Differentiating between Benign Pleuritis and Mesothelioma by Radiograph using ILO 2000 Classification

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Abstract

A mesothelioma epidemic in asbestos consuming countries is anticipated within 30 years. Recognition of this malignant disease is essential in order to avoid advanced cases being found after it is too late to apply a possible cure. We aimed to depict radiographical findings of benign pleural abnormalities and those indicative of malignant mesothelioma. The ILO 2000 International Classification of Radiographs of Pneumoconioses, a widely used classification for medical screening of pneumoconioses, was revised in order to systematise decisions on types of pleural thickening: plaque and diffuse pleural thickening. The costophrenic angle obliteration is taken as a prerequisite of diffuse pleural thickening, that is usually formed after benign pleural effusion. Existence of advanced pleural thickening makes it difficult to detect other abnormal findings, including malignancy, on radiographs. In this presentation, some cases with malignant complication are shown to depict differences between benign pleural diseases and malignant mesothelioma. There is a need to distribute clinical information on benign and malignant cases related to asbestos among Asian countries in order to standardize the medical screening system in this region. In the present study, some cases with mesothelioma or benign pleuritis on chest X-ray are presented.

Introduction

A mesothelioma epidemic in asbestos consuming countries is anticipated within 30 years. Recognition of the malignant disease is essential in order to avoid advanced cases being found after it is too late to apply a possible cure. We aimed to depict radiographic findings of benign pleural abnormalities and those indicative of malignant mesothelioma. For this purpose we selected a set of digital radiograph films (including a mesothelioma case) which we suggest could, at some future date, be incorporated into the standard film set used in the ILO classification of radiographs of pneumoconioses. However, in this report, we focus on a workshop we held in Thailand on the ILO 2000 International Classification of Radiographs of Pneumoconioses (ILO 2000 classification), where we used this set of digital radiographs, prepared by the Japan Pneumoconioses Study Group (JPSG).

The ILO 2000 classification, a widely used classification for medical screening of pneumoconioses, was revised in order to systematise decisions on types of pleural thickening: plaque and diffuse pleural thickening. The costophrenic angle obliteration is taken as a prerequisite to diffuse pleural thickening, that is usually formed after benign pleural effusion. Existence of advanced pleural thickening makes it difficult to detect other abnormal findings, including malignancy, on radiographs. Also the category “me,” for mesothelioma, was introduced to show the importance of

the disease among the dust-exposed.

As the epidemic of dust-related occupational health problems has gradually spread from industrialized countries to developing countries, public health measures should be taken effectively to minimize the adverse health effects among those countries. It is needed to distribute clinical information on benign and malignant asbestos-related cases among Asian countries, one of the regions where an epidemic of the diseases may occur, in order to standardize the medical screening system in this region.

We aimed to discuss the usefulness of the ILO 2000 when interpreting chest X-rays of asbestos exposed workers, especially those with pleural effusion. The revised ILO classification added the category "me" for mesothelioma, as stated above. Preliminarily, we have performed a trial to assess improvement of physicians' basic knowledge and reading proficiency of mass lesions in pneumoconioses, both with silicosis and asbestosis, after they took the introductory ILO workshop. Possibilities of introducing new modalities into medical screening of asbestos-related respiratory diseases were also discussed.

Participants and Methods

Thirty Asian physicians, who participated in the ILO workshop in Bangkok, Thailand in July 2004, were asked to answer three mini quizzes before and after the 4-day course. At the end of the course, they were also asked to classify two chest radiograph films according to the ILO 2000 classification.

The statements in the three mini quizzes, which participants were asked to mark as true or false, were as follows: 1) Silica exposure increases malignant mesothelioma; 2) tuberculosis is a common complication of Silicosis; and 3) Asbestosis causes fibrosis in bilateral lower lobe of lungs.

The two films given to participants to classify by ILO 2000 classification were: 1) a film with high profusion and large opacity, and 2) a film with pleural effusion and mesothelioma. Both had CT verification and the one showing mesothelioma also had pathological verification.

The digital radiograph films were prepared by the JPSG. The JPSG has accumulated case series with conventional CXR, digital radiograph (DR), a digital X-ray technique using amorphous silicon flat-panel detector, and high-resolution (HR) CT that uses thin-slices (less than 3 mm) and a high-resolution algorithm for reconstruction of the image. Thirty DR films with typical findings have been tentatively selected to show film quality of DR. This set could be used as reading material in introductory courses of ILO classification and to provide candidate films for inclusion in some future revision of the ILO standard film set.

Results

The attendees were drawn from a wide variety of fields: nine radiologists, eight occupational physicians, two public health physicians, two general physicians, one internist and other chest physicians attended the workshop. Some missing answers for quizzes or reading results were explained by the fact that participants sometimes left the workshop to attend patients or to perform other duties They had been practicing medicine for 3 months to 30 years, so their experiences varied widely. Other participants did not answer the questionnaire.

The percentage of the mini quiz marks among 26 participants who gave answers improved from 74.4 before the course to 80.8 after the course. Three out of 8 physicians with middle grade marks

improved their grade after taking the course, while only one out of 6 physicians with the worst marks had a better mark after the course. Therefore, physicians with middle grade marks seemed to find it easier to improve their grade than the physicians with the worst marks.

Reading results for the case with highly profused small rounded opacities and large opacities agreed well among the participants. Sixteen among the 21 participants classified the case as category 3, while 3 participants classified it as category 2 and one participant skipped profusion. A majority of them agreed that the size of the small opacities lay somewhere around q/r, r/q, r/r and 3 other participants chose q/q or q/t. All the physicians detected large opacities, two thirds of them chose size A and the rest chose B.

As for the mesothelioma case, most of the participants saw unusual shadow but no small opacities. Fourteen of them interpreted the unusual shadow as suggesting mesothelioma, four among them also suspected cancer. Another doctor suspected only cancer, three others suspected other diseases and another three physicians did not think of malignant diseases but correctly described the presence of pleural effusion.

Discussion

Medical Screening by Radiograph: surveillance and training

The medical screening for asbestosis by radiograph is sometimes a gateway to diagnosis of malignant respiratory diseases including mesothelioma, as the population at risk for both diseases is the same, although it is not designated as screening for malignant diseases. The ILO workshop was shown to be effective for obtaining knowledge and X-ray reading skills on pneumoconioses. In this study, there were no participants with lower marks after the course compared to marks at the beginning of the course. The purpose of the ILO workshop on pneumoconioses was to provide an introductory education on ILO classification, which plays an important role in the fulfillment of the WHO/ILO Global Programme for Elimination of Silicosis. The goal of this elimination programme states that silicosis as an occupational health problem should be eliminated by 2030 by effective cooperation within an international framework. Although the programme is for silicosis elimination, the ILO workshop covers pathological and radiological aspects of asbestos-related respiratory diseases.

This tentative result suggested, however, that rearrangement of materials and teaching methods used in the workshop may benefit introductory participants more than the workshop in its present form. But designating the course as “introductory” does not necessarily mean it is an easy course. As the study of pneumoconioses involves occupational health, it includes clinical aspects, occupational health and safety aspects, legal aspects and aspects of the public health surveillance system. The usual participants with clinical backgrounds found the content of this course covered too many fields of interest and they could not follow all the content of the course. As the course deals with silicosis, coal-miners pneumoconiosis, and asbestosis, it would be better to have both a knowledge based and reading proficiency based summary at the end of the course, in order to clarify which are the core points of the course that all the participants should know.

ILO classification and recognition of mesothelioma

One of the differences before and after the year 2000 revision was the addition of the category “me” to the list of additional findings in the ILO 2000 classification sheet, which was a step forward in helping physicians to detect mesothelioma cases. The authors would propose further to have a

standard or reference film of a typical mesothelioma to give physicians a definite idea of what mesothelioma looks like on a chest radiograph. In order to encourage more physicians to detect mesothelioma, training courses that demonstrate chest x-ray findings of the disease are essential.

Although the radiographic findings of mesothelioma are not specific and sensitive enough, signs of solidified chest wall and presence of unilateral pleural effusion are some important findings indicative of malignant mesothelioma. Garg and Lynch[1] stated that mesothelioma shows "freezing the hemithorax" as it grows. This prevents the contralateral medialstinal shift associated with a large effusion. As the occurrence of a pleural effusion in a patient with past asbestos exposure suggests malignant mesothelioma, it is important to differentiate between an effusion associated with mesothelioma and that with benign asbestos pleurisy, which is usually recurrent and bilateral. Their article nicely reviewed prevalences of these findings, and gives us a clue as to how to start differential diagnosis from a radiograph.

The ILO classification of radiographs of pneumoconioses has enabled semi-quantification of radiographic findings of pneumoconioses in a reproducible manner. As taking one PA radiograph is a relatively cheap and accessible means of examination that allows classification of pneumoconioses, radiography enables the screening of large numbers of exposed workers to determine whether they have pneumoconiotic opacities or not. ILO classification with a conventional radiograph system, however, leaves some problems to be solved in the future. It uses 1960s films, original film of standard is not available now, conventional films demand large room for storage, and so on. New modalities, including digital X-ray techniques, one of which was used to produce JPSG materials, should be considered in future revision of the classification.

Digital X-ray techniques: available for asbestos-related diseases?

Digital techniques have been widely introduced into medical apparatus, including radiological diagnostic measures. Digital radiography is a system that is able to produce digital data of X-ray examination. At present there are basically two streams of technology: digital storage phosphor radiography and an amorphous silicon flat-panel detector system. The flat-panel detector system does not need an imaging plate and directly changes the x-ray image into digital data with minimum step by fluorescent layer. This employs the so-called "digital X-ray camera" with 43 cm × 43 cm flat-panel detector that consists of 160 μm × 160 μm sensors. On the other hand, the storage phosphor system involves scanning the imaging plate instead of the x-ray film in order to obtain digital data.

It has been 4 years since the Japanese Ministry of Health, Welfare and Labour first accepted the storage phosphor digital x-ray system, which is widely known as computed radiography or CR, as a substitute of conventional CXR for medical screening of pneumoconioses. In Japan, dust-exposed workers are classified by the Japanese classification, which is a radiograph classification system ~~as~~ similar to ILO 2000, using the storage phosphor CR system. Unfortunately, the flat-panel detector has not yet been accepted, mainly because the system was too new to be fully understood by experts at that time and partly because civil servants in the ministry in charge were unwilling to endorse the more practical decision. Contrary to the Japanese government's choice, most researchers prefer the newer technique of digital X-ray, the flat-panel detector system. It does not mean, however, that phosphor storage system is too old to use.

There has been controversy over the introduction of digital techniques into radiological screening of dust-exposed workers for pneumoconioses, including asbestos-related respiratory diseases.

Arguments against introducing computed radiography have been: 1) inferiority of image quality produced by computed radiography that was only capable of producing 2/3 sized films[2)], and 2) possibility of improper manipulation of the radiographic image. When applying digital radiography for medical screening of dust-exposed workers it is difficult to compare subject film to standard film of the ILO classification, and even more difficult to compare soft copy of the subject's X-ray to the standard. The National Institute of Occupational Safety and Health (NIOSH) of the United States, the main user of the ILO classification of pneumoconioses, does not approve the use of digital X-ray techniques for medical screening of pneumoconioses.

The amorphous silicon flat-panel detector has been studied very recently, and Fink et al and Hennings et al have shown the superiority of the flat-panel detector over conventional radiography when depicting the anatomical structure of lungs[3 4)]. These studies showed that the amorphous silicon flat-panel detector produces similar or better images compared to a conventional radiography system. Both the phosphor strorage[5)] and the flat-panel[6)] systems detect lesions and calcification overlapping the mediastinum or diaphragm better than conventional radiography. But some researchers still think that conventional radiographs depict parenchymal lesions better than both types of digital radiographs, especially for detecting small rounded opacities and interstitial opacities, including reticular opacities and ground glass opacities. Ishigaki et al have reported that digital and conventional radiographs were not statistically different in detecting subtle interstitial opacities[7)]. Woodard et al show that the sensitivities of detecting CT-proven nodules (mean diameter 1.5 cm) by digital and conventional radiographs were 66% (95%CI, 54-76%) and 64% (95%CI, 52-74), respectively[8)].

CT/HRCT for medical screening for the asbestos-exposed

Another issue in digital techniques of radiological diagnosis is computed tomography using high resolution algorithms. The high resolution algorithm we employed involved using thin collimation, GE bone algorithm and targeting, for reconstruction. Applying this technique, secondary lobules surrounded by interlobular septa can be observed. As the secondary lobule is where pathological change occurs in diffuse lung diseases, including pneumoconioses, HRCT gives us useful information on the early manifestation of pneumoconioses.

Application of this classification may differ from country to country where it is used as a measure of secondary prevention of dust-induced respiratory diseases. It may depend on the availability of CT apparatus and implications of CT screening[9)] for dust-exposed individuals, social interest or needs for dust-induced respiratory diseases, and so forth. In fact, although 67% of Japanese hospitals possess CT scanners, and even though this percentage is exceptionally high, CT screening is not obligatory for classification of pneumoconioses according to governmental regulations. Japan has been using chest X-rays for legitimate screening of dust-exposed workers since 1960. Recently, the Scientific Committee of the Ministry of Health, Welfare and Labour, Japan has recommended that pneumoconiotics undertake annual spiral CT exams in order to screen for lung cancer and the Pneumoconioses Law has been revised to include this statement.

On the other hand, some European countries, namely Finland [10)], Germany [11)] and France [12)] have started HRCT screening programmes. However, CT scanners are not as abundant in Japan as in these countries, and there has been added pressure for screening for lung cancer and mesothelioma in Europe because of the public recognition of asbestos as a potent carcinogen. Also, the Helsinki criteria [13)] agreed in 1997 may have convinced European researchers to introduce HRCT for screening for earlier manifestations of asbestosis or asbestos-related pleural abnormalities than

irregular opacity 1/0 of the ILO (1980) radiographic classification. By the utilisation of this HRCT classification, earlier recognition of dust-induced occupational lung diseases would become possible and positive test individuals will increase largely in number; if the causative dust was known to be carcinogenic they could then be subjected to cancer screening by spiral CT.

As described above, target diseases of medical screenings for dust-exposed individuals are of two kinds: non-malignant respiratory diseases and malignant diseases. Although screening of dust-exposed individuals for assessment of pneumoconioses has been performed in most of developed countries, not many countries have introduced screening programmes for occupational lung cancer. Japanese pneumoconiosis law legitimises medical screening by chest X-ray for dust-exposed workers at risk of contracting dust-induced benign respiratory diseases, while for individuals with carcinogenic dust exposure another law legitimises chest X-rays for detection of malignant respiratory diseases. German researchers have already developed a CT/HRCT classification to detect very subtle findings up to tumours and have performed a survey of over 600 dust-exposed workers [14)]. In their protocol non-malignant respiratory diseases were screened by HRCT, while malignant respiratory diseases were screened by spiral CT. The latter technique has a lower resolution than HRCT but, theoretically, has no gap between slices. A similar practice was used by a Finnish group [10)]. They have developed their own Fibrosis Grading system to assess the clinical severity of each case by HRCT. Their results showed the superiority of the grading by HRCT to ILO classification through receiver operating curve (ROC) analysis.

Whatever high-tech modalities are introduced, secondary prevention is certainly not a measure that will decrease the number of new cases. Finding cases by medical screening using chest radiographs may not directly result in a reduction of new pneumoconiosis cases. That will only happen when people, including both employers and employees, recognize the scale of the losses that dusty workplaces engender. So our work is a starting point for installing preventive measures in workplaces. Where there is no recognition of a disease, there will be no measure to prevent it.

Conclusion

The ILO workshop so far has been effective as an introduction to the systematic classification of radiographs of pneumoconioses. The workshop may be more effective when introducing quizzes to show participants key points, as the workshop covers a variety of aspects of dust-induced occupational health problems. The JPSG film set will provide a good source of best quality films with CT proof, some of which may serve as future candidate films for use in a revision of the ILO standard film set.

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