CORRELATION OF CHEST FILM AND LUNG FUNCTION ANALYSIS IN PATIENTS WITH SILICOSIS

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INTRODUCTION

Numerous studies treating the subject on the correlation between X-rays of a patient with silicosis and a pulmonary function test can be found in today's literature. However, only a mere correlation between the two methods of examination could be demonstrated. The possible reason for this may be the inaccurate description of the X-rays which in all current publications was conducted using the ancient silicosis classification. For this reason we investigated a sizable patient collective with mixed dust silicosis for reasons of correlation and, in the process applied the new precise ILO-classification of 1980 in it's expanded version. In the course of this, the attempt was made to draw up a sum index which will register the crucial parameters of the chest X-ray, in order to establish the relation to the pulmonary function.

MATERIAL AND METHODS

Our material consisting of 283 miners was to be studied in a survey at our hospital. In addition to the clinical examinations, chest X-rays p.a. and lateral were made according to the technique suggested by the ILO. The coding was effected by two examiners employing the ILO-classification. In case of deviations a renewed classification was jointly carried out. The pulmonary function analysis involved the measurement of the vital capacity, the resistance, the intrathoracal gas volumina (ITGV) as well as the blood gas analysis.

The obtained data was statistically worked out applying the Chi-Square-Test and the regression analysis.

RESULTS

In Figure 1 it can be seen that 40% of the experimentees showed no signs of large opacity, in 20% an A-shadow, in 30% a B-shadow and in 10% a C-shadow was evident. The analysis indicating on which side the opacity was located revealed type A to always be single sided, type B to be mostly single sided and type C to be predominantly both sided ($p = 0.001$). Figure 2 demonstrates the distribution of the individual categories of profusion.

Sections S1 and S2 are predominant, thus groups 0/1 to 2/3. A similar distribution can be found in the size of the small rounded opacities, although hereby the categories p/p to p/q are dominant; 20% show larger spotty shadows. There was a correlation between the formation of small rounded opacities, inasmuch as large opacities turned up significantly more often when more formations of small rounded opacities were apparent in the pulmonary fields.

In the correlation of radio-morphological variation to the bronchial resistance, a significant augmentation in resistance was observed while the size of large opacities increased ($p = 0.05$). Most characteristic was the effect in B- and C-type shadows (Figure 4). At first, the number of large opacities, the size of small rounded opacities, the category of profusion as well as the distribution over the 6 pulmonary fields seemed to be of no importance. We then divided the patient collective into simple and complicated CWP. A positive correlation between the category of profusion and an increased bronchial resistance in patients without large opacities was found (Figure 5). Thus, the dominating factor influencing the resistance is to be found in the formation of large opacities.

There are many reasons for the lacking influence of the formation of small rounded opacities on the resistance. Following extensive epidemiological investigations Ulmer and Reichel have found the obstruction not to be an immediate result of pneumoconosis, but rather a result of the increased incidence of bronchial catarrhs in persons suffering from silicosis. An additional critical factor is the loss of elastic fibers which again will lead to small airways disease (Legg et al.). From a purely qualitative point of view, this lack of correlation between radiomorphologic and pneumofunctional analytical findings is clearly described in observations made by Marek. He conducted comparative examinations between miners, arc welders and persons exposed to asbestos and found concrete differences between size, form and number of pneumoconiotic small rounded opacities, however, there was no correlation between X-rays and progressive pneumofunctional disorders.

The vital capacity shows a clear and significant correlation to the size of the large opacity (Figure 6). In the same manner a statistically significant relationship to the number of large lesions was observed.

With increasing size of small rounded nodes, a statistically proven decrease in vital capacity was detected, while the number of small rounded opacities expressed in category of profusion showed no relation to the vital capacity, at most, a tremendous reduction of VC after an increasing category of profusion could be observed ($p = 0.073$). The influence of the vital capacity by the large opacity's size may at first be

explained by a decrease of intact tissue, on the other hand, however, the formation of an emphysema also plays a certain part. Yet, it must be considered that this fibrotic reaction in anthracosilicosis which leads to an increase of restrictive functional disorders occurs much less than in asbestosis (Ruckley). The lack of correlation to the formation of small rounded opacities could possibly be due to the fact that the small spotty shadows are often surrounded by an emphysema leading to a significant functional cut back, however, the X-ray picture will give cause for a much too low classification. At all events, the perinodular emphysema, however, shows no correlation to the silicosis degree (Hieber).

The comparison between type of lesion, the number of large opacities and the distribution over the pneumatic fields revealed no correlation whatsoever to the ITGV. Merely an increasing category of profusion indicated a trend towards an increase of ITGV ($p = 0.12$). This fact can be explained through observations made by Worth and Smidt, suggesting that already an early state of silicosis will lead to a significant bronchiolitis with bronchiolectasis as well as a dynamic bronchiolostenosis with a constructive formation of an emphysema. These alterations are radiomorphologically not ascertainable, yet they have an enormous influence on the pulmonary function and hereby especially on the ITGV. Furthermore, it should be considered, that an increase in the ITGV occurs with every chronic exposure to dust, thus making the disruption in pulmonary function silicosis unspecific (Ulmer).

The blood gas analyses exclusively demonstrate a dependency to the number of large opacities; an increase in number causes a statistically significant increase in the carbondioxide pressure as well as a decrease in the oxygen pressure, whereby the latter occurs only when there are bilateral lesions. The missing correlation to the formation of small rounded nodes may be due to the fact that in the case of an anthracosilcosis a fibrotic reaction happens only following an extended exposure, which then may lead to a disruption in the gaseous interchange.

We chose two of the 24 supplementary symbols available in the ILO-classification to investigate for a possible correlation to the pulmonary function. We selected the symbols em and tb to be the most profitable expecting a most likely relationship between morphology and function. The symbol em was coded in a total of 159 (56%) experimentees (Figure 7). The explanation for this large number is that the symbol em is not clearly explained in the ILO-classification and that the radiological definition is unclear seeing that no less than 36 radiologic symbols are described which are compatible with an empyhsema. Beyond this, the critical examination of the single symptoms is generally impossible since those structures of small rounded nodes and large opacities which are of interest are being superimposed. Nevertheless, in a medium or severe increase of ITGV a significantly more frequent coding of the symbol em was received.

The symbol th was applied to 68 (24%) experimentees. No correlation to the pulmonary function analysis was evident in this group. The reason for this is the fact that a coding of the symbol tb happens most often when there are inactive apical localizations of pulmonary tuberculosis present which are of no importance to the pulmonary function.

In order to achieve an exact correlation of several radiological parameters with one single pulmonary functional analytical parameter each, a score for the radiological findings was introduced. The large opacities includinq their size, the small rounded opacities in size and distribution as well as the allocation over the pulmonary fields were given a value between 1 and 3, merely the location of large opacities received only half a point value, because no correlation could be obtained in previous single results. With an increasing sum index a significant boost in resistance ($p = 0.006$) as well as an important decrease in vital capacity was noted ($p = 0.0395$).

This result signifies that our originally stated assumption holds true, namely of a positive correlation between radiomorphologically comprehensible parameters, which can be metrically documented using symbols according to the ILO-classification. This conformity is of statistical significance in a large patient collective. Yet, the attempt to project the results on to the individual experiment turned out insufficient and uncertain because in the isolated case drawing to a safe conclusion from the X-rays to the anticipated pulmonary functions is impossible.

CONCLUSION

1. Severe silicosis with small rounded opacities having a category of profusion of 2/3–3/3 as well as large opacities of type B and C occure significantly more along with an increase of resistance. The number of lesions, as well as the size of small rounded opacities and their distribution over the six pulmonary fields have no influence on this functional parameter.

2. The size of large opacities and their number as well as the size of the formation of small rounded nodes significantly correlates with the vital capacity and vice versa.

3. An evaluation of the ITGV on the basis of radiologically comprehensible parameters is only possible in modestly severe and severe augmentations of the ITGV. Here the symbol em was coded much more frequently.

4. A correlation between X-rays and blood gas analysis exists only if several large opacities are apparent in both lungs and this holds true for hypercapnia as well as for a diminution in oxygen pressure.

5. By the establishment of a score, which takes into account all radioparameters including their various importance, a statistically significant correlation to resistance and vital capacity was found in the total collective. In the isolated case, however, the evaluation of the pulmonary function by means of radiological parameters is not reliable enough, thus making the use of such a score when applied to expert interrogations not sufficiently adequate.

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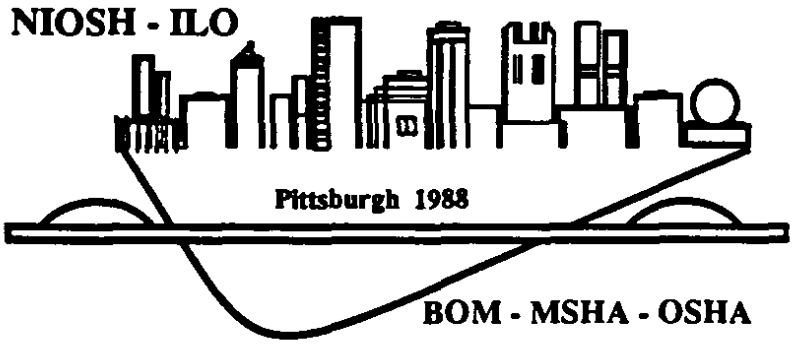

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