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## ARTICLES

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# Prevalence of Herniated Intervertebral Discs of the Cervical Spine in Asymptomatic Subjects Using MRI Scans: A Qualitative Systematic Review

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**ABSTRACT. Introduction.** Our objective was to review articles that report the prevalence of cervical disc herniations in asymptomatic subjects using MRIs and conduct a qualitative systematic review.

**Methods.** A MEDLINE search for articles published between 1974 and 2004 was performed, and five articles were retained in this review.

**Results.** Teresi et al. (1987) studied 35 asymptomatic subjects retrospectively and 65 asymptomatic subjects prospectively, and found 20% of subjects aged 45-54 years, 35% of subjects aged 55-64 years, and

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57% of subjects older than 64 years had cervical disc herniations/bulges. Boden et al. (1990) studied 63 asymptomatic subjects and found 10% of subjects of less than 40 years and 5% of subjects older than 40 years had disc herniations. Lehto et al. (1994) studied 89 asymptomatic subjects and found that each of 2 subjects (one 29 and the other 56 years) had a disc prolapse; the prevalence was 2.2%. Matsumoto et al. (1998) studied 497 asymptomatic subjects. They found that 70 of 2480 discs scanned were prolapsed posteriorly (2.8%), and reported that the frequency of these lesions increased after 40 years. Siivola et al. (2002) compared 15 asymptomatic and 16 symptomatic subjects after 7 years and found no disc herniations (0%) in the asymptomatic group and 4 disc herniations (25%) in the symptomatic group.

**Conclusions.** The prevalence of cervical disc herniations in asymptomatic subjects of less than 40 years of age is 3% to 10% and increases to 20% in subjects up to 54 years of age. The prevalence increases with age—from 5% to 35% in subjects between 40 and 64 years of age. [Article copies available for a fee from The Haworth Document Delivery Service: 1-800-HAWORTH. E-mail address: <docdelivery@haworthpress.com> Website: <<http://www.HaworthPress.com>> © 2006 by The Haworth Press, Inc. All rights reserved]

**KEYWORDS.** Intervertebral disk, MRI scans, cervical disc, prevalence, asymptomatic

## INTRODUCTION

Clinicians, researchers, and forensic experts commonly cite studies that have determined the prevalence of intervertebral disc derangements—and in particular, disc herniations—of the cervical spine in asymptomatic subjects using magnetic resonance imaging (MRI) scans. These disc derangements are an eclectic group of disorders that includes, but is not limited to, osteophytes, prolapses, protrusions, bulges, and herniations (1). The purpose of this study was to review articles that report the prevalence of cervical disc herniations in asymptomatic subjects using MRI and conduct a qualitative systematic review.

## METHODS

A MEDLINE search for English language articles published between 1974 and 2004 was performed using the medical subject headings (MeSH) terms *intervertebral disk*, *intervertebral disk displacement*, *MRI*

scans, and *disk, herniated* as well as, the non-MeSH terms *cervical disc, prevalence, and asymptomatic*. The related articles/link feature of MEDLINE was used to identify articles similar to those retrieved from the initial search. Correspondence was initiated with the primary author of a seminal paper in this field to identify articles we may have overlooked. A total of six articles were retrieved. Loose inclusion criteria were applied to the articles because of the few retrieved. Articles not consistent with the purpose of this study were excluded (Table 1). One article was excluded because it used computed tomography (CT) and not MRI; therefore, five articles were retained in this review. Table 2 lists these five articles in chronologic order of publication year.

## RESULTS

*Teresi et al. study.* Teresi et al. (2) studied individuals referred for MRI scans of the larynx who did not report cervical spine symptoms. They studied 35 asymptomatic subjects retrospectively and 65 asymptomatic subjects prospectively (n = 100), and found that 20% of subjects aged 45-54 years, 35% of subjects aged 55-64 years, and 57% of subjects older than 64 years had cervical disc herniations/bulges. Figure 1 is a bar chart illustrating this data (2).

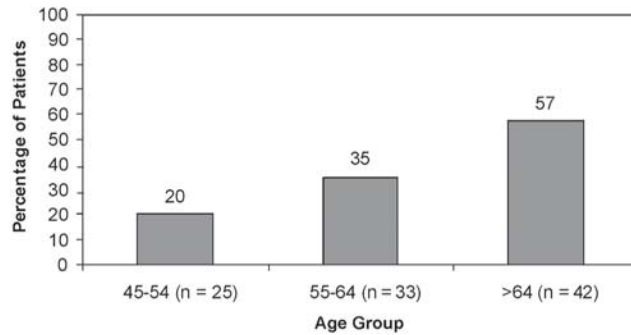
TABLE 1. Criteria used in this study

Inclusion Criteria	Exclusion Criteria
Articles published in peer-reviewed <i>Index Medicus</i> journals.	Articles that used an imaging modality other than MRI.
Articles published in English between the years 1974 and 2004.	
Articles that used MRI as an imaging modality.	

TABLE 2. Articles retained in this study

Teresi et al. <i>Radiology</i> 1987 (2)
Boden et al. <i>J Bone Joint Surg</i> 1990 (3)
Lehto et al. <i>Neuroradiology</i> 1994 (4)
Matsumoto et al. <i>J Bone Joint Surg Br</i> 1998 (5)
Siivola et al. <i>Eur Spine J</i> 2002 (6)

FIGURE 1. Percentage of asymptomatic subjects with herniated/bulged cervical discs



*Boden et al. study.* Boden et al. (3) studied 63 asymptomatic subjects ( $n = 63$ ) who were initially solicited for the study and then screened using a questionnaire and personal interviews to ensure that they had no history of symptoms attributable to the cervical spine. The MRI scans of these subjects were mixed randomly with 37 scans of subjects who had definitive symptomatic lesions of the cervical spine—that is, a herniated disc or foraminal stenosis—and all of the scans were independently evaluated by three neuroradiologists. The authors found that 10% of subjects less than 40 years and 5% of subjects older than 40 years had disc herniations. Figure 2 is a bar chart illustrating this data.

*Lehto et al. study.* Lehto et al. (4) studied 89 asymptomatic subjects prospectively ( $n = 89$ ) and divided them into 4 age groups: I ( $10.5 \pm 0.7$  years, 20 subjects), II ( $22 \pm 1.6$  years, 21 subjects), III ( $29.9 \pm 1.4$  years, 20 subjects), and IV ( $51.9 \pm 5.5$  years, 28 subjects). Only subjects in groups III and IV were found to have disc herniations—in group III, the prevalence was 5% and in group IV, the prevalence was 3.6%. Collectively, these authors (4) found that the prevalence was 2.2% in 89 asymptomatic subjects between the ages of 9 to 63. Figure 3 is a bar chart illustrating the data for groups III and IV.

*Matsumoto et al. study.* Matsumoto et al. (5) studied 497 asymptomatic subjects, with no previous history of cervical spine disease, prospectively ( $n = 497$ ). A total of 2480 discs were evaluated and the prevalence was 2.8% in asymptomatic subjects between the ages of 10 to over 60. Figure 4 is a bar chart illustrating the data. Note that the prev-

FIGURE 2. Percentage of asymptomatic subjects with herniated cervical discs

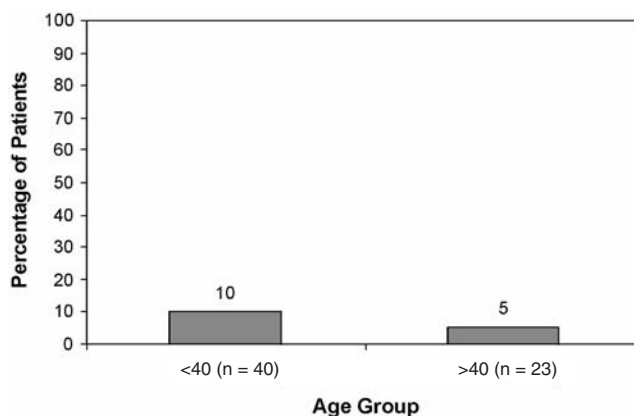
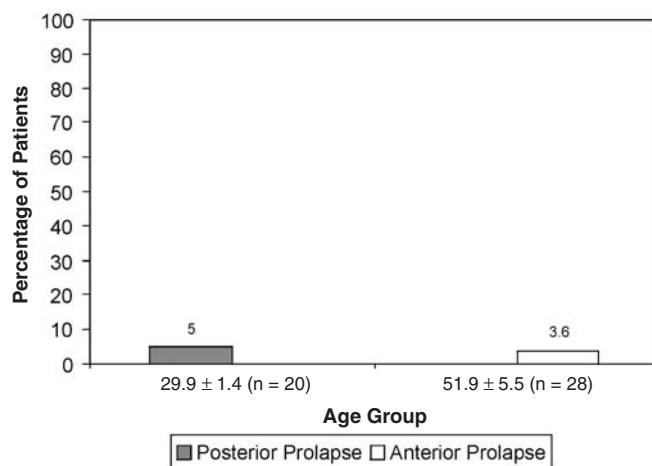


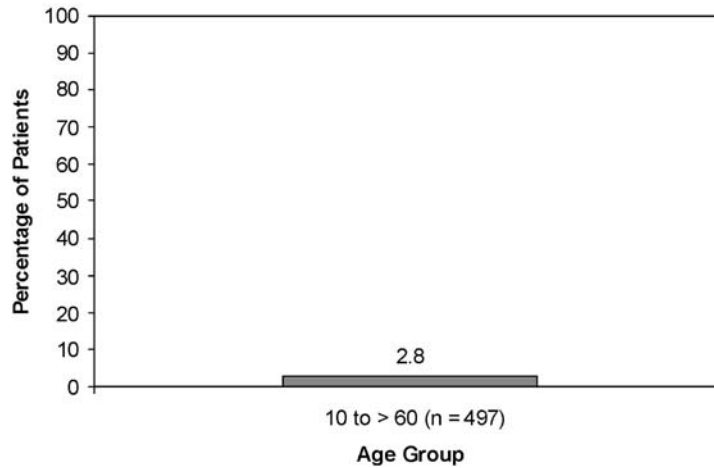
FIGURE 3. Percentage of asymptomatic subjects with herniated/bulged cervical discs



alence was calculated using the total number of discs studied as opposed to the number of subjects (n) in the study.

*Siivola et al. study.* Siivola et al. (6) compared 15 asymptomatic and 16 symptomatic subjects after a 7-year period and found no disc herniations (0%) in the asymptomatic group and 4 disc herniations (25%) in the symptomatic group.

FIGURE 4. Percentage of asymptomatic subjects with herniated cervical discs



### *DISCUSSION*

Figure 1, which illustrates the data of Teresi et al. (2), should be interpreted with caution. Although there is a positive correlation between age and prevalence of herniated/bulged cervical discs, the number of subjects in each age group is dissimilar. Furthermore, in this study, the authors did not distinguish between a herniated and bulged disc—thus, it is plausible to assume that the prevalence for each age group is lower than that depicted in the figure. It is noteworthy to point out methodological flaws in the design of this study. Because the subjects used in this study did not receive a history or physical examination (only their medical records were reviewed), their status as asymptomatic subjects is questionable. More importantly, the applicability of the results from this sample to the asymptomatic population at large should be done with caution because these subjects were referred for a laryngeal MRI study because of potential pathologies. Thus, they cannot be considered healthy asymptomatic subjects. Table 3 summarizes the flaws of this study.

In the study by Lehto et al. (4), only the subjects in groups III and IV were found to have disc herniations. The authors noted that the subjects in group II were medical students and those in group III were doctors and sedentary workers. Because the authors may have known some of the subjects, self-selection bias may have been inadvertently introduced

into the study. Matsumoto et al. (5) mention that most of their 497 subjects were known to them—thus, self-selection bias may have been present in this study as well.

Differences in the meaning of a herniated disc between studies made comparison difficult. Table 4 compares the nomenclature of each study.

Table 5 highlights the discs examined in each study and the reported prevalence of cervical disc herniations.

TABLE 3. Methodological flaws in the Teresi et al. study

- |    |   |
|----|---|
| 1. | Subjects did not undergo a history or physical exam. Their asymptomatic status was determined by a review of their medical records only.                          |
| 2. | Subjects were referred for a laryngeal MRI study because of potential pathologies—thus, they may not be representative of the healthy asymptomatic population.    |
| 3. | The authors did not distinguish between herniated and bulged discs. Therefore, the prevalence of herniated cervical discs in each age group may be overestimated. |

TABLE 4. Comparative nomenclature

Authors	Study Design	n	Definition of Herniated Disc
Teresi et al. (1987)	Prospective/retrospective	65/35	Identification of extruded disc material beyond the posterior vertebral line. (Herniation = protrusion = bulge.)
Boden et al. (1990)	Prospective	63	A mainly focal extrusion beyond the osseous confines of the vertebral body. A disc bulge was defined as a small diffuse non-focal protrusion of non-osseous material beyond the normal disc space. (Herniation ≠ bulge.)
Lehto et al. (1994)	Prospective	89	A focal mass with high signal intensity on T2*-weighted images extending beyond the margins of the adjacent vertebral bodies. A disc bulge or protrusion is when disc material bulged beyond the confines of the vertebral body. (Herniation ≠ bulge/protrusion.)
Matsumoto et al. (1998)	Prospective	497	A disc prolapse is a focal extrusion. A disc bulge is a small diffuse non-focal protrusion of non-osseous disc material. (Herniation = prolapse ≠ bulge.)
Siivola et al. (2002)	Longitudinal	15	Classifications were given for disc herniation, annular tear, and protrusion. For example, the classification for the degree of herniation is: 1 = slight, only visible in the sagittal image, 2 = herniation filling half of the ventral liquor space in the sagittal and axial directions, 3 = herniation reaching out to the spinal cord, and 4 = herniation reaching out to the spinal cord and classified as contained or non-contained. (Herniation ≠ annular tear ≠ protrusion.)

TABLE 5. Other comparative data

Authors	Discs Studied	Prevalence of Disc Herniation/Bulge*
Teresi et al. (1987)	Not directly reported; subjects were referred for laryngeal MRIs	20% of subjects 45-54 years; 35% of subjects 55-64 years; 57% of subjects older than 64 years
Boden et al. (1990)	Not directly reported	10% of subjects less than 40 years; 5% of subjects older than 40 years
Lehto et al. (1994)	C2/3, C3/4, C4/5, C5/6, C6/7, C7/T1	2.2% of subjects 9 to 63 years
Matsumoto et al. (1998)	C2/3, C3/4, C4/5, C5/6, C6/7	2.8% of subjects 10 to over 60 years <sup>†</sup>
Siivola et al. (2002)	Not directly reported; 6 levels inferred	0% of subjects with a mean age of 25.7 years

\* Prevalence = total number of cases at a specific point in time / specified population.

† This number was calculated using the total number of discs studied as opposed to the number of subjects (n) in the study.

## CONCLUSIONS

Based upon the articles retained in this review, the prevalence of cervical disc herniations in asymptomatic subjects of less than 40 years of age is 3% to 10% and increases to 20% in subjects up to 54 years of age. The prevalence increases with age—from 5% to 35% in subjects between 40 and 64 years of age. The prevalence of cervical disc herniations in asymptomatic subjects can most accurately be described as a range and not a single, discrete number.

A major limitation of the present study was that statistical analyses were not performed because of the paucity of studies, differences in study design and number of subjects, lack of standardized nomenclature between studies, and disparity of MRI technology between studies.

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