

Publication No. II
THE JOHN ALEXANDER MONOGRAPH SERIES
On Various Phases of Thoracic Surgery

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The POSTOPERATIVE CHEST

Radiographic Considerations After Thoracic Surgery

Written for radiologists and surgeons who must interpret the X-Ray picture of the chest following the changes produced by surgical intervention. Since it is part of a series of books commemorating the late John Alexander, emphasis on the surgery of pulmonary tuberculosis is appropriate.

By using a relatively high KV technique (120 KV - 130 KV) with a stationary grid, a highly discriminating radiograph has been obtained. This has permitted a clearer analysis of the shadows seen in the postoperative radiograph.

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By careful selection from well over 300 suitable cases which clearly highlight these various elements and combinations of elements, a reasonably complete analysis of the postoperative chest has been possible.

These elemental illustrative cases have been arranged so as to delineate their respective responsibility in producing the whole postoperative picture. Since progression or regression of these changes affects the prognosis, the undeniably important element of time has been reckoned with in this study.

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The Postoperative Chest

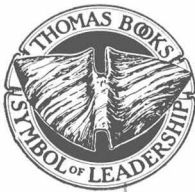
RADIOGRAPHIC CONSIDERATIONS
AFTER THORACIC SURGERY

by

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A Memorial to John Alexander (1891-1954)
Professor of Surgery, University of Michigan

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Affectionately dedicated to our wives

Foreword

SURGICAL

IT is universally accepted that the chest x-ray is a very revealing and informative picture, and permits the recognition of changes which are indicative of disease. The perspicacity with which experts interpret shadows seen in the intact and anatomically undisturbed chest is truly amazing.

When the chest is entered surgically, shadows are recorded on the x-ray film as in the undisturbed chest, but interpretation becomes complex because of the addition of "postoperative" changes. The postoperative film will reveal clearly the handiwork of the surgeon, and serves as a yardstick with which to measure progress and to prognosticate the end result.

Thoughtful reflection upon the problems of interpretation presented in the postoperative chest x-ray indicate at once the fact that many of the shadows recognized as deviations from the preoperative film are more or less expected constants under the circumstances. Thorough familiarity with these expected changes and their proper evaluation sets the limits of the range of normal. It is rather to be expected that the range of normal in the postoperative chest will be broader than in that of the intact and undisturbed thorax, since the same amount of postoperative edema, the same amount of residual hemothorax or pneumothorax or dressings, etc., need not occur from case to case.

It is then evident that the appearance of a "postoperative chest" represents a composite of many usual and expected changes, all within the range of normal for the given circumstance.

An attempt to analyze these changes and break them down into their component elements has permitted greater assurance in prognosis. In the present volume we are attempting to pass on to our readers the results of such analyses.

The technical aspects of the surgical procedures are those commonly employed. A posterolateral incision is preferred, the pleura being entered through the bed of a resected rib. Pulmonary resection is carried out by individual ligation of the vessels at the appropriate hilum, and the bronchus is likewise treated as an independent structure, being closed with simple sutures of silk.

Drainage by one medium-sized rubber tube, evacuating the gutter inferiorly and posteriorly, and placed intercostally, is used after all thoracotomies except when pneumonectomy is carried out. A smaller tube so placed in the axilla that it evacuates the upper anterior chest is generally employed in addition to the lower tube when a lung is partially resected.

The post-pneumectomy chest is rarely provided with tube drainage. Instead, intrapleural pressures are adjusted at thoracentesis by removal or addition of air, as determined by the patient's symptoms, or by the position of the mediastinum as seen on the x-ray, and/or the intrapleural pressures as read from a pneumothorax manometer.

The drainage tubes are led off to waterseal bottles as an initial step. Suction is added to this system when indicated. Our postoperative routines are kept as simple as is consistent with good care.

RADIOLOGICAL

With the vastly increased volume of lung surgery being performed, the problem of interpreting postoperative chest radiographs has become increasingly important. In observing a rather large series of chest surgery cases, we were impressed by the number in which postoperative radiographs presented problems in interpretation, in which the "normal" was difficult to define. The cases presented herein represent a resume of our experience.

There are numerous papers in the literature concerning the various aspects of the expected postoperative changes after chest surgery and various complications encountered. The majority of these papers concern a single phase of surgical change, and a few provide some general concepts of x-ray diagnosis in evaluating the postoperative chest film.

Accordingly, we reviewed our material in an effort to separate the varying appearances encountered into proper categories, i.e., changes of extrapleural soft tissues, ribs, pleura, lungs and mediastinum. This approach helped us to define more adequately the expected changes in postoperative chests. Deviations from these anticipated changes could then be classified as abnormal or representative of complications.

We have classified the roentgen appearances encountered in our material in the following manner and have attempted to include examples of various categories:

I. Soft Tissues—Extracostal

- A. Hematoma and edema
- B. Air collections
 - 1. Incision
 - 2. Muscle
 - 3. Subcutaneous and fascial plane
 - 4. Air along neurovascular bundles
- C. Subscapular space air-fluid collections

II. Foreign Bodies

- A. Drainage tubes
- B. Dressings

- C. Pressure dressings
- D. Tape
- III. Ribs
 - A. Resection
 - B. Regeneration
- IV. Diaphragm
 - A. Elevation
 - B. Adhesions
- V. Mediastinum
 - A. Displacement
 - 1. To surgical side
 - 2. Away from surgical side
 - B. Fluid
 - 1. Increased "hilus" shadow
 - 2. Mediastinal exudate
 - C. Emphysema
- VI. Pleural Cavity
 - A. Air fluid collection
 - 1. General in pleural cavity
 - 2. Primarily apical
 - 3. Primarily anterior
 - 4. Loculated
 - 5. Basal
 - B. Hematoma or unusual exudate
 - C. Volume changes
- VII. Lungs
 - A. Rearrangement
 - 1. Fissures demonstrated, posteroanterior and lateral views
 - 2. Accessory fissures
 - B. Bronchus stump
 - C. Compensatory emphysema
 - D. Herniation of lung
 - E. Hematoma
- VIII. Complications
 - A. Excess air in soft tissues
 - B. Pneumothorax
 - C. Chronic pneumothorax or subscapular air
 - D. Mediastinal emphysema
 - E. Bleeding into soft tissues or pleural cavity
 - F. Mediastinal displacement

- G. Infection of surgical wound and/or empyema
- H. Bronchopleural fistula
- I. Infection about prosthesis
- J. Atelectasis
- K. Pneumonia

It has been our experience that routine x-ray studies performed with "high kilovoltage" technique consistently give more uniform radiographs and in general "yield" a greater number of lesions. Portable studies are utilized in the immediate post-surgical period. Our impression concerning our routine films was gained after using comparative studies with lower kilovolt techniques on all hospital admissions for a one-year period. Postero-anterior and lateral films are used routinely except in the immediate post-operative period.

Bilateral simultaneous bronchography is freely used as well as laminography in the anteroposterior and lateral views. Lateral laminography, incidentally, is utilized in many cases. This has proved of great value particularly preoperatively in predicting infiltration and cavity relationship to fissure, consequently the anatomic extent of disease. This procedure has been aptly described as a "bloodless thoracotomy" by one investigator. Thus, the surgeon can anticipate the extent of disease and determine whether definitive surgery should be preceded by pleural space diminishing procedures. Laminography, similarly, can be utilized postoperatively for the definition of infiltration, air collection and lung rearrangement.

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The publisher also made our task simpler with patience and excellent guidance.

H.T.L.
A.M.P.
M.M.

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The Postoperative Chest

Fig. 1. *Incisional Swelling.*

- (A) One notes areas of soft tissue swelling along the right lower lateral chest wall. This soft tissue change is one which is expected. It consists chiefly of edema, minimal hematoma, and at times extracostal air collections. In this particular case, air is not noted to good advantage, but subsequent illustrations will demonstrate various forms of subcutaneous and intramuscular air collections.
- (B) Line drawing of (A).