

PNEUMOCONIOSIS: INTER-READER VARIABILITY IN THE CLASSIFICATION OF THE TYPE OF SMALL OPACITIES IN THE CHEST ROENTGENOGRAM*

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COAL workers' pneumoconiosis is recognized by certain fairly distinctive roentgenographic appearances and a history of an appropriate occupational exposure. It is divided into 2 types, simple and complicated. The former is recognized by the extent and profusion of small opacities present in the chest roentgenogram.⁸ These are divided primarily by their shape into regular and irregular types, and secondarily by their size. Regular opacities are thus designated according to their dimensions as either p, q, or r and irregular opacities as s, t, or u. The p type of opacity measures up to 1.5 mm. in diameter, the q between 1.5 and 3 mm. and the r between 3 and 10 mm. In regard to irregular opacities, no dimensions are given; however, the s type opacity is described as fine, t as medium, and u as coarse or blotchy. The extent of the inter-observer variation that occurs when films are being categorized for pneumoconiosis has been recognized for some time; nevertheless, most studies have restricted themselves to quantifying the variation that occurs in categorizing the profusion of small opacities rather than to quantifying that which occurs when differentiating the types into p, q, r and s, t, and u.³⁻⁶

This study is an attempt to determine the degree of observer variation reported, when chest roentgenograms with pneumoconiosis are being categorized according to the type of small opacity present.

MATERIAL AND METHOD

Over the past 5 years the Appalachian Laboratory for Occupational Respiratory

Diseases has been conducting a large epidemiologic survey of the respiratory status of a sample of working coal miners. Between 1969 and 1971 over 9,000 miners had chest roentgenograms taken in the first round of examinations. The second round started in July, 1972 and is presently continuing. Many of the participants have had films taken in both rounds. Four physicians have been involved in the interpretations of the films. Each used the UICC Classification; however, all 4 have not read the whole set of films taken in both rounds.

From the first round of examinations 8,523 chest roentgenograms were selected while a further 929 were selected from the second round. Films read as complicated pneumoconiosis were excluded. In the first round comparative readings were available from only 2 readers, C and D, but in the second round the sample was interpreted by C as well as by 2 other readers, A and B.

Inter-reader variability was quantitated by computing the percentage of disagreements among readers according to the type of opacity recorded. Readers A, B, C, and D were compared 2 at a time by cross-classifying their readings. For the reasons stated above, A and B could not be compared with D. An example of such a cross-classification is illustrated in Table 1 for readers A and C. Those films in which there were disagreements as to type are counted in the off diagonal cells. Films were designated as "negative," if small opacities were not found. This should not be taken to imply that all roentgenograms with small opacities were read as simple pneumoconiosis, since a small number of

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TABLE I
CROSS-CLASSIFICATION OF READER A VERSUS READER C
ACCORDING TO TYPE OF OPACITY

Reader A																	
	Nega- tive*	Irregular			Regular			Irregular and Regular									
		s	t	u	p	q	r	ps	pt	pu	qs	qt	qu	rs	rt	ru	
Negative*	548		33	4	4	148		2	1			10	1				
Irregular	s	2	1	1	2	3			1			2					
	t	7		5	1	18						2	1				
	u																
Regular	p	5		2	2	13						1					
	q	19		6		44	6					5	2			1	
	r	1		1	1	2	3										
Irregular and Regular	ps	1			1												
	pt					2											
	pu																
	qs					2											
	qt	1				2	2								1	3	
	qu																
	rs																
	rt																
	ru																

Of the 929 films read, 35 per cent lie in the off-diagonal cells, *i.e.*, the bold faced numbers.

* Roentgenograms in which small opacities were not found.

the total sample was read as subcategory o/i.

RESULTS

The percentage of disagreements among readers in the classification of type is illustrated in Table II. It is apparent that the number of disagreements between C and D is enormous (86 per cent), between A and B moderate (38 per cent), between A and C moderate (35 per cent), and between B and C slight (19 per cent).

Table III shows the percentage of films which were read as negative and positive; *i.e.* with and without small opacities. The positives are broken down into regular, irregular, and both regular and irregular small opacities for each reader. Readers A, B, and C classified the majority of roentgenograms as negative; in contrast, D read the majority as positive. Of the positive films, regular nodules were most frequently

recorded by A, B, and C, while irregular opacities were most frequently recorded by D.

Table IV contains the percentage of regular opacities classified as p, q, or r. Readers A, B, and C assign type q more frequently than p or r. A reads it almost exclusively (91 per cent), and B and C assign it 73 and 53 per cent of the time, respectively.

TABLE II
PERCENTAGE OF DISAGREEMENTS BETWEEN READERS
IN THE CLASSIFICATION OF THE TYPE OF OPACITIES

Readers	Per Cent
<i>2nd Round Sample</i>	
A vs. B	38
A vs. C	35
B vs. C	19
<i>1st Round Sample</i>	
C vs. D	86

TABLE III

PERCENTAGE OF FILMS CLASSIFIED AS NEGATIVE* OR AS SHOWING THE PRESENCE OF REGULAR, IRREGULAR OR BOTH REGULAR AND IRREGULAR SMALL OPACITIES

Reader	Negative*	Regular	Irregular	Both
<i>2nd Round Sample</i>				
A	63	28	6	3
B	85	5	5	5
C	81	12	5	2
<i>1st Round Sample</i>				
C	82	10	6	2
D	13	0.5	47	39.5

* Roentgenograms in which small opacities were not found.

DISCUSSION

The results of the study indicate that inter-reader variation in the classification of the type of small opacity present in the films showing pneumoconiosis is appreciable. There is disagreement in a minimum of 1 out of 5 classifications and in a maximum of 1 out of 1.16. Although D almost never agrees with C (14 per cent), A, B, and C are not too dissimilar. The fact that D reads so many films as positive partly explains the inconsistencies between him and the other readers, but he also reports irregular opacities much more frequently. The average percentage of disagreements among A, B, and C is approximately 31 per cent, or 1 out of 3. Although A, B, and C all read predominantly regular opacities, A differs from the others in the more frequent assignment of type q.

Since the UICC Classification is used extensively to categorize chest films for coal workers' pneumoconiosis, the extent of the inter-observer variability that occurs with its use should be clearly appreciated. From previous studies, disagreements among readers as to the 4 major

categories of profusion have been recorded in approximately 40 to 50 per cent of the roentgenograms.^{5,6} When the elaborated 12 point scale is used, disagreement is even more frequent. Since there is a 40 per cent or more disagreement according to major category and a further 30 per cent according to the type of opacity, the use of a scale which combines profusion and type should lead to marked reader to reader variation. Thus there are 3 regular and 3 irregular type opacities which can be assigned individually or in combination, with the result that there are 63 possible combinations in which small opacities may be classified. The 15 categories employed in Table 1 should be considered the most frequent and could be combined with the UICC 12 point scale of profusion. With the exception of subcategories o/- and o/o the scale would consist of 15 type classifications with each of the remaining ten profusion subdivisions, and this serves to emphasize the possible inter-reader variation and does much to explain the lack of consistency found in this study.

It has been suggested that progression of pneumoconiosis should be measured by trying to assess separately the increases in small regular and small irregular opacities. Over-all progression would be the sum of the individual progression of the regular and irregular opacities considered separately. If such a system is to be used, the plethora of possible combinations is bound to lead to undue inter-reader variability. On the other hand, if progression is re-

TABLE IV

THE FREQUENCY OF VARIOUS TYPES OF SMALL ROUNDED OPACITIES ACCORDING TO READER

Reader	p (per cent)	q (per cent)	r (per cent)
A	4	91	5
B	27	53	20
C	20	73	7

corded by estimating the combined increase of both opacities together, without trying to separate them, less variation should result.

Whether it is important in coal workers' pneumoconiosis to differentiate regular from irregular small opacities and to further subdivide them according to the size, is at present unknown. There is some evidence that the r type of regular opacity has a different pathology from the other regular opacities (p and q). Its etiology may be related to the presence of the rheumatoid diathesis.¹ In addition, miners with the p type of opacity have been shown to have a marginally lower diffusing capacity than do those with type q and r.⁷ Nonetheless, it must be remembered that so far it has not been possible to show a pathologic distinction between the p and q type of radiographic opacity. Further studies are needed before it can be claimed that there is any useful purpose served by attempting to differentiate between the various types of small regular opacities.

Irregular opacities are observed much less frequently in coal workers' pneumoconiosis than they are in certain other pneumoconioses, *viz.* asbestosis. Moreover, while there is no doubt that they may be seen in coal workers' pneumoconiosis, the assumption that their presence is a consequence of the inhalation of coal dust is much more debatable. Again, as yet there is no pathologic explanation for the presence of irregular opacities in CWP; however, there is some evidence to support that cigarette smoking rather than retention of coal dust is responsible.²

CONCLUSION

The inter-observer variation that occurs in the differentiation of the various types of small opacities present in the chest roentgenograms of working miners was quantified. In approximately 2 out of 3 films there was disagreement as to the type of small opacities present. Since this variation is appreciable, epidemiologic studies that depend on the differentiation of these types of opacity should involve a majority

opinion from several interpreters rather than relying on 1 reader only. In addition, the rigid training of readers periodically by the same standards should help to keep this variation within acceptable limits.

Finally, the progression of coal workers' pneumoconiosis should be quantified by assessing simultaneously the combined increase of both regular and irregular opacities. If progression is to be independently determined for each type of small opacity and then summed to obtain the over-all progression, the procedure will almost certainly lead to an unacceptable amount of inter-observer variation.

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