THE PREOPERATIVE CHEST X-RAY

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The Oxford English Dictionary defines routine as "a regular course or procedure, a more or less mechanical or unvarying performance of certain acts or duties". Over the past 20 years a chest radiograph has become a routine part of the assessment of a patient prior to general anaesthesia. It is right that we should periodically confirm, or perhaps question, our reasons for performing any investigation which has become routine, particularly when there is some hazard, however small, to the patient as a result of the examination. One must weigh the benefits against the risks. Obviously the benefits are going to be greater in preoperative chest radiography in patients with symptoms or physical signs referable to the chest, than in patients with no chest symptoms.

Patients with no chest symptoms or physical signs.

There are two reasons for the routine chest radiograph in this group: (1) to reveal unsuspected disease; (2) as a baseline for postoperative care.

Preoperative chest radiography provides an opportunity to screen the population for chest disease. In this country though, it is doubtful whether random radiography of all persons is now justified. The use of mass radiography was widely introduced in the 1940s. Its success in the detection of pulmonary tuberculosis led to the view that every person, whether healthy or not, should have a chest X-ray at least once a year. This training, both of doctors and of the population, is difficult to dispel. In the 1940s 6.7 new cases of pulmonary tuberculosis were being discovered per 1,000 persons X-rayed (Springett and Eley, 1956). Nowadays, figures of 4.4 to 40.5 per 1,000 X-rays are found in developing countries, whereas in industrial countries such as Great Britain, only 0.2 to 4.4 unknown cases of active pulmonary tuberculosis are discovered per 1,000 X-rays (Neumann, 1972). As a result, the use of random mass miniature X-ray surveys of the population has now been greatly reduced. In South-West London in 1972, the incidence of pulmonary tuberculosis in the general public attending the mass miniature units was 0.6 per 1,000, whereas the incidence in patients referred by general practitioners was 5.8 per 1,000 (Nash, 1972). Neither group would be symptom-free, but the general practitioner group would consist mainly of patients with chest symptoms. Furthermore, the incidence of tuberculosis in rural areas is about half the incidence in urban areas like South-West London (Registrar-General, 1971), and the incidence in males is almost twice that of females (Department of Health and Social Security, 1973).

Other conditions which may be found on a chest radiograph in a symptomless patient include malignant neoplasm, benign tumours, sarcoidosis, pneumoconiosis, and congenital cardiac and vascular abnormalities. In elderly patients, particularly obese females, fixed hiatus herniae may be seen behind the heart shadow. Some of these conditions will be detected by physical examination, and apart from lung cancer and hiatus herniae, their incidence without symptoms is extremely low. Lung cancer without symptoms is detected in only 0.27 per 1,000 X-rays (Brett, 1959). This is such a low incidence that random X-rays would not seem justified for detection of this disease. There is good evidence, however, that survival from lung cancer after surgical treatment depends on how often routine chest X-ray examinations are made, and Nash, Morgan and Tomkins (1968) suggest that men over the age of 55 who are smokers should be examined at 6-month intervals to achieve the best survival. Also, Stoloff and Stein (1972) found that those who are compelled to have annual chest X-rays have a higher survival rate than those who are self-referred or referred by physicians.

Brill, Ewing and Dunn (1973) examined the radiographs of 1,000 healthy children in New York City and found 6% to be abnormal. The abnormalities consisted of minor skeletal anomalies and none required treatment. The authors concluded that preoperative chest radiography should be considered on an individual rather than a routine basis in the paediatric age group.

Regarding the incidence of pulmonary tuberculosis and of lung cancer in this country, it would
appear that preoperative chest radiographs are not justified as a routine in asymptomatic patients in all age groups. The examination should be selective and each case assessed individually. Patients in the high-risk groups, such as smokers over the age of 50, immigrants who have not previously been X-rayed, or patients on steroid treatment, should have preoperative radiographs. Factors also to be taken into account are the history of a previous normal chest radiograph, and the interval since that examination. The investigation of the surgical condition may have included a recent radiograph of the chest; for example, it would be indicated in a search for metastases in patients with malignant disease.

In cases of severe injury, a chest radiograph should be taken to exclude hidden injury to the thorax or its contents, as part of the surgical assessment, particularly if the patient is not fully conscious.

There is a case to be made for having a preoperative X-ray as a baseline for possible postoperative complications. It is of value to know for certain that a shadow seen on a postoperative film was not present preoperatively. This aids in diagnosis by eliminating chronic disease. A normal preoperative radiograph may be of value in assessing the vascular changes associated with pulmonary embolism (Kerr, Simon, and Sutton, 1971). The justification for a preoperative radiograph will vary according to the severity of the operation and the likelihood of postoperative chest complications. A young healthy adult undergoing minor surgery would hardly require a radiograph on these grounds, whereas an elderly patient undergoing a major operation would do so.

The risk.

The hazard of radiation will obviously have a greater influence on the decision to X-ray a patient without symptoms than in the case of a patient with symptoms. When considering the risk of radiation, account has to be taken of the risk to the individual and to the population as a whole, of leukaemia or other malignant disease, and of life-shortening (somatic effects), and of increase in mutations (genetic effects). In the small doses involved in chest radiography, both the somatic and the genetic effects are likely to be very small. For a chest examination the mean bone marrow dose has been calculated as approximately 40 m.rad (I.C.R.P., 1970); the gonadal dose is less than 10 m.rad. This compares with 200 m.rad mean marrow dose and 1,000 m.rad gonadal dose on examination of the lumbar spine. However, chest radiography makes up 30–50% of the population bone marrow dose from diagnostic radiology, as it is one of the commonest examinations made.

Morgan (1971) suggests that the price paid in deaths per year in the United States, as a consequence of radiation damage from diagnostic medical exposure, is 3,500 to 29,000; of these, 2,000 to 26,000 are due to genetic deaths. This is an extremely pessimistic estimate, and assumes a linear dose-effect relationship and that each genetic mutation results ultimately in death. Friedell (1971), commenting upon these figures, stresses that it is important to consider information per unit of dose, and adjudges that without the benefit of X-rays an additional 200,000 would have died in one year in the United States.

The estimates of the risks of leukaemia following radiation of the bone marrow are extrapolated from known increases in the incidence of leukaemia at the level of some hundreds of rads. The only information on lower doses is obtained from the increase in leukaemia found in children who have previously been irradiated whilst in utero (Stewart, Webb and Hewitt, 1958). The Adrian Committee (Ministry of Health, 1966) concluded that an individual undergoing some 20 average X-ray examinations (all areas) in the course of a lifetime would have his annual chance of contracting leukaemia raised eventually by at most 2 per million above the level of about 50–60 per million for a person having no X-ray examination.

It will be seen from these widely differing figures that there are no hard-and-fast rules which can be laid down regarding the risk of radiation. There are quite wide differences in the doses measured by different workers, and there is disagreement on the interpretation of the data. There is unanimity of opinion, however, that whatever the dose, all ionizing radiation is harmful, and the younger the person the more harmful it is likely to be.

Patients with chest symptoms.

The discussion of the possible findings on a radiograph, in a patient with symptoms or signs referable to the respiratory or cardiovascular systems, would embrace the whole of chest and cardiac radiology. It is not the purpose of this paper to give an exhaustive summary of chest radiology, but rather to draw attention to some of the ways in which the
The chest radiograph may be of value in preoperative assessment. The anaesthetist has to balance the influence and danger of dysfunction of respiration or circulation against the hazard of delay in surgical treatment. In this assessment the radiograph is complementary to the clinical examination. There are several conditions, such as asthma and bronchitis, where the radiograph may be entirely normal. Some simple respiratory function tests might then be much more informative. But in most lung diseases the radiograph is of considerable value in demonstrating abnormality, and delineating its extent. In addition, there is much information to be obtained from the radiograph about the physiological state of the respiratory and cardiovascular systems.

For example, when widespread emphysema has been diagnosed radiologically (fig. 1), respiratory function tests invariably show severe airways obstruction, which is more or less irreversible (Simon, 1964). Close correlation can be shown between the radiographic features of emphysema, the findings of airways obstruction in respiratory function studies, and the presence of structural emphysema as seen on pathological examination (Reid, 1967). In pulmonary emphysema, the mid-lung pulmonary arteries appear narrow, straight, and sometimes of uniform calibre over several centimetres instead of tapering towards the periphery (Laws and Heard, 1962). There is a rather abrupt reduction in size between the hilar and the mid-lung vessels. When these changes are seen in more than four zones, the condition is widespread. Other features of emphysema—the low flat diaphragm, large retrosternal translucent zone in the lateral view, the narrow vertical heart, and bullae—may be present. Local emphysema may cause compression of adjacent lung.

The chest radiograph is a simple investigation for estimation of the severity of elevation of pulmonary venous pressure in left-sided heart failure, or in mitral valve disease (fig. 2). Simon (1958) demonstrated that in patients with mitral stenosis there is engorgement of the upper lobe veins and narrowing of lower lobe veins. Unfortunately, in correlating physiological studies with the degree of dilatation of upper lobe veins alone, it is found that there is not a direct proportional relationship. The appearances are effected by increase in pulmonary artery pressure, which causes reduction in peripheral vessels and enlargement of the proximal arteries, affecting the lower zones first, then becoming widespread. The combined effects of pulmonary venous pressure.

**Fig. 1.** Widespread emphysema. There is reduction in the size and number of the mid-lung and peripheral lung vessels in more than four zones. The diaphragm is low and flat.

**Fig. 2.** Mitral valve disease. The upper lobe vessels are dilated and there is constriction of lower lobe vessels indicating elevation of pulmonary venous pressure.
and arterial hypertension are, therefore, to reduce the peripheral pulmonary blood flow, so that the venous engorgement becomes less. Analysis of these combined changes on the plain radiograph, and correlation with physiological studies, show that assessment attains a clinically valuable degree of accuracy (Milne, 1963), and in a patient with mitral stenosis or left-sided heart failure the recognition of dilated upper lobe veins and of pulmonary oedema may be a more reliable indication of the severity of the physiological change than the patient's symptoms or the physical signs.

An excess of sputum may be hazardous during anaesthesia in patients with bronchiectasis. The preoperative treatment of postural drainage and physiotherapy to reduce the amount of sputum will be influenced by the location of the disease. The plain radiograph (fig. 3) reveals changes highly suggestive of bronchiectasis in the great majority of patients with this condition (Fraser and Paré, 1970). Crowding of the pulmonary vessels, parallel line shadows of thickened bronchial walls, cystic spaces and irregular opacities are typical changes. The cystic spaces may be round, or oval, up to 2 cm in diameter, and may or may not contain air-fluid levels; they may be numerous, and cause a "honeycomb" appearance. A bronchogram is necessary to determine the full anatomical extent of the disease.

Pneumothorax as a problem during anaesthesia with nitrous oxide and oxygen was reported by Hunter (1955). Due to the different solubilities of nitrogen and nitrous oxide in blood, the pneumothorax may increase in size during anaesthesia. It may then compress the lung and cause mediastinal shift. A similar danger is theoretically present in large air-containing lung cysts, and in obstructive emphysema. The recognition of a pneumothorax on a preoperative radiograph is therefore of great importance to the anaesthetist. The essential diagnostic feature is the identification of the visceral pleural line (fig. 4). There are no pulmonary vessels seen in the pleural space beyond this line, but the overall density of the partially collapsed lung is not increased until it is greatly reduced in volume. If a pneumothorax is suspected a radiograph taken erect in full expiration may enhance these features.

The size of a pleural effusion can be demonstrated on a chest radiograph. A typical effusion (fig. 5) is seen as a density in the costophrenic sulcus, laterally and posteriorly on the standard chest radiograph.

![Fig. 3. Bronchiectasis of both lower lobes. Numerous cystic spaces are present causing a "honeycomb" appearance in the lower lung fields.](image)

![Fig. 4. Right-sided pneumothorax. The visceral pleural line (arrowed) is the essential diagnostic feature.](image)
FIG. 5. Left-sided pleural effusion. A density rising in the axilla is typical of an effusion.

The density curves gently downwards with a smooth concave medial and anterior margin. The larger the effusion, the larger the density, and the more the normal thoracic structures are displaced. If there is no underlying pulmonary collapse, the heart and mediastinum will be displaced towards the opposite side. However, quite large effusions which do not show these typical features may collect between the lung and the diaphragm (fig. 6). This sub-pulmonary collection of fluid can be mistaken for the shadow of the diaphragm, but it has a peak which is lateral to the peak of the normal diaphragm. On the left side the top of the density of the effusion is separated from the gastric air bubble. On a lateral radiograph there is a step in the configuration of this pseudodiaphragm at the oblique fissure, since a subpulmonary effusion does not extend anterior to this. A radiograph in the lateral decubitus position will demonstrate the presence of this type of effusion, and will show its size (fig. 7).

The existence of tumours, cysts (fig. 8), enlarged lymph nodes or a retrosternal goitre which are displacing and compressing the main airways, will be seen on the plain radiograph, but tomography and perhaps a barium swallow may be necessary to demonstrate accurately the degree of compression.

The timing of the preoperative radiograph in patients with symptoms or physical signs will depend upon the nature and history of the disease. If the lung disease is of recent onset, then a radiograph immediately before surgery is necessary, but if it is a chronic condition, then a radiograph some days or weeks previously may be adequate.

CONCLUSION

Preoperative chest radiographs are essential in persons with respiratory and cardiovascular symptoms, as they are complementary to the clinical examination. When there are no symptoms or physical signs the examination should be performed in high-risk patients, such as smokers over the age of 50 and immigrants who have not been examined previously.
Elderly obese patients who may have unsuspected hiatus herniae, and severely injured patients, should have a preoperative radiograph. Each case should be assessed individually. A preoperative chest X-ray should not be a routine, however.

REFERENCES


