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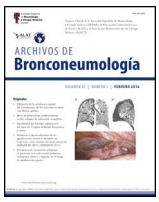

Editorial

Exercise Training Versus Neuromuscular Stimulation in Severe COPD☆

Entrenamiento físico frente a estimulación neuromuscular en la EPOC grave

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Exercise intolerance is a hallmark of severe chronic obstructive pulmonary disease (COPD), resulting from early onset of breathlessness and fatigue on exertion, due in turn to impaired oxygen uptake, reduced cardiovascular fitness and skeletal muscle dysfunction.[1] Exercise tolerance can be improved by aerobic and resistance training, which is typically packaged as part of pulmonary rehabilitation. Nonetheless, not everyone may benefit due to issues with poor uptake and completion, particularly in very severe disease[2] or following acute exacerbations,[3] and response isheterogeneous.[2] Furthermore, symptom burden may restrict patients' ability to perform whole body exercise at the intensity needed to induce meaningful physiological adaptations. Interest in neuromuscular electrical stimulation (NMES) as an alternative training modality in severe COPD has therefore grown steadily since early studies at the turn of the century.[4,5] There is now convincing evidence that NMES provides a valid stimulus to cause muscle adaptions,[6] and placebo-controlled data support a secondary effect on exercise tolerance.[7] But how does NMES compare to classic forms of training? And where might this modality fit in the exercise toolkit when supporting patients with severe disease? Here we consider NMES studies with active comparator, usually another training modality, to begin to understand a role for this modality in practice and suggest possibilities for the next generation of studies in this field.

NMES vs. Resistance or Endurance Training

In the largest comparative effectiveness trial, Sillen et al. randomised patients with severe COPD and lower limb weakness (n=120) to receive either high frequency NMES, low frequency NMES, or resistance training as the exercise component of an 8-week inpatient rehabilitation programme.[8] All three groups improved their exercise tolerance when compared to baseline, but quadriceps strength improved only in those allocated to high frequency NMES or resistance training. The lack of effect following low frequency NMES likely reflects an insufficient load being placed on the muscle, which can be difficult to achieve using low frequency currents without concurrent use of high stimulation amplitudes that patients can find uncomfortable. Absolute changes in strength were numerically greater following high frequency NMES than resistance training, though not statistically different between groups. This finding challenges the common assumption that resistance training produces greater muscular adaptation. A training effect from NMES is limited by the discomfort associated with high amplitudes currents applied to the skin plus the early onset of fatigue.[9] Contractions achieved with NMES typically equate to 15%–25% of one-repetition maximum,[6] although it should be remembered this reflects the periphery of the muscle working maximally and the rest not at all. Whilst this is low compared to what can be achieved with resistance training, it should be borne in mind that the latter has a higher metabolic cost, therefore in severe disease the added exertion may compromise regular training. Indeed, although the resistance training group in the study demonstrated appropriate training progression, and the use of isokinetic testing mimicked the training tasks, only a modest improvement of ~0.5 kg in quadriceps strength was observed.[8]

There are no data from randomised trials comparing NMES to endurance training, but two observational studies, including a "real-life" evaluation from the clinical setting by Coquart et al.,[10] are available. Consecutive patients (n=189) undergoing home-based pulmonary rehabilitation received resistance exercises with free weights, education, and psychosocial support for up to 9 weeks with once-weekly therapist visits. Additionally, patients received either endurance training using a stationary cycle (30–45 min 5 times weekly) or NMES (30 min, twice daily), which was offered to patients demonstrating poor performance during a step test.[10] Whilst the allocation protocol resulted in a better baseline performance among the endurance training group,

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after the programme similar percentage changes were observed in functional mobility and exercise capacity across cycling and NMES groups, and a similar proportion of responders in terms of overall health status.[10] Despite the methodological limitations, this work is a commendable example of how NMES can be integrated into clinical practice. The findings also corroborate an earlier report on a smaller cohort (n=50),[11] although the protocol was less explicit on when NMES was selected over endurance training.

NMES as a Training Adjunct

In many international settings, the exercise component of pulmonary rehabilitation is predominantly walking-based and has only a marginal effect on quadriceps strength and mass. Although supervised resistance training augments the overall strengthening effect, access to specialist resistance training equipment may be limited, particularly in the home setting and in low income countries. NMES may therefore have a role as a training adjunct to enhance lower limb muscle mass and function. A randomised pilot study (n=27) from Tasdemir et al. explored whether adding NMES to a 10-week pulmonary rehabilitation programme had additive effects on functional performance.[12] There were no significant inter-group differences in quadriceps strength, symptom burden or health status following the programme, but incremental shuttle walk test performance was significantly reduced following active NMES compared to placebo.[12] The authors concluded that "increase in exercise capacity is less important when NMES is used as an adjunct to pulmonary rehabilitation", but this interpretation questions the very hypothesis under investigation. We suggest that the described NMES programme (two 20 min sessions each week) offered an inadequate training dose – indeed good evidence of an added strengthening effect was also lacking – and, viewed in this context, the difference in exercise performance may represent a chance finding. An adequately powered study, ideally with measurements to demonstrate a mechanism of action, is justified.

NMES as a Training Precursor

Another role for NMES in severe disease may be as a precursor or bridge to more intense training or pulmonary rehabilitation. Whilst there are no data directly supporting this role, the pragmatic trial by Greening et al.[13] in which early rehabilitation following an acute exacerbation did not reduce readmission rates compared to usual care, provides some useful insights. Whilst much of the debate around this study concerns whether the intervention was 'pulmonary rehabilitation',[14] it is not widely considered a NMES study despite 90% of patients choosing NMES as their core training modality. The short length of hospital stay meant the dose of supervised training was modest (typically 3–4 sessions) and the home component was lightly supervised, resulting in poor adherence.[14] Interestingly, uptake of outpatient pulmonary rehabilitation following the trial intervention was higher in the control group (22% vs. 14%), perhaps suggesting that patients in the intervention group may have considered their rehabilitation needs to have been met.[13] This is unfortunate, as the post-exacerbation period represents a window of opportunity to engage patients inrehabilitation,[3] a notion supported eloquently by a health coaching study by Benzo et al.[15] in which pulmonary rehabilitation attendance was enhanced considerably in the 3 months following hospital discharge (50% vs. 33%). Given that patients view NMES as attractive at this time, and can be motivated to enrol for supervised training following recovery, it may serve as an interim measure offered clearly to complement rather than replace pulmonary rehabilitation services.

In summary, based on current evidence, NMES appears to be a reasonable alternative to resistance training if used as part of a comprehensive rehabilitation programme, particularly in advanced disease or where training intensity is limited by exertional symptoms. The lack of high-quality controlled data limits any comparison between NMES with endurance training or the role of NMES as a training adjunct. Further studies, with exercise (rather than muscle) endpoints are required before practical recommendations can be made.

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