

# Histopathological Examination of Intervertebral Disc Specimens: A Cost-Benefit Analysis

Adam S. Wu, Daryl R. Fourney

**ABSTRACT:** *Object:* Routine histopathological examination of intervertebral disc specimens is commonly performed in North American hospitals, but recent studies have questioned the utility of this practice in cases where the indication for surgery is a benign process such as degenerative disc disease. In this study, we have performed a cost-benefit analysis of this practice. *Methods:* We performed a cost-benefit analysis of routine histopathological examination of 1775 routine (non-neoplastic and non-infectious indications for surgery) and 70 non-routine (suspected neoplastic or infectious indications for surgery) discectomy specimens obtained over an eight-year period (1996 and 2004). Chart reviews were used to determine if any histopathology findings were clinically significant (i.e., affected subsequent patient care). Total costs were calculated. A literature review was conducted to compare our results with other published series. *Results:* We found four unexpected histopathology results among 1775 specimens obtained from routine cases, one of which was clinically significant. We calculated costs of \$42,165.25 per unexpected histopathological finding and \$168,625 per clinically significant histopathological finding. For non-routine surgeries, the cost per abnormal pathological finding was \$116.67. *Conclusions:* In routine cases, histopathological examination of disc specimens is not justified. The decision to send specimens for pathological examination should be based on the surgeon's judgment.

**RÉSUMÉ:** *Examen anatomopathologique de spécimens opératoires de disques intervertébraux : analyse coût-bénéfice.* *But :* Dans les hôpitaux nord-américains, les spécimens de disques intervertébraux sont examinés de routine en anatomopathologie. Cependant, des études récentes ont remis en question la pertinence de cette pratique dans les cas où l'indication chirurgicale est une pathologie bénigne comme une maladie discale dégénérative. Cette étude porte sur le ratio coût-bénéfice de cette pratique. *Méthodes :* Nous avons effectué une analyse coût-bénéfice de l'examen anatomopathologique fait de routine entre 1996 et 2004 sur 1775 spécimens provenant de discectomies faites de routine (indications chirurgicales non néoplasiques et non infectieuses) et 70 spécimens provenant de discectomies chez des patients chez qui on soupçonnait une néoplasie ou une infection. La revue des dossiers a permis de déterminer si les constatations anatomopathologiques étaient significatives au point de vue clinique, c'est-à-dire si elles avaient influencé le traitement du patient. Nous avons calculé le coût total. Une revue de la littérature nous a permis de comparer nos résultats à ceux d'autres chercheurs. *Résultats :* Nous avons découvert 4 comptes rendus anatomopathologiques inattendus parmi les 1775 spécimens provenant des cas de routine, dont un était significatif au point de vue clinique, à un coût de 42 165,25 \$ par trouvaille anatomopathologique et de 168 625 \$ par trouvaille anatomopathologique significative au point de vue clinique. Pour les chirurgies qui n'étaient pas faites de routine, le coût par constatation anatomopathologique anormale était de 116,67 \$. *Conclusions :* Quand il s'agit de cas de routine, l'examen anatomopathologique des spécimens de disques n'est pas justifié. La décision de demander un examen anatomopathologique de ces spécimens chirurgicaux devrait être basée sur le jugement du chirurgien.

Can. J. Neurol. Sci. 2007; 34: 451-455

The routine histopathological examination of intervertebral disc specimens remains common practice in many North American hospitals. The majority of these specimens were obtained from procedures where the indication for surgery is a benign process, such as degenerative disc disease. Recent studies<sup>1-5</sup> have questioned the likelihood of discovering clinically significant, unexpected pathology in such cases, and some surgeons have stopped sending so-called "routine" discectomy specimens for histopathological examination. In an age of evidence-based accountability for medical costs, the routine study of disc specimens is arguably unjustified, but this remains an area of controversy.

In a recent e-mail survey of members of the Canadian Spine Society conducted by the senior author with respondents representing 45 major Canadian hospitals, roughly half indicated

From the Division of Neurosurgery, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

RECEIVED FEBRUARY 26, 2007. ACCEPTED IN FINAL FORM JUNE 18, 2007.

Reprint requests to: Daryl R. Fourney, Residency Training Program, Division of Neurosurgery, University of Saskatchewan, Royal University Hospital, 103 Hospital Drive, Saskatoon, Saskatchewan, S7N 0W8, Canada.

that they continue to send discectomy specimens for histopathological examination in every case.

We have previously published a review of the incidence of unusual or unexpected histological findings in routine discectomy specimens at our center.<sup>5</sup> In the present study, we have added an analysis of discectomy specimens from “non-routine” cases (where preoperative indications for surgery were suspected neoplasm or infection) and performed a cost-benefit analysis.

## MATERIALS AND METHODS

Ethics approval was obtained from the Saskatoon Health Region for this study. The final pathology reports for all intervertebral disc specimens obtained in the Saskatoon Health Region between 1996 and 2004 were cross-referenced with the Health Region’s clinical records database and classified according to the initial indication for surgery, with chart reviews being performed if the indication for surgery could not be found in the database. During the study period, the institutional policy was to send all disc specimens routinely for histopathological examination.

All benign (non-neoplastic and non-infectious indications for surgery) were classified as “routine discectomy”. These indications included degenerative disc disease, spinal stenosis, spinal trauma, and scoliosis. Surgeries for known or suspected neoplastic or infectious conditions were classified as “non-routine discectomy”.

For the routine group, any final pathological diagnosis that was not “fibrocartilage,” “degenerative changes,” and/or “intervertebral disc material” was considered to be unusual and unexpected. Chart reviews were conducted for all of these cases to determine if the unusual histopathological results had any clinical significance with regards to subsequent patient care.

The amount of material sent to pathology in individual cases was not available, and would have varied from case to case. The decision to send a minimal sample or an entire specimen was made by the surgeon on a case to case basis in both routine and non-routine cases.

Specific information regarding the processing of individual disc specimens in the pathology department was not available. Decalcification and additional studies such as immunohistochemistry were performed at the discretion of Pathology.

The cost-benefit value was determined by dividing the total cost of histopathological examination of specimens obtained from routine and non-routine cases by the number of specimens with clinically significant or unusual pathological results. The cost of histopathological analysis of disc specimens was obtained from the Department of Pathology of the Saskatoon Health Region.

For the literature review, a MEDLINE search was conducted for all English language papers using the search terms “routine discectomy” and “histopathology.” Four case series were identified.<sup>1,2,4,6</sup> A fifth series<sup>3</sup> was found by examining the citations of one of these papers.<sup>4</sup> Each series was evaluated to determine if a cost-benefit analysis had been performed.

## RESULTS

A total of 1858 specimens obtained during 1782 spinal procedures were identified. The following cases were excluded:

(1) three specimens obtained during myelomeningocele or lipomeningocele repair; (2) three synovial cysts erroneously coded as disc material; (3) three reports in which no recognizable material for pathological examination was identified; (4) four specimens for which the indication for surgery was not available

**Table 1: Demographic information for the routine and non-routine discectomy groups**

	Routine	Non-routine
Mean age	44	60
Median age	42	64
Age Range	0 to 89	17 to 86
Male: Female	1061:658	29:21

in the database and the charts were unavailable for review. Table 1 summarizes demographic information for the routine and non-routine discectomy groups. Table 2 describes the indications for surgery for all cases and the final pathological diagnoses in the non-routine group.

We have previously published a clinical analysis without cost-benefit calculations for the routine discectomy group.<sup>5</sup> We found a total 1775 specimens from 1719 procedures, out of which there were four unusual pathological findings. Three were cases of pseudogout with no clinical significance. The fourth was significant, in that it resulted in a change in patient care. In this case, a histopathological result of “amyloidosis with unusual

**Table 2: Indications for surgery for the routine and non-routine discectomy groups**

Routine Discectomy		Non-routine Discectomy		
Indication for surgery	Procedures/Specimens	Indication of surgery		Procedures/Specimens
			Final diagnosis	
Degenerative disc disease		Suspected neoplasm		33/51
	Cervical	255/277	Metastases	
	Thoracolumbar	1136/1161	Lymphoma	2/2
Spinal Stenosis			Hemangioma	2/2
	Cervical	10/10	Meningioma	1/1
	Thoracolumbar	19/19	Schwannoma	1/1
Spondylolisthesis	8/9		Multiple myeloma	1/1
Scoliosis	26/26		Benign disc	8/10
Spondylosis, unspecified		Suspected infection		17/19
	Cervical	39/44	Osteomyelitis	
	Thoracolumbar	176/178	Epidural abscess	3/4
Trauma	50/51		Paravertebral abscess	1/1
			Benign disc	3/3
Total	1719/1775	Total		50/70

immunological features" prompted further investigations for multiple myeloma (serum and 24-hour urine protein electrophoresis, skeletal survey and bone scan), which were all negative.

In the non-routine discectomy group, there were 70 specimens from 50 procedures, of which 57 specimens from 39 procedures were abnormal, and 13 specimens from 11 procedures were normal.

### Cost Calculation

In the Saskatoon Health Region, the total cost of processing, preparing, examining and reporting disc specimens in routine cases was \$95.00 (Canadian currency) per specimen as of January 2005. This value included both technical and professional fees, but a specific breakdown of the components used to derive this cost was not available. Using this value, the total cost in routine cases was calculated to be \$168,625, or an average of \$21,078.18 per year. With just four cases of unexpected findings, the cost of detection was \$42,165.25 per case. As there was only a single case where the pathology impacted subsequent patient care, the cost of detecting this type of abnormality equaled the total cost of examining all 1775 specimens over the eight-year study period (\$168,625 or \$21,078.18 per year).

For non-routine surgeries, the cost per specimen varied depending on how much additional specialized processing was required in each case. Using the available values for specimens from routine surgeries, we calculated a total cost of histopathological examination of \$6650, and the cost per abnormal pathological finding was \$116.67. This is an underestimation of the true cost, since the additional required specialized processing (e.g., immunohistochemistry) that may have been needed in these cases would have added to the actual per specimen cost.

### Cost-benefit Literature Review

Three published series<sup>3,4,6</sup> reported costs for the histopathological examination of routine discectomy specimens, and the results varied widely. Variations in the way costs were recorded and calculated by different centers, as well as actual cost differences between centers probably accounted for these differences.

Gryzbicki et al<sup>3</sup> reported that the cost was \$28.71 CAN (converted from \$US using the current exchange rate of 1.16, all subsequent values are in Canadian dollars) per disc specimen. The cost to detect an unexpected histopathological finding among routine discectomy procedures was \$10,249.47. Reddy et al<sup>4</sup> reported a total cost over the first three years of their study period (1995 to 1998) of \$85,283.20 for routine discectomy. The same authors reported an increase in cost to \$165.88 and \$213.44 per disc specimen at the two study centers they studied as of January 2000. Hasselblatt et al<sup>6</sup> reported a per specimen cost of \$29, resulting in a cost per unusual finding of \$21,044.34, and a cost per clinically significant unusual finding of \$31,566.50.

### Cost Calculation, Pooled Results

Combining results from published series of routine discectomy specimens, we have previously reported an estimated incidence of 10/7322 (0.14%) for unusual or unexpected

**Table 3: Costs of detection per histopathological finding for routine discectomy procedures\***

Processing and Evaluation Costs per Specimen	Total Cost per Histopathological finding	
	Total unusual	Unusual and <i>clinically significant</i> **
\$25	\$18,305.00	\$61,016.67
\$50	\$36,610.00	\$122,033.33
\$75	\$54,915.00	\$183,050.00
\$100	\$73,220.00	\$244,066.67
\$125	\$91,525.00	\$305,083.33
\$150	\$109,830.00	\$366,100.00
\$175	\$128,135.00	\$427,116.67
\$200	\$146,440.00	\$488,133.33

\*Based on the combined incidence of abnormal histological findings reported in the literature: 10/7322 (0.14%) for unusual or unexpected findings and 3/7322 (0.04%) for clinically significant findings (see text for details).<sup>7</sup>

\*\*Clinically significant findings are defined as those that affect subsequent patient care, including the undertaking of additional diagnostic studies.

histopathological findings and 3/7322 (0.04%) for clinically significant findings.<sup>5</sup>

Table 3 summarizes the calculated costs per abnormal histopathological finding, based on the combined incidence of such findings in the literature. Costs were calculated for a range of possible specimen processing and evaluation costs (\$25-\$200 per specimen). Even for a very low per specimen cost of \$25, the cost to detect one clinically significant finding in routine discectomy is high: \$61,016.67. If a more realistic per specimen cost in the \$100 to \$150 range is used, the cost for a single clinically significant finding in routine procedures becomes greater than \$250,000.

### DISCUSSION

Our results are consistent with those of previous studies<sup>1-5</sup> that suggest that histopathological examination of intervertebral disc specimens very rarely provides clinically significant information when the indications for surgery are routine. The rates of unexpected pathological findings (4/1775, 0.22%) and clinically significant unexpected pathological findings (1/1775, 0.06%) in our series is consistent with those reported in the literature. The highest rate published for unexpected histopathological findings in the literature was 0.28% (3/1069, Grzybicki et al<sup>3</sup>), and the highest rate for unusual clinically significant findings was 0.09% (2/2177, Hasselblatt et al<sup>6</sup>).

For non-routine cases (i.e., where neoplasm or infection is suspected preoperatively), the cost of detecting an abnormal histopathological finding is obviously much lower. In our series, this cost was \$6650 over the entire study period, and the cost per abnormal pathological finding was only \$116.67. From a clinical perspective, in non-routine cases, the histopathological diagnosis is essential for the planning of the course of future treatment, and even normal results in these cases are important. Thus, it can be argued that all histopathological results in non-routine cases are clinically significant, and the cost for one clinically significant result is the same as the cost per specimen of histopathological examination. Only two previously published reports<sup>3,4</sup> provided details about histopathological findings in non-routine discectomy. It could be argued that a description of results for non-routine cases is necessary in order to demonstrate that the “unexpected findings” reported in “routine discectomy” series are truly unexpected.

In a study by Raab,<sup>7</sup> decision analysis was used to determine the incidence threshold for clinically significant findings that would justify performing histopathological examination in every case. This cost-effectiveness threshold relates to the cost of histopathological examination and the value of the benefit that could be expected to be obtained. Raab defined benefit in terms of gain in life expectancy, and a clinically significant finding was considered to be that of previously unsuspected disease, the detection of which resulted in an increase in life expectancy of at least one year. Thus, if the value of a gain of one year of life expectancy was \$50,000 and the cost of histopathological examination was \$25 per specimen, then the cost-effectiveness threshold is a clinically significant finding in one out of every 2000 specimens. If the cost of examination is doubled to \$50, and the life-year value remains constant, then the cost-effectiveness threshold is also doubled, and becomes one out every 1000 specimens. If the life-year value is doubled to \$100,000 and the cost of examination remains unchanged at \$25, then the cost-effectiveness threshold is halved, to one out of every 4000 specimens.

Essentially, histopathological examination of disc specimens in routine cases would be financially justified if the value of the expected benefit is greater than the cost. However, determining the value of the benefit of detecting unusual, clinically significant, histopathological findings in disc specimens from routine procedures is difficult. Unusual but clinically insignificant cases without any impact on patient care would clearly have no benefit from a clinical perspective, though the information obtained from these examinations may have some potential benefit in research or quality-control. The benefits of unusual clinically significant findings in routine cases are difficult to determine exactly because of the wide range of potential pathology that might be found.

The discovery of a previously unsuspected infection may allow for the initiation of timely treatment and result in substantial clinical and financial benefit in reduced patient morbidity. However, out of 7322 total cases, our literature review found no reports of previously unexpected infections discovered by histopathological examination in routine discectomies.

The amount of benefit obtained from early discovery of a neoplasm would depend greatly on the nature of the neoplasm and the patient’s clinical condition. There have been two

unexpected neoplasms detected by routine discectomy in the literature and in both cases, the disease was metastatic.<sup>6</sup> It is likely that the majority of neoplasms that could be discovered in disc material would be metastatic. Discovery of such a neoplasm via histopathological disc examination may not result in a large benefit in terms of increased life expectancy, although it would provide an opportunity for earlier initiation of palliative therapies.

If we use a benefit value of \$50,000 and the per specimen cost from our study of \$95.00, the cost-effectiveness threshold incidence of clinically significant disease would be 0.19%, or one out of every 526 specimens. In actuality we found an incidence of clinically significant histopathological findings of only 0.06%, and no cases where the pathological finding could be reasonably expected to have improved life expectancy or avoided future costs.

Combining our results with the published series, the incidence of clinically significant unusual findings was about 0.04%, or one in 2441, which is less than the threshold of one in 2000 reported by Raab<sup>7</sup> (using a benefit value of \$50,000 and a cost per specimen of \$25). Given the higher current costs of histopathological examination, the combined incidence of unexpected or clinically significant findings among published routine discectomy series is far from meeting a reasonable threshold for cost-effectiveness.

In addition to purely clinical issues, other factors may impact the total costs and benefits of sending or not sending disc specimens for histopathological examination. Some of these factors include medicolegal considerations, academic and teaching needs, and research. As with the clinical considerations, it is difficult to assign numerical values to the true costs, but in almost every scenario more cost-effective options to automatic histopathological examination of every disc specimen can be considered.

For example, in some jurisdictions, surgeons are legally mandated to send all surgical specimens for pathologic analysis. However, if histopathological examination does not provide any clinical benefit to the patient, and there is potential for harm from false negative results prompting unnecessary investigations that expose the patient to additional risks, one may argue that such laws can no longer be justified and should be changed. Not sending disc specimens could potentially result in medicolegal exposure from not having tissue in the medical record for a particular procedure, and forfeiture of the tissue record component of patient advocacy. As a counterargument, sending disc specimens automatically for histopathological examination in every case means depriving the patient of the right to consent to having his or her tissue banked. This may be considered a breach of patient autonomy and privacy which cannot be justified if histopathological examination does not provide any definite clinical benefit. Issues revolving around patient advocacy can be potentially resolved by allowing the patient to consent or not consent to having disc tissue sent to pathology at the time that informed surgical consent is obtained.

Academic institutions and teaching hospitals may wish to have samples of degenerative disc material available for the purposes of teaching and research. This, however, does not necessarily require sending the disc specimen in all routine cases. Tissue banks of adequate size can be obtained by other

means, such as by sending random subsets of samples. Also, if histopathological examination of routine disc specimens does not provide any significant clinical benefit to the patient, and the primary motivation for obtaining such a specimen is not related to patient care, but for teaching and research purposes, then, ethically, patient consent is required, and automatically sending disc specimens in every case once again cannot be justified.

Cost containment options are also available in the pathology laboratory. In jurisdictions where there is a legal requirement to send all tissues to pathology, disc specimens from routine cases may be only examined grossly. The pathologist could decide on a case by case basis whether or not to perform a histopathological examination on microscopic slides, and whether or not to archive the tissue. These are all viable options if the medicolegal and academic considerations outlined above prompt an institution to continue sending disc specimens in all routine cases.

### CONCLUSION

In an era of increasing demand for health-care services, the wise utilization of resources with careful consideration of costs and potential benefits is essential. We have previously shown that the frequency of clinically significant histopathological findings in routine discectomy procedures is exceedingly low.<sup>5</sup> Due to the large volume of routine discectomy procedures performed, the cost of histopathological examination in every case is substantial. It is our opinion that routine histopathological examination of disc specimens cannot be justified on clinical grounds alone, and that there are more cost-effective options for dealing with medico-legal and academic concerns. Surgeons should consider the clinical presentation, results of laboratory and imaging studies, and the intraoperative findings to determine when to send a disc specimen to the pathologist.

### ACKNOWLEDGEMENTS

We thank Dr. Nazmi Sari for his helpful comments in preparing this manuscript; the Health Records Services and the Department of Pathology of the Saskatoon Health Region for assistance with the data collection and members of the Canadian Spine Society who responded to the email survey.

### REFERENCES

1. Boutin P, Hogshead H. Surgical pathology of the intervertebral disc. Is routine examination necessary? *Spine*. 1992;17:1236-8.
2. Daftari TK, Levine J, Fischgrund JS, Herkowitz HN. Is pathology examination of disc specimens necessary after routine anterior cervical discectomy and fusion? *Spine*. 1996;21:2156-9.
3. Grzybicki DM, Callaghan EJ, Raab SS. Cost-benefit value of microscopic examination of intervertebral discs. *J Neurosurg*. 1998;89:378-81.
4. Reddy P, Williams R, Willis B, Nanda A. Pathological evaluation of intervertebral disc tissue specimens after routine cervical and lumbar decompression, a cost-benefit analysis retrospective study. *Surg Neurol*. 2001;56:252-5.
5. Wu AS, Fourny DR. Incidence of unusual and clinically significant histopathological findings in routine discectomy. *J Neurosurg Spine*. 2006;5(5):410-13.
6. Hasselblatt M, Maintz D, Goll T, Wildforster U, Schul C, Paulus W. Frequency of unexpected and important histopathological findings in routine intervertebral disc surgery. *J Neurosurg Spine*. 2006;4:20-3.
7. Raab SS. The cost effectiveness of routine histological examination. *Am J Clin Pathol*. 1998;110:391-6.