CERVICAL SPINAL CORD COMPRESSION AND THE HOFFMANN SIGN

John A. Glaser, M.D.*
Joel K. Curé, M.D.**
Kelly L. Bailey, PA-C†
David L. Morrow, M.D.††

ABSTRACT

Little information exists about the ability of the Hoffmann sign to predict cervical spinal cord compression. The objective of this study was to determine the correlation between the Hoffmann sign and cervical spinal cord compression in a consecutive series of patients seen by a single spine surgeon. All new patients with complaints related to their cervical spine were included. Hoffmann sign was elicited by flicking the nail of the middle finger. Any flexion of the ipsilateral thumb and/or index finger was considered positive. All imaging studies were reviewed for spinal cord compression. Cord compression was defined as flattening of the AP diameter of the spinal cord coexisting with obliteration of CSF around the cord compared to normal levels.

Of 165 patients, 124 patients had imaging of their spinal canal. Review by the spine surgeon found sensitivity of the Hoffmann sign relative to cord compression was 58%, specificity 78%, positive predictive value 62%, negative predictive value 75%. 49 studies were also read by a "blinded" neuroradiologist, the sensitivity was 33%, specificity 59%, positive predictive value, 26%, negative predictive value 67%.

Although attractive as a simple method of screening for cervical spinal cord compression, the Hoffmann sign, in the absence of other clinical findings, is not in our experience a reliable test.

INTRODUCTION

The Hoffmann sign has been in clinical use for approximately one hundred years. It was initially taught by Johann Hoffmann at the end of the nineteenth century and described in the literature by his assistant Curschmann in 1911.[1] It was felt to be a test for disease of the corticospinal pathways. It has also been described as the digital reflex, the snapping reflex, Tromner's sign and Jakobson's sign.[1,2]

The incidence of the Hoffmann sign in otherwise normal college students was evaluated in the 1930s. Two separate studies found the incidence to be two percent and 1.63 percent. Both of these studies included only male subjects.[3,4] Denno and Meadows described the "dynamic" Hoffmann sign. This involves performing the Hoffmann test with "multiple active full flexion to extension of the neck." This was felt to aid in the diagnosis of early spondylotic cervical myelopathy.[5]

Two recent studies have also discussed the utility of the Hoffmann sign. Handal et al evaluated fifty one patients with cervical spine complaints and found the Hoffmann sign and hyper-reflexia to be the physical findings most sensitive and with the highest accuracy for correlation with the ten patients found to have radiographic evidence of cervical myelopathy.[6] Sung and Wang looked at sixteen people with a positive Hoffmann sign but without complaints referable to the cervical spine and found that fifteen of the sixteen had "definite cervical pathology with neural compression" and all had "spinal pathology" on MRI scan although the pathology was in the thoracic spine.[7]

The purpose of this study was to further expand on these previous studies and evaluate the Hoffmann sign in a population of patients being seen by a spine surgeon for cervical spine problems. We wished to evaluate the Hoffmann sign as a screening tool for radiographic evidence of cervical spinal cord compression

*Department of Orthopaedic Surgery, University of Iowa Hospitals and Clinics
**Department of Radiology, University of Alabama—Birmingham
†Charleston, South Carolina USA
††Charleston Bone and Joint PA, Charleston, South Carolina 29425

Study performed in the Department of Orthopaedic Surgery, Medical University of South Carolina

Reprints and Correspondence
John A. Glaser, M.D.
Department of Orthopaedic Surgery
University of Iowa Hospitals and Clinics
200 Hawkins Dr., 01022 JPP
Iowa City, Iowa USA 52242

and to correlate radiographic findings such as spinal cord dimensions with the presence or absence of a Hoffmann sign.

MATERIALS AND METHODS

This was a prospective analysis of all new patients seen in the practice of a university-based spinal Orthopaedic surgeon with complaints related to their cervical spine. Patients were excluded if they gave a history of brain injury, central nervous system disorder, cerebrovascular accident, previous brain surgery or intradural cervical spine surgery. The study period lasted from May 1, 1997 through February 1, 1999.

Evaluation consisted of a standard spinal history and physical examination. A Hoffman test was performed on all patients by the surgeon. This was performed by flicking the fingernail of the long finger, from dorsal to volar, on each hand while the hand was supported by the examiner's hand. The test was done with the neck in the neutral position and then with the neck maximally forward flexed.[4] Any flexion of the ipsilateral thumb and/or index finger was interpreted as a positive test.

All radiographic studies of the spinal canal, whether performed at our institution or elsewhere, were interpreted by the same surgeon. Only magnetic resonance imaging and CT myelograms were defined as spinal canal-imaging and were reviewed for evidence of spinal cord compression.

All patients who underwent magnetic resonance imaging at our institution were scanned on one of two 1.5 Tesla scanners (Signa, GE Medical Systems, Milwaukee, WI, or Edge, Picker International, Cleveland, OH). Each patient's examination included a T1 weighted 3D Fourier radio frequency-spoiled GRASS (3D-SPGR) sequence performed in the coronal plane. The 3D-SPGR data set was reconstructed in the axial plane as a series of 2 millimeter contiguous slices. Images were transferred to a PACS workstation (Impax, Agfa, Ridgefield Park, NJ). All of these studies were analyzed by a single neuroradiologist. Measurements of the transverse and anterior to posterior (AP) spinal cord diameter were made at each intervertebral disc level using electronic calipers. Additionally a visual assessment, with no knowledge of the patient's clinical status, was made regarding the presence or absence of spinal cord compression at each level. The spinal cord was considered to be compressed when the following conditions coexisted: the cord appeared flattened in its AP diameter, and the cerebrospinal fluid (CSF) within the subarachnoid space was obliterated at the level of flattening.

Table 1
All Patients with Spinal Canal Imaging

	Radiographic Evaluation	
	Compression	*No Compression*
Positive Hoffmann	28(A)	17(B)
Negative Hoffmann	20(C)	59(D)
N= 124		
Sensitivity (A/A+C)	58%	
Specificity (D/B+D)	78%	
Positive Predictive Value (A/A+B)	62%	
Negative Predictive Value (D/C+D)	75%	

The presence or absence of the Hoffmann sign and cord compression as well as age, gender and diagnosis were recorded.

The sensitivity, specificity, positive predictive value and negative predictive value for the Hoffmann sign as it relates to radiographic evidence of cervical spinal cord compression were calculated for the entire group of patients with spinal canal imaging and for the subgroup of patients at our institution with a standardized imaging protocol. The coefficient of correlation (kappa statistic) was also determined comparing the readings of the surgeon and the neuroradiologist for patients imaged at our institution. Multiple analysis of variants (MANOVA) was performed for the anterior to posterior and transverse measurements at each level accounting for the status of the Hoffmann sign and cord compression.

RESULTS

One hundred sixty-five patients met the inclusion criteria. One hundred four were female (63%) and 61 were male. The mean age was 49 years. Forty-five of 49 (92%) patients with a positive Hoffmann sign and 79 of 116 (68%) with a negative Hoffmann sign had imaging studies of their spinal canal. Thirty-nine of the 49 (80%) patients with a positive Hoffmann sign were female.

Table 1 shows the distribution of all 124 patients who had imaging of their spinal canal evaluated by the treating surgeon. Imaging studies were performed both at our institution and elsewhere. Seventeen of these 124 (13.7%) had a positive Hoffmann sign and no radiographic evidence of compression.

Table 2A
Patients with Standardized Imaging Read by Blinded Neuroradiologist

	Radiographic Evaluation	
	Compression	*No Compression*
Positive Hoffmann	5(A)	14(B)
Negative Hoffmann	10(C)	20(D)

N= 49
Sensitivity (A/A+C) 33%
Specificity (D/B+D) 59%
Positive Predictive Value (A/A+B) 26%
Negative Predictive Value (D/C+D) 67%

Table 2B
Patients with Standardized Imaging Read by Treating Surgeon

	Radiographic Evaluation	
	Compression	*No Compression*
Positive Hoffmann	4(A)	15(B)
Negative Hoffmann	9(C)	21(D)

N= 49
Sensitivity (A/A+C) 31%
Specificity (D/B+D) 58%
Positive Predictive Value (A/A+B) 21%
Negative Predictive Value (D/C+D) 70%

Of the 104 female patients 39 (38%) had a positive Hoffmann sign whereas 10 of 61 (16%) of male patients had a positive Hoffmann sign. Of those 39 females, 35 underwent spinal canal imaging, and 21 (60% positive predictive value) were felt to have radiographic evidence of spinal cord compression. Of the 10 male patients, all had imaging and 7 (70%) were felt to have compression.

Table 2A shows the distribution of the 49 patients who underwent MRI at our institution, evaluated by a neuroradiologist blinded to the patients' clinical status. Table 2B shows the evaluation of those same patients by the treating surgeon.

The kappa statistic for these forty-nine studies between the neuroradiologist and the surgeon for these patients was .62. A kappa of one is perfect agreement, zero is what would be expected by chance and negative one is totally imperfect agreement. The level attained in this study is considered good reproducibility.

Figures 1A and 1B show the anterior to posterior and transverse dimensions respectively of the cervical cord at each level for each group.

MANOVA revealed that statistical significance ($p < .05$) was only achieved when comparing radiographically compressed to noncompressed levels. When radiographic compression was eliminated as a factor, there was no statistically significant difference at any level between the Hoffmann positive group and the Hoffmann negative group. When the transverse measurements were evaluated, there was no statistically significant difference at any level, regardless of Hoffmann or compression status.

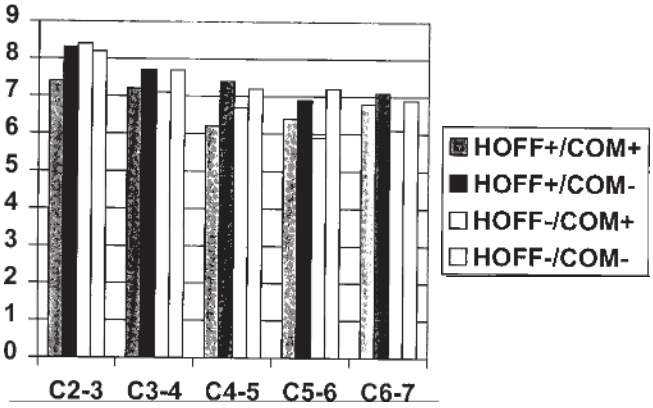
DISCUSSION

A number of issues are raised by this study, both about the Hoffmann sign and about the radiographic interpretation of cervical spinal cord compression. The first is whether the Hoffmann sign is even related to pathology of the spinal cord. Sung et al and Denno et al reinforced the belief that it is related.[4,7] We also feel that there is a relationship between cord pathology and the Hoffmann sign but, like many aspects of clinical medicine, the test is not foolproof and clinical judgement remains the mainstay of evaluation rather than a single physical finding.

Our study shows a significantly higher incidence of both false positive and false negative findings than others.[3-7] One possible explanation for the high rate of false positives we believe relates to gender. Earlier studies looked only at males and we had a high percentage of females who appear to have a much higher rate of having a positive Hoffmann sign. Of the 61 males evaluated, only 3 had a positive Hoffmann sign without radiographic evidence of compression. Although we know there were some "false negatives" in this group as well, when comparing this incidence (3/61 = 4.9%) , to the studies by Echols and Fay, there is a significantly smaller discrepancy.[3,5] To the best of our knowledge, the incidence of a positive Hoffmann sign in females has not been documented previously. We do not know the reason for this difference.

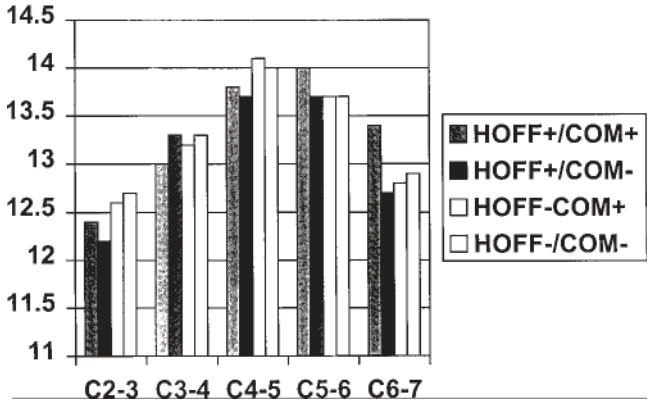
One possible explanation for the false negative findings is the coexistence of both spinal cord and nerve root pathology. For the Hoffmann sign to be present it may be that the reflex arc of the relevant nerve root

Figure 1A
Mean Anterior to Posterior Cord Measurements (mm)



HOFF = Hoffmann sign
COM = Compression

Figure 1B
Mean Transverse Cord Measurements per Level (mm)



HOFF = Hoffmann sign
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needs to be fully functional. Compression of the root in the foramen, or anywhere along its course, may suppress the Hoffmann reflex, leading to a false negative finding.

The other issue related to this is that the study group that we evaluated was not the normal population and no control group was used. Therefore it is possible that patients with symptoms related to their cervical spine do have a higher incidence of a positive Hoffmann sign than the general population.

This leads to the issue of the sensitivity of the radiographic evaluation. All of the imaging studies were done with the patient supine and the head in the neutral position yet the Hoffman test is done with the patient upright and often with the head in different positions. We feel that it is possible that, in at least some of these patients, the Hoffmann test was more sensitive for finding early spinal cord dysfunction than the imaging studies.

CONCLUSION

In conclusion, we feel that the Hoffmann test is not a reliable screening tool for predicting the presence of cervical spinal cord compression. This may be due to: a higher than previously reported incidence of normal individuals with a positive Hoffmann test, a suppression of the Hoffmann reflex in patients with cord compression by the coexistence of root compression, the possibility that the Hoffmann test is more sensitive than our techniques of radiographic imaging of the spinal canal, or simply the inherent uncertainties of any one clinical finding in attempting to evaluate a complex pathologic process.

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