

Pregnancy and the Syndrome of Herniated Lumbar Intervertebral Disc; An Epidemiological Study¹

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In a study of the epidemiology of acute herniated lumbar intervertebral discs in the New Haven, Connecticut, area, it was found that the female cases had had more pregnancies resulting in live births than women of similar age without known herniated discs. However, cases had not had more pregnancies resulting in miscarriages than other women of their age. Among women who underwent surgery for their herniated discs, the association between number of live births and herniated discs was found for women with herniations at the L₅ level but not for women with herniations at the L₄ level.

INTRODUCTION

The herniated lumbar intervertebral disc is a common medical problem, yet little is known of its causation. One factor that has been considered in its etiology, but not well studied, is pregnancy. It has been pointed out by O'Connell (1) and by DePalma and Rothman (2) that there are two main reasons that the lumbar intervertebral discs are placed under excessive stress during pregnancy: One reason is the mechanical stress from carrying the fetus, and the other is the ligamentous laxity brought about toward the end of pregnancy by relaxin from the corpus luteum.

O'Connell (1) has further suggested that pregnancy is an etiologic factor on the basis of his observation that 30% of women with surgically proven lumbar disc protrusions who had borne children reported that they had developed symptoms of disc protrusion in pregnancy or the puerperium. No data, however, were presented on the frequency with which such symptoms occurred during the pregnancies and puerperia of women without disc protrusions, so it is not possible to tell whether this actually represented an excess over what would be expected in the absence of disc disease.

A previous paper from an epidemiological study of herniated lumbar intervertebral discs in the New Haven, Connecticut, area (3) showed that female cases had significantly more children than females in two control groups but that there was no difference in the mean number of children of male cases and controls. This paper, therefore, focuses on the females in the study population and examines the role of pregnancy in the etiology of herniated lumbar discs.

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METHODS

The general design of this study involved comparing characteristics of persons with recent herniated lumbar intervertebral discs to characteristics of two groups of people of the same sex and similar age without herniated lumbar discs. Details of the study design are given elsewhere (3) and will be described briefly here.

Female cases were ascertained from persons in the age group 20–64 yr residing in the New Haven, Connecticut, Standard Metropolitan Statistical Area who had lumbar X rays at the Yale–New Haven Hospital, the Hospital of St. Raphael in New Haven, and the office of two of the private radiologists in New Haven during the period June 1971–May 1973. Although lumbar X rays alone are of limited value in diagnosing herniated discs, the assumption was made that most people with severe low back or sciatic pain would have lumbar X rays taken, so that many people with herniated discs could be found among these patients. In order to determine which of these people having low back X rays were likely to have herniated discs, they were interviewed within a few weeks of the time they were X-rayed. During the interview, they were asked about demographic characteristics and exposure to possible risk factors; they were also asked about symptoms and were given a few simple diagnostic tests by the interviewers. Subsequently, relevant information from their medical records was abstracted. On the basis of the symptoms and signs noted during the interview, the radiologist's report (which could be used to exclude persons with other conditions, such as spondylolisthesis and tumors, bringing about the same symptoms and signs), and the surgeon's report (when surgery had been performed), the persons having low back X rays were divided into those who might have herniated lumbar discs and those who probably did not.

Among those considered likely to have herniated lumbar discs, the following diagnostic criteria were applied:

1. *Surgical cases* were those in which all of the following three criteria were fulfilled: (a) The surgeon stated on the hospital chart that he saw the herniated disc during surgery;³ (b) the patient gave evidence, in his answers to the questionnaire, that his pain was distributed along the sciatic nerve; and (c) the patient had a positive straight leg raising test and/or the symptoms of increased pain in the low back or along the sciatic nerve when stretching or extending his leg from a sitting position and/or the symptom of increased pain along the sciatic nerve when coughing or sneezing.

2. *Probable cases* were similar to the surgical except that the herniation need not have been observed at surgery. Included were cases in which the sciatic pain was felt in both the thigh and lower leg and cases in which there was sciatic pain in part of the leg and numbness in another part.

3. *Possible cases* differed from the probable in that the sciatic pain was only in the thigh or the lower leg but not in both. Also, if the leg was numb so that the distribution of pain was unknown but straight leg raising brought about an increase of pain in the low back, the person was classified as a possible case.

Only persons who had developed the symptoms within the previous year were included since it was desired to find out about events prior to the onset of the disc herniation rather than subsequent to it.

Two control groups of persons without known herniated lumbar discs were used. The first was a matched control group. For each surgical, probable, and possible case, the next person admitted to the same hospital service or to the same

³The descriptions *ruptured*, *free fragments*, *herniated*, *prolapsed*, *bulging*, and *extruded* are included but not *disc degeneration* without evidence of nerve root involvement.

radiologist's office for a condition not related to the spine and who was of the same sex and about the same age as the case was selected as a control. Emergency room patients were matched within 2 yr of age in one hospital and within 3 yr of age in the other hospital; all other patients were matched within 10 yr of age. Any person who had previously suffered a herniated lumbar disc or chronic low back pain could not serve as a control. Also, the controls had to have sought medical care for a condition that they had had for no more than a year prior to the time of the interview, so that like the cases, they had recently acquired their disease. When a matched control had to be excluded, another person of the appropriate age and sex admitted to the appropriate service was selected.

The second control group consisted of people who had lumbar X rays taken and were therefore interviewed in the course of ascertaining cases but who were not classified as surgical, probable, or possible cases and who had not experienced their symptoms for more than a year. Because different types of people went to the various hospital services, the female cases and unmatched controls were compared in six separate groups: Yale-New Haven Hospital neurosurgical and orthopedic inpatients; Hospital of St. Raphael neurosurgical and orthopedic inpatients; Yale-New Haven emergency room patients; St. Raphael emergency room patients; all other Yale-New Haven and St. Raphael patients; and private radiologists' patients. The age distributions of the cases and controls in each of these groups were similar, so they did not have to be compared on an age-specific basis.

The same questionnaire and diagnostic tests were administered by carefully trained nonmedical interviewers to all cases and controls. Most cases and controls were interviewed in their homes, although some were interviewed in hospital when this was possible. The response rate was 79% for persons having low back X rays and 77% for matched controls.

As was mentioned above, only the females are considered in this paper. A total of 89 female matched pairs was available for study; 91 cases⁴ and 227 controls are included in the comparisons of cases and unmatched controls.

Details of the demographic characteristics of the cases and controls are given elsewhere (3). The median age of the female cases in this study was 40.0 yr; the age group with the greatest frequency of new cases was the 40-44 yr group, although there were some cases throughout the 20-64-yr age range used in this study. Seventy-three percent of the female cases were white, 68.2% had graduated from high school, 48.3% lived in the city of New Haven, and 51.7% lived in the suburbs.

Tests of statistical significance are somewhat different for the comparisons between cases and matched controls and between cases and unmatched controls. The comparisons of cases and matched controls used the paired *t*-test, as described in Snedecor and Cochran (4), while the comparisons of cases and unmatched controls involve taking a weighted average of differences between means for cases and controls in each of the six groups. The formula used in the latter procedure is given at the bottom of Table 2.

RESULTS

The average numbers of pregnancies, pregnancies resulting in live births, and pregnancies not resulting in live births (the vast majority of which were miscarriages) among cases and matched controls are given in Table 1. The average number of pregnancies is somewhat greater among the cases than the matched controls

⁴Unfortunately, controls could not be found for two of the female cases seen at the office of the private radiologists because of problems related to confidentiality of names of persons seeking medical care from private physicians.

TABLE 1
Mean Number of Total Pregnancies, Pregnancies Resulting in Live Births, and Pregnancies Not Resulting in Live Births among Female Cases and Matched Controls, by Category

Category of cases	Number of pairs	All pregnancies			Pregnancies resulting in live births			Pregnancies not resulting in live births		
		Mean number of cases	Mean Number of controls	<i>t</i>	Mean number of cases	Mean number of controls	<i>t</i>	Mean number of cases	Mean number of controls	<i>t</i>
		Surgical	28	3.29	2.61	0.94	2.93	2.00	1.66	0.36
Probable	43	3.28	2.93	0.62	2.84	2.30	1.10	0.44	0.63	-0.92
Possible	17	3.00	3.18	-0.13	2.65	2.29	0.35	0.35	0.88	-0.99
All cases	88	3.23	2.88	0.81	2.83	2.20	1.79*	0.39	0.67	-1.68*

* $P < 0.10$.

(3.23 compared to 2.88), but this is not statistically significant. When only pregnancies resulting in live births are considered, however, the average number of pregnancies among cases, 2.83, is almost significantly greater than the average number among the controls, 2.20, a difference that is particularly striking among the surgical and probable cases and their controls. The average number of pregnancies not resulting in live births, however, is greater in controls than cases.

Table 2 shows similar comparisons for cases and unmatched controls, by hospital service. In general, the cases reported a greater number of pregnancies than the unmatched controls. However, when only pregnancies resulting in live births are considered, in each group the mean is higher for cases than controls, and, when the groups are combined, statistical significance is reached. The average number of

TABLE 2
Mean Number of Total Pregnancies, Pregnancies Resulting in Live Births and Pregnancies Not Resulting in Live Births among Female Cases and Unmatched Controls, by Hospital Service

Hospital service	Number in group		All pregnancies		Pregnancies resulting in live births		Pregnancies not resulting in live births	
	Cases	Controls	Cases	Controls	Cases	Controls	Cases	Controls
I. Yale-New Haven inpatients	25	10	2.66	3.00	2.54	2.10	0.12	0.90
II. St. Raphael inpatients	19	14	2.89	2.85	2.47	2.14	0.42	0.71
III. Yale emergency room patients	18	73 ^a	4.05	3.16	3.44	2.57	0.61	0.59
IV. St. Raphael emergency room patients	14	74	3.50	2.61	3.00	2.14	0.50	0.47
V. Other Yale and St. Raphael patients	11	40	2.91	2.08	2.46	1.88	0.45	0.20
VI. Private radiologists' patients	4	13	4.00	4.08	3.75	3.77	0.25	0.31
	\bar{d}^b		0.373		0.603		0.027	
	<i>Z</i>		1.342		2.131		0.130	
	<i>p</i>		<0.20		<0.05		<0.10	

^aNumber of pregnancies unknown for one female

$$b^d = \sum_{i=1}^6 w_i d_i / \sum_{i=1}^6 w_i; \text{ and } Z = \frac{\bar{d}}{1 / \sum_{i=1}^6 w_i^{1/2}}; i = \text{hospital service}; d_i = \text{difference between means for}$$

each hospital service; w_i = reciprocal of variance of difference between means.

pregnancies not resulting in live births is almost the same for these cases and controls. Thus, comparisons of cases with both matched controls and unmatched controls suggest that cases have had more pregnancies resulting in live births than other women of their age. If stillbirths are combined with live births rather than with miscarriages and abortions, the same trends are seen, since the number of stillbirths was small relative to the number of live births and miscarriages.

Cases and both control groups were also compared according to their age at the time of their first live birth and according to the number of years since they had last given birth. No differences between cases and either control group were found for either of these variables, and the data are not shown here.

Next, the likelihood of lumbar disc herniation was considered relative to the number of live births; in other words, is there an increase in the risk with an increase

Controls: Number of live births

		A			B			C		
		0	1	2	3	4	5	6	7	8+
Cases: Number of live births	A	0	1	2	3	4	5	6	7	8+
		11	3	2	2	1	0	0	0	2
		3	1	1	1	0	1	0	0	0
		4	2	4	5	1	0	0	1	0
		18	6	7	8	2	1	0	1	2
					11					
	B	3	4	5	6	7	8+			
		3	3	2	3	0	2	1	1	0
		2	1	2	0	2	1	0	0	1
		2	1	0	2	2	0	0	0	0
	7	5	4	5	4	3	1	1	1	
				12						
C	6	7	8+							
	1	0	1	2	0	1	0	0	0	
	1	0	0	0	0	0	0	0	0	
	1	0	2	1	1	1	0	0	0	
	3	0	3	3	1	2	0	0	0	
				6						

Application of sign test to comparisons in above table

TABLE 3
Distribution of Number of Live Births of Cases and Matched Controls
Grouped by Number of Live Births

Comparison	Number of pairs in which		Proportion of pairs in which case has had more live births than control
	Case has had more live births than controls	Control has had more live births than case	
AA (below diagonal vs above diagonal)	9	6	0.60
BB (below diagonal vs above diagonal)	4	3	0.57
CC (below diagonal vs above diagonal)	0	0	—
AB (Table BA vs Table AB)	16	11	0.59
BC (Table CB vs Table BC)	6	3	0.67
AC (Table CA vs Table AC)	6	3	0.67
Total	41	26	0.61 = \hat{p}^a

^aTest of significance of whether \hat{p} based on totals differs from 0.5: $X^2_1 = (41 - 26)^2/67 = 3.358$, $Z = 1.83$, $p = 0.07$.

TABLE 4
 Mean Number of Pregnancies, Pregnancies Resulting in Live Births, and Pregnancies Not Resulting
 in Live Births of Cases and Matched Controls by Level of Disc Lesion

Level and type of pregnancy	Cases	Controls	<i>t</i>
L₅ only (<i>n</i> = 11)			
Total pregnancies	3.45	2.55	1.18
Pregnancies resulting in live births	3.09	1.91	1.88*
Pregnancies not resulting in live births	0.42	0.64	-0.42
L₄ only (<i>n</i> = 12)			
Total pregnancies	3.17	3.00	0.11
Pregnancies resulting in live births	2.58	2.33	0.24
Pregnancies not resulting in live births	0.58	0.67	-0.16

**P* < 0.10.

in the number of live births? The complete distribution of case-control pairs according to number of live births was divided into the nine tables making up Table 3. Table AA, for instance, gives the distribution for pairs in which both case and control had 0, 1, or 2 live births, and Table AB gives the distribution for pairs in which the case had 0, 1, or 2 live births and the control 3, 4, or 5 live births. In the analysis below, comparisons are made within and between these various tables of the number of pairs in which the case had more live births than the control with the number of pairs in which the control had more live births than the case. The rows labeled AA, BB, and CC make these comparisons *within* the corresponding tables. In Table AA, for instance, the nine pairs ($3 + 4 + 2 = 9$) in which the case had more live births than the control are compared to the six pairs ($3 + 2 + 1 = 6$) in which the control had more live births than the case. Rows AB, BC, and AC make comparisons *between* tables. Row AB, for example, compares the 16 pairs in which the case had 3-5 live births and the control 0-2 live births with the 11 pairs in which the case had 0-2 live births and the control 3-5 live births. In all of the comparisons, there were more pairs in which the case had a greater number of live births than the control than pairs in which the control had more live births than the case; in fact, there is a marked consistency around the overall proportion of 0.61. Application of the sign test to the totals indicates that the overall tendency for cases to have more live births than controls is almost statistically significant when examined in this way. The data thus suggest that the risk increases with subsequent births as well as the first few births, although the precise nature of the relationship cannot be determined with these relatively small numbers.

Next, consideration is given to the level at which the herniation occurred among the cases who underwent surgery. In Table 4, the mean numbers of total pregnancies, pregnancies resulting in live births, and pregnancies not resulting in live births are given for the 11 cases in which the herniation occurred at the L₅ level as seen during surgery and the 12 cases in which the herniation occurred at the L₄ level as seen during surgery. Despite the small numbers, it is apparent that the larger number of live births among the cases is almost entirely attributable to the cases who had herniated discs at the L₅ level. Women with herniated discs at the L₅ level averaged 3.09 live births compared to 1.91 among their controls, whereas women with herniated discs at the L₄ level averaged 2.58 live births compared to 2.33 in their matched controls. In direct comparisons of the numbers of pregnancies and live births of women with L₅ herniations and women with L₄ herniations, differences were not quite statistically significant; however, it can be seen in Table 4 that differences were nevertheless substantial, despite the fact that the average age of the

women with L₄ herniations, 42.7, was slightly greater than the average age, 39.5, of women with L₅ herniations. Thus it appears that most, if not all, of the association between pregnancies resulting in live births and herniated lumbar discs is attributable to herniations at the L₅ level.

DISCUSSION

Before discussing the findings of this study, consideration should be given to its limitations, some of which have been described elsewhere (3). Among these are the disproportionate number of cases who were hospital patients, the somewhat disappointing response rate (about 78%), the lack of a control group from the general population, and the relatively small number of females.

Another problem, of course, is the difficulty of diagnosis. In this study diagnosis was based on symptoms and signs that could be elicited from the entire study population by nonmedical but carefully trained interviewers and on information routinely recorded in medical records. The diagnostic criteria were thus particularly appropriate for preliminary epidemiological research. Tests of knee jerks and ankle jerks and a test for weakness of the big toe extensor were performed by the interviewers, and information on results of these and other tests was abstracted from medical records; however, these tests were not included in the diagnostic criteria, since it is known (2) that positive signs from these tests are not found in a substantial proportion of patients with herniated lumbar discs, especially at early stages of the disease, and since there is so much variability in these measurements. Results of myelography were also abstracted from medical records, but myelograms had not been performed on a sufficient number of probable and possible cases to be useful as part of the diagnostic criteria.

Undoubtedly some misclassification of cases did occur, both because there may have been some atypical cases who were not picked up by our criteria and because there might have been some people with other conditions that produced the same signs and symptoms as herniated lumbar discs but that were not visible on X ray. However, the ability of the various risk factors, such as number of live births, to differentiate between cases and other people having lumbar X rays, as well as between cases and persons with conditions not involving the spine (matched controls), together with the consistency of the trends among the surgical, probable, and possible cases, gives one some confidence in the ability of our diagnostic criteria to pick out persons with herniated lumbar discs. Furthermore, although these cases by no means constitute a random sample from the general population, it is difficult to see why differences between these cases and these controls would not be indicative of differences between persons with and without acute herniated lumbar discs in a general population. In any event, it is felt that with so little known about the epidemiology of herniated lumbar discs, a case-control study based on patients seeking medical care is the approach of choice and that any leads arising from this study may be examined in more detail in subsequent studies based on more general populations.

The first relevant finding, reported previously (3), that females with herniated lumbar discs have more children than females in either control group, while the male cases have about the same number of children as the controls, suggests that something occurring during pregnancy rather than something related to caring for children may be responsible for an increased risk for herniated lumbar discs. It is also possible that differences between mothers and fathers in ways of caring for children may be involved. For instance, the argument may be put forth that mothers

spend more time with their children than fathers and therefore are more frequently engaged in such activities as lifting their children; another possibility is that mothers and fathers hold their children in different ways. However, if lifting and holding children were responsible for the increased risk in women who have borne children, it still does not seem reasonable that there is no increased risk whatsoever in men who have children. Furthermore, results from another part of this study (5) indicated that lifting on the job has little relationship to the development of herniated lumbar discs (although it may in some cases be the precipitating event), so it would be difficult to see why the lifting of children should be important. The more likely explanation would appear to be that pregnancy itself is the risk factor rather than caring for children, although the latter hypothesis can by no means be ruled out and certainly warrants further investigation.

The next result, described in the present paper, was that the association between pregnancy and subsequent herniated lumbar discs is only seen for full-term pregnancies; those resulting in miscarriages, in fact, were somewhat more common among the matched controls than the cases and were reported with about the same frequency in the cases and unmatched controls. This suggests that something occurring towards the end of pregnancy is responsible for the association, but since both relaxin and mechanical stress would have their greatest effect at the end of pregnancy, this observation does not differentiate between these two possibilities. Thus, further research is needed.

The finding that the more live births a woman has, the more likely she is to have a subsequent disc herniation lends further support to the belief that the association is a real one. In a case-control study such as this it is important to have the findings replicated in another study, especially in view of the relatively small number of females included. However, since such a study has not yet been undertaken, consideration must be given to the consistency of the relationship using the two control groups, the sizable difference in number of live births of cases and controls, and the presence of the association in females but not in males; all these factors lend support to the belief that the association is real.

Finally, the observation that the entire difference in the mean number of live births in surgical cases and controls is attributable to cases with disc herniations at the L₅ level is worth noting, but the numbers of surgical cases and controls are small, and it would be desirable to see this verified in another study. In fact, it is hoped that all the results that were found in this preliminary study will be examined further in other investigations.

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