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Should the diaphragm be evaluated after abdominoplasty?

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The engine that moves air in and out of the lungs, sometimes referred to as the respiratory pump (or vital pump), relies on skeletal muscles, specifically the respiratory muscles. When the respiratory muscles contract, they create pressure gradients: negative to inhale and positive to exhale. With the exception of the diaphragm, all of the respiratory muscles have a secondary function as postural and chest wall stabilizers, forming and supporting the walls of the chest and abdomen. Quiet breathing is normally achieved by active inspiration, the diaphragm playing the major role, especially when the individual is in the supine position. The other inspiratory muscles contribute to quiet breathing, particularly when the individual is seated or standing. However, when higher levels of ventilation are required (e.g., during exercise) or when there are explosive events, such as coughing and vomiting, the other inspiratory muscles are strongly recruited, together with the expiratory ones. Expiration normally occurs as a passive return to functional residual capacity, and expiratory muscles do not usually contract in healthy subjects at rest.[1,2] Therefore, the diaphragm is the most important respiratory muscle. Diaphragmatic function can be assessed via invasive or noninvasive methods. The invasive methods require the use of esophageal catheters or ionizing radiation and are therefore not routinely used in clinical practice.[3,4] Ultrasound is a well-tolerated, noninvasive modality that allows quantitative measurements of diaphragm thickness and diaphragmatic excursion. When the diaphragm contracts, its normal movement is caudal, creating a piston-like effect to increase abdominal pressure and reduce pleural pressure. M-mode ultrasound allows the amplitude of the excursion of the hemidiaphragms to be quantified. The amplitude of excursion is defined as the maximal distance (from the end-expiratory baseline to the maximum height during inspiration) on the vertical axis of the M-mode ultrasound tracing of the echogenic line running between the liver (or spleen) and the lung, which corresponds to the diaphragm. The portability of an ultrasound device allows that measurement to be made directly at the bedside of patients, even of those who are critically ill. Reduced mobility of the diaphragm can be an indicator of muscle dysfunction.[5-7] Because of the major role played by the diaphragm, its dysfunction can have an impact on survival and quality of life, often being associated with dyspnea, exercise intolerance, and severe sleep disorders, including excessive daytime sleepiness.

The proper functioning of the diaphragm depends on three factors: innervation (i.e., phrenic nerve integrity); contractile muscle function; and the mechanical coupling of the diaphragm to the chest wall. Surgery can affect one or more of these factors, resulting in diaphragmatic dysfunction. Siafakas et al.[8] listed the following pathophysiological mechanisms that impair the function of the respiratory muscles after surgery: impaired neural control of respiratory muscles (e.g., after phrenicotomy); loss of the integrity of the respiratory muscles caused by the surgical incision; respiratory reflex mechanisms (phrenic nerve inhibition); a change in the length/tension relationship of respiratory muscles because of a change in functional residual capacity; a change in thoracoabdominal mechanics (e.g., due to reduction of the rib cage and/or abdominal compliance); the suppressive effects of pharmacological agents used for anesthesia and postoperative analgesia; specific surgical procedures (e.g., cooling during open heart surgery); and surgical procedures involving organs that affect respiratory muscle function (e.g., parathyroidectomy). The authors emphasized that some types of surgical procedures have a favorable effect on respiratory muscle function, whereas others influence it adversely. Abdominal surgery has a negative impact on respiratory muscles, the diaphragm in particular.[9,10] In fact, a shift to predominantly rib cage breathing after abdominal surgery indicates that the intercostal inspiratory muscles are more active than is the diaphragm in the postoperative period. In addition, MIP, MEP, and transdiaphragmatic pressure all decrease after upper abdominal surgery. Those decreases persist for at least 48 h after surgery and may not return to normal until a week after. In particular, the reported incidence of respiratory muscle dysfunction is very low (2-5%) after lower abdominal surgery, whereas it is considerably higher (20-40%) after upper abdominal surgery, the diaphragm being the muscle that is most affected in the latter.

Surgically induced diaphragmatic/respiratory muscle dysfunction can result in a number of postoperative pulmonary complications, including atelectasis and pneumonia, which can increase morbidity and mortality considerably. The study conducted by Fluhr et al.,[11] published in the current issue of the JBP, shows the negative repercussions that lipoabdominoplasty, a common type of cosmetic surgery, has for the diaphragms (and lungs) of healthy women. They showed that diaphragm mobility, assessed by M-mode ultrasound, was reduced in the first 10 days after surgery, as were lung volumes, and that both were restored to preoperative values after one month. Postoperative pain does not seem to seem to be a major indicator of diaphragmatic function, because it was reported by only 35% of women, in whom the amplitude of diaphragmatic excursion was similar to

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that observed in the women who reported no such pain. The authors attributed to the plication of the rectus abdominis next to the xiphoid appendix, and to the consequent increased intra-abdominal pressure, the cause for the reduced motion of the diaphragm. Therefore, surgery per se puts the diaphragm at a mechanical disadvantage, presumably because of a reduction in abdominal compliance and an increase in intra-abdominal pressure, also resulting in a restrictive ventilatory defect in patients undergoing this type of surgery.

The study conducted by Fluhr et al.[11] further confirms the need for physicians who deal with patients undergoing lipoabdominoplasty to be aware of the detrimental effects that the procedure has on the respiratory muscles, the diaphragm in particular. Physicians should be especially aware of the possibility that these complications will occur in healthy subjects or after surgical procedures that are not strictly linked to respiratory problems, as in the Fluhr et al. study,[11] as well as the chance that they will be present at hospital discharge despite appropriate postoperative follow-up. Such awareness should lead physicians to take the appropriate measures to minimize the occurrence of complications related to and reduce the magnitude of surgically induced respiratory muscle dysfunction.

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