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Biomechanic

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The Effects of Preoperative Botulinum Toxin A Injection on Respiratory System Function

Background:
Botulinum toxin type A has become an increasingly used tool in the preoperative management of giant abdominal wall hernias. Its primary objective is to “downstage” the hernia by inducing temporary paralysis of the lateral abdominal wall muscles, thereby increasing their compliance and enabling safer fascial closure. While the muscular and anatomical benefits of this approach are well documented, the potential effects on pulmonary function remain poorly studied, despite the involvement of the targeted muscles in the process of breathing.

Objective:
This study aimed to evaluate the impact of botulinum toxin type A on respiratory system function, using spirometry to assess whether any observed changes reflect true improvement, mechanical compensation, or potential impairment.

Methods:
This prospective, observational study included 37 patients with large abdominal wall hernias and a Loss of Domain component. All patients received 300 units of botulinum toxin type A injected bilaterally into the external, internal oblique, and transversus abdominis muscles under ultrasound guidance. Spirometry was performed before the injection and again on the day of surgery. Evaluated parameters included forced vital capacity, forced expiratory volume in one second, the ratio of forced expiratory volume to forced vital capacity, peak expiratory flow, maximum mid-expiratory flow, maximal expiratory flow at 75, 50, and 25 percent of forced vital capacity, forced inspiratory vital capacity. Results were analyzed using paired statistical tests with a significance threshold of $p < 0.05$.

Results:
No statistically significant changes were observed in forced vital capacity or forced expiratory volume in one second. However, statistically significant increases were recorded in maximum mid-expiratory flow and maximal expiratory flow at 50 percent of lung volume. Peak expiratory flow showed a trend toward improvement but did not reach statistical significance. These changes appear to reflect altered expiratory dynamics due to increased diaphragmatic excursion, rather than improved ventilation. Forced inspiratory vital capacity decreased slightly. Only two patients reported subjective changes in breathing.

Conclusion:
Botulinum toxin type A does not impair core lung volumes but induces mechanical changes that may affect airflow velocity. Standard spirometry may not fully reflect these dynamics, and further investigation is warranted to better understand respiratorv outcomes in this patient group.

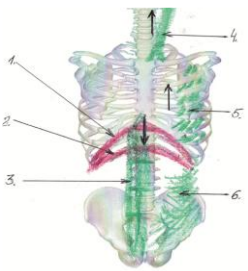

Figure 1. Mechanism of inspiration.
1. Position of the diaphragm at the beginning of inspiration.
2. Position of the diaphragm at the end of inspiration.
3. Rectus abdominis muscles.
4. Sternocleidomastoid muscle.
5. Intercostal muscles (anterior and posterior).
6. Lateral abdominal wall muscles (transversus abdominis, internal oblique, external oblique).

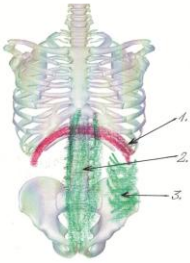

Figure 2. Mechanism of expiration.
1. Diaphragm
2. Rectus abdominis muscles
3. Lateral abdominal muscle group

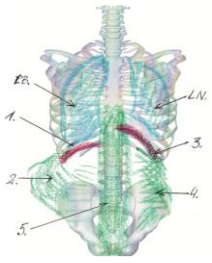

Figure 3. Diagram of Diaphragm Positioning and Abdominal Mechanics Post-BTA Injection.
1. Diaphragm position at the end of expiration following botulinum toxin administration.
2. Passive stretching of the lateral abdominal wall creating more space for the abdominal viscera.
3. Diaphragm position at the end of inspiration under natural (non-BTA) conditions.
4. Lateral abdominal muscle position at the end of inspiration under natural (non-BTA) conditions.
5. Rectus abdominis muscles (function preserved in both conditions).
6. LB – representation of lung volume at the end of expiration post-BTA.
7. LN – representation of lung volume at the end of expiration without BTA.