adjusted risk ratio for the highest quartile of breast size compared with the lower two quartiles was 8.43 (the lower two quartiles of breast size were combined because there were no cases of carpal tunnel syndrome in the lowest quartile). The adjusted risk ratio for the highest quartile of breast size compared with the third quartile was 6.33. Caucasians compared with African-Americans had an adjusted risk ratio of 2.92. Breast size displayed an independent risk ratio of 6.67 when comparing the upper quartile of size to the combined two lower quartiles.

A forward stepwise logistic analysis was performed to investigate the best predictors for carpal tunnel syndrome. Only breast size ( $p <$

TABLE III

Prevalence of Carpal Tunnel Syndrome According to Various Patient Characteristics

	Total	Carpal Tunnel Syndrome*	Percent	95% Confidence Intervals (%)	
				Lower	Upper
Patients	151	30	19.9	13.8	27.1
Controls	64	0	0	0	0
Race					
Caucasian	145	21	14.5	9.2	21.3
African-American	69	8	11.6	5.1	21.6
Breast size (cm)					
14.0–23.0	55	0	0.0	0.0	6.5
23.1–30.0	48	7	14.6	6.1	27.8
30.1–35.0	57	5	8.8	2.9	19.3
35.1–47.5	55	18	32.7	20.7	46.7
Body mass index (kg/m <sup>2</sup> )					
<25.0	53	2	3.8	0.5	13.0
25.0–29.9	53	6	11.3	4.3	23.0
>30.0	109	22	20.2	13.1	28.9

\* Positive symptoms and at least two physical examination findings.

0.0001) and race ( $p = 0.03$ ) were significant. The adjusted risk ratios for the highest quartile of breast size compared with the combined lower two quartiles was 10.11. The adjusted risk ratio compared with the third quartile was 6.12. For Caucasians compared with African-Americans, the adjusted risk ratio was 3.02.

#### DISCUSSION

Many manifestations of excessively large breasts are well recognized and may include painful chronic mastitis, lower cervical pain, backache, hypertrophic arthritis of the lower cervical vertebrae, postural changes such as kyphosis and compensatory lordosis, grooving and irritation of the shoulders from brassiere straps, submammary intertrigo, and lack of self-esteem.<sup>1-7</sup> Several recent articles describing outcome results of reduction mammoplasty have mainly compared techniques, discussed postoperative complications, and determined patient satisfaction. Most symptoms are relieved rapidly, and most patients have a high degree of satisfaction with the surgical results.<sup>10,13-24</sup> In our series, we found a high incidence of upper-extremity neurologic symptoms, mostly in the distribution of median nerve.

Consensus criteria for the classification of carpal tunnel syndrome in epidemiologic studies were recently elaborated; it was determined that the combination of electrodiagnostic findings and symptom characteristics provides the most accurate diagnosis, and in the absence of electrodiagnostic studies, a combination of symptom characteristics and physical examination findings provides the greatest diagnostic information. This combination of symptoms and physical examination findings was reported to have a sensitivity of 0.12, a specificity of 0.97, and a positive predictive value of 0.31, assuming a prevalence of carpal tunnel syndrome of 10 percent.<sup>25</sup> In the absence of electrodiagnostic data, we defined carpal tunnel syndrome as recommended by the consensus criteria, and we required the presence of two positive physical examination findings.

Although our results suggest that having mammary hypertrophy increases the risk of carpal tunnel syndrome, this result may be due to other factors that are associated with both carpal tunnel syndrome and mammary hypertrophy. Medical disorders related to carpal tunnel syndrome have been reviewed recently. In

addition to older age, the diseases most commonly associated with carpal tunnel syndrome include hypothyroidism, diabetes mellitus, wrist osteoarthritis, and obesity.<sup>26</sup> Other than obesity, these risk factors were not addressed in our study. We found that breast size was a much better predictor of carpal tunnel syndrome than was body mass index, even after adjusting for body mass index, age, and race. It is likely that carpal tunnel syndrome is the result of a complex interaction between systemic susceptibilities and internal and external mechanical forces.

The 1988 National Health Interview Survey of 44,233 persons determined the prevalence of carpal tunnel syndrome in the general population of women in the United States. The telephonic survey was conducted by the National Center for Health Statistics and classified the prevalence of carpal tunnel syndrome into two categories: "self-reported" carpal tunnel syndrome and "medically called" carpal tunnel syndrome. Respondents had "medically called" carpal tunnel syndrome if they had worked within the previous 12 months and had seen a health care provider (physician, chiropractor, physical therapist, or other) for prolonged hand discomfort (pain, burning, stiffness, numbness, or tingling in the hand, wrist, or fingers for 20 or more days or at least 6 consecutive days in the past year) and had been told it was carpal tunnel syndrome. By this definition, the national female prevalence was only 0.67 percent (95 percent confidence interval, 0.51 to 0.82). The study authors believe this finding was reasonably accurate because the questions used to elicit a positive response were limited to people who had prolonged hand discomfort and because the respondents volunteered the term "carpal tunnel syndrome" without a leading question.<sup>27</sup>

Prevalence and confidence intervals from our study were far higher than the prevalence reported in the 1988 National Health Interview Survey. Despite the statistical difficulties inherent in comparing such different groups, it is unlikely that they would account for the large difference in the prevalence of carpal tunnel syndrome. Although race by itself was not a significant predictor of carpal tunnel syndrome, after adjusting for breast size there was noted a difference between Caucasians and African-Americans. This may be related to differences in types of occupation and will be the subject of further investigation by examining

carpal tunnel rates in different breast size categories.

It is unclear why breast hypertrophy should lead to the development of neurologic signs and symptoms. Kaye,<sup>8</sup> although describing symptoms in an ulnar nerve distribution, attributed the findings in his patients to a type of thoracic outlet syndrome, where the lower trunk of the brachial plexus was compressed against the first rib. Others have described the effects of mammary hypertrophy on the skeletal system and have speculated that tingling, numbness, and weakness in the arms may result from brachial plexus compression between the coracoid process of the scapula and the rib cage as forward depression of the shoulders tilts the coracoid downward. The pectoralis minor muscle could be mostly responsible for moving the coracoid forward and narrowing the space through which the brachial plexus travels. The pressure from brassiere straps for the elevation of heavy breasts can contribute to the compression of the brachial plexus as well.<sup>28,29</sup>

Our findings of a high prevalence of carpal tunnel syndrome in women who present for reduction mammoplasty could be important in helping to establish criteria for third-party reimbursement of the procedure. There is little in the medical literature to help insurers develop objective criteria for reimbursement; there is no precise definition or diagnostic criteria for macromastia or pathologic breast hypertrophy. Because of the large number of body types and the variety of physical changes that occur with aging, it is difficult to determine the size at which breast enlargement becomes pathologic in any individual or group of large-breasted women. Many precertification requirements, such as back pain or the interpretation of a preoperative photograph, are subjective, and insurance companies are usually reluctant to reimburse patients unless certain criteria are met, such as specific amounts of breast-tissue resection or reduction in bra cup size. Such criteria have been challenged by noting that the procedure is usually performed to relieve painful symptoms and physical signs of breast hypertrophy rather than for primarily cosmetic or emotional reasons. Relief of symptoms is independent of body weight, body surface area, body mass index, and amount of breast tissue removed.<sup>16,21,30-32</sup>

In our evaluation of women with mammary hypertrophy who presented for reduction

mammoplasty, the prevalence of carpal tunnel syndrome was 19.9 percent when the condition was defined as the coexistence of symptoms and two physical examination signs. This represents a greatly increased risk of having carpal tunnel syndrome as compared with women in the general population. Breast size was a significant predictor of carpal tunnel syndrome, much better than was body mass index, and remained significant after adjusting for other physical characteristics. To determine whether there is a causal link between mammary hypertrophy and carpal tunnel syndrome, a follow-up study is planned to investigate the decrease in signs and symptoms after reduction mammoplasty.

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