CHAPTER 40

EFFECT OF DIAPHRAGM PACING ON QUALITY OF LIFE: THE STATE OF ART

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INTRODUCTION:

The main goal of diaphragm pacing is to improve daily quality of life of the patients with decreased diaphragm contraction. [1]. The increase in quality of life is determined by effective breathing, good sleep cycles, lack of air hunger, decrease in time spent on non-invasive mechanical ventilation (NIMV), effective mobilisation, decrease in respiratory infections linked to mechanical ventilation (MV). In 1873, Schechter published the first direct stimulation of the phrenic nerve for neonatal treatment of asphyxia, reported by Hufeland [2]. After the first implantations at cervical level, the implantation site changed, moving to the pleural cavity with bilateral synchronous stimulations [3]. At cervical level the movements of the neck resulted in wire break down. The thoracic approach was regularly performed with success in a few centres in the world [4,5], then more recently a laparoscopic approach was developed [6,7]

The thoracic approach involves the use of video-surgery to make phrenic nerve dissection safer and reduce scars. This thoracic approach through bilateral small anterior thoracotomy requires general anaesthesia with double-lumen intubation to carefully place the electrodes around the phrenic nerve [1,4]. On both sides, the intrapleural electrodes are connected to the subcutaneous receivers. The largest multicentric study using the thoracic approach reported 165 patients with chronic hypoventilation [8] Implantation was bilateral in 100 patients and unilateral in 65. 81.81% of the patients had full success or significant breathing support. In 2008, Hirschfeld reported a prospective clinical study of 64 spinal cord injury patients. 32 patients who received the electrodes had reduced incidence of respiratory infections. The healthcare cost spent for the additional purchising of the device was offset in less than a year [9]. In 2011, Le Pimpec-Barthes and et al. published 19 patients with posttraumatic tetraplegia an done with congenital CHS. After reconditioning time of 6 weeks 16 patients achieved full and 2 received parital weaning form mechanical ventilation [4]. In 2012, Romera et al. reported higher survival rates in a group of 38 patients with high SCI tetraplegic patients who received the thoracal implantation (mean 21.78 years) compared with the 50 SCI patients who were on MV (mean 8.69 years) [5].

The laparoscoic procedure, intraperitoneal diaphragm pacing, involves the implantation of the 4 electrodes to each hemidiaphragms close to the phrenic nerve endings using a implantation needle [10]. The first step is the mapping of the diaphragm to find the best point to place the electrodes. Then each electrode is connected to an external stimulator percutaneously. The laparoscopic technique was evaluated by Food and Drug Administration (FDA) with 50 SCI patients and

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DPS of 16.1 months from symptom onset and 9 months from the start of NIV compared with NIV alone in Lechtzin's cohort (24,25). McDermott et al conclude that diaphragmatic pacing should not be used as a routine treatment for all patients with ALS in respiratory failure and add that they cannot exclude the possibility that it is beneficial in a subgroup of patients (14). At this point we suggest that adding the diaphragm ultrasound to the preoperative tests and having the thickness fraction measurement can provide a new *to go ahead criteria* for DPS. Moreover diaphragm ultrasound can show when to increase the time to spend on DPS during the day (Figure 4). With close monitoring of the patients who are on DPS, longer survival may be achieved in ALS patients.

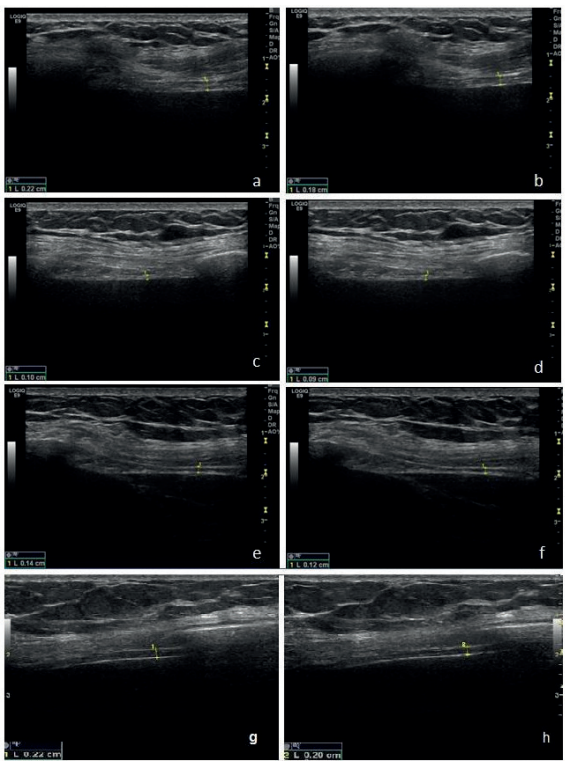

Figure 4: Diapgragm USG of the same patient at different intervals. a,b: End-inspiratory (EI: 2.2 mm) and end-expiratory (EE: 1.8mm) thickness measurements 4 months after DPS placement, patient is on 12 hours/day pacing. TF:22% c,d : 11 months after DPS. EI: 1 mm, EE:0.9 mm. TF:11% Patient started to experience dyspnea. Pacing is increased for 24 days/day. e,f: Patient is on 24 hours pacing for 5 months. EI: 1.4 mm, EE: 1.2 mm. TF:17%. g,h: 19 months after DPS placement. EI: 2.2 mm, EE:2.0 mm, TF: 10%.

The limitations of our study is the small sample size, short average follow-up and not having a comparison group such as patients using only NIV. Due to these limitations, we are unable to propose a meaningful safe zone however with the better understanding of the respiration dynamics in patients who underwent pacing, timing of the implantation will be precise. We do accept that diaphragm pacing alone can not be recommended as an alternative to NIV. Diaphragm thickness fraction measurement is a reliable tool to assess disease progression. This preliminary study showed that pacing may treat respiration insufficiency in select patients by increasing the thickness of the diaphragms. As the disease progression is heterogeneous and the cohort size is small, it is assertive to state that system may prolong survival by delaying ventilator dependence.

To conclude, diaphragm pacing in SCI patients and in ALS patients with excitable diaphragms can improve respiratory insufficiency by increasing the thickness of the diaphragms. Good patient selection should be done for successful pacing results. Although the lack of randomised trials to validate pacing is a contradiction, given the improvement in quality of life, it seems difficult and unfair not to propose the pacing.

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