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Effect of Lateral Recumbency on Pulmonary Function

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It is the general belief that in the lateral recumbent position, which is a frequent position during bed rest, the lower chest, the one which is in contact with the mattress, expands less and consequently its function is diminished. Several authors1-6 have investigated this function by means of clinical observations, radiographical and spirometric examinations but the result of these investigations and the interpretations of the findings were contradictory.

Adams and Pillsbury1 believed that the excursion of the lower hemidiaphragm had a greater respiratory efficiency. Webb, Foster and Gilbert2 found the tidal movement of the lower hemidiaphragm greater than that of the upper; however, after an interval of about an hour it equalized. Contrary to this finding, Pierson and Newell,3 who made their investigations primarily in dogs, did not find the tidal ventilation to be equalized after a longer time.

Vaccarezza and his collaborators4 found increased oxygen consumption through spirometric determination, greater complemental air, and increased vital capacity of the recumbent lung on a person who maintained the same position for two weeks; however, they supposed that the recumbent lung is in elastic repose.

Rothstein, Landis and Narodic5 found spirometrically that oxygen consumption of the recumbent lung is increased. This finding was perplexing to them and they explained this increase as due to the larger capillary bed from relative congestion.

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Wade and Gibson found that the diaphragmatic excursion, measured by a special device, showed a slightly greater excursion of the lower diaphragm. They believed, however, that this increased excursion is not sufficient to increase the respiratory function because the expansion of the lower part of the thoracic cage is reduced.

The purpose of this investigation is to demonstrate, by clinical observations substantiated by radiographic findings, that the function of the recumbent lung is increased and the function of the upper lung is decreased.

**Hypothesis, Method and Findings:**

It was supposed that in lateral recumbent position the function of the upper lung is diminished because in this position the upper shoulder is caudad and the upper hip is cephalad and the arm usually rests on the chest wall. These factors exercise a splint-like action on the upper chest. The function of the lower lung is actually increased because the lower shoulder in this position is cephalad which pulls up the shoulder girdle and the hip is caudad. This permits maximum excursion of the ribs. This excursion is further facilitated by the fact that the patient is lying on two prominent bony structures—the hip and the shoulder. This position is illustrated in Figure 1. Mattresses exert some resistance against the lower chest but not enough to prevent the pulling action of the shoulder girdle where several secondary inspiratory muscles are attached. To substantiate this supposition by radiological findings, x-ray films in right lat-
eral decubitus were taken of a slender man (Figure 2), a slender woman, and a stout, short man in deep inspiration and full expiration. X-ray film was also taken of the stout, short man, in left lateral decubitus, for comparison. Roentgenogram in the upright position was also taken to show the physiological expansion of the chest and normal excursion of the diaphragm during the full phase of vital capacity (between full expiration and deep inspiration) (Figure 3).

All exposures were made from the standard six feet distance, the patient

FIGURE 2: Right lateral recumbent position in full expiration shows the right diaphragm at the level of the ninth posterior rib while the left is a little over the 11th. The same position in deep inspiration shows both diaphragms at the level of the 11th posterior rib. Note the marked airlessness of the right lung and the narrowing of the intercostal spaces in the expiration film.
lying in lateral recumbent position on a stretcher covered by a thin, one inch mattress.

It was found that in lateral recumbent position the hemi-diaphragm of the lower lung moved from the 11th posterior rib up to the ninth posterior rib between deep inspiration and full expiration, while the hemi-diaphragm of the upper lung hardly moved. In addition to this impressive finding, it could be seen that the under lung is markedly less aerated in expiration while the change in aeration of the upper lung is negligible. It can also be seen that in spite of the lower lung being in full expiration stage during deep expiration—as we can judge from the relative airlessness and the elevated diaphragm—the ribs of the lower thorax do not approximate correspondingly to the full expiration stage. This is the effect of the pulling action of the high shoulder girdle which does not permit the ribs to approximate and keeps the apical part of the lung in a constant anatomical expansion. Furthermore, it was evident that while the ribs over the under lung moved during respiration to a certain extent, in spite of the pull of the shoulder girdle, the ribs of the upper lung moved little or not at all. A marked shift of the mediastinum toward the recumbent side could be seen, especially on the plate of the young woman whose mediastinal structures are still elastic.

X-ray films of the short, stoutly built person show movement of the upper hemi-diaphragm. This moderate excursion of the upper chest wall is explained by the fact that the lower shoulder girdle and hip of this stout person are not so prominent; the lower chest leans over the mattress and consequently the upper shoulder and hip approach each other to a lesser extent permitting some excursion of the upper chest wall. The film of the slender woman showed the excursion of the lower hemi-diaphragm and the widening of the intercostal spaces even more pronounced. This is explained by taking into consideration that the hips of women are more prominent.

FIGURE 3: X-ray films taken in upright position of the same persons, show normal diaphragmatic excursion.
Comment

All of these findings, which are: the change of the intercostal spaces of the recumbent part of the chest wall, the change in aeration of under lung, the marked excursion of the lower hemi-diaphragm, the almost unchanging picture of the upper chest wall, lung field, and hemi-diaphragm, and the increased oxygen consumption of the under lung, clearly indicate that in the lateral recumbent position the function of the under chest wall, pleura, and lung increased, and of the upper is decreased.

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