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Sleep apnoea

The role of masseter muscle EMG during DISE to predict the effectiveness of MAD: preliminary results

Il ruolo dell'EMG del muscolo massetere durante la sleep endoscopy nel predire l'efficacia del MAD: nostri risultati preliminari

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SUMMARY

The use of a mandibular advancement device (MAD) increases the activity of the temporo-mandibular (TM) complex and masseter (MM) muscles with the risk of reducing treatment compliance. Predictors of treatment outcome are of importance in selecting patients who might benefit from MAD without side effects. The role of mandibular advancement (MA) during drug-induced sleep endoscopy (DISE) is controversial. In three cases (BMI < 30) affected by non-severe OSAS (AHI < 30 e/h), we recorded the surface EMG signal of MM activity during DISE. At follow-up all cases improved the AHI, two cases that showed transient increase of MM activity did not suffer from changes of overjet and did not complain of discomfort with the use of MAD. The case that showed a continuing increase of MM activity reported TM discomfort without changes of dental occlusion. EMG of MM during DISE may contribute to ameliorate the selection of cases amenable to treatment with MAD.

KEY WORDS: OSAS • Mandibular advancement • Masseter muscle • EMG

RIASSUNTO

È noto che l'applicazione dell'apparecchio per l'avanzamento mandibolare (MAD) aumenta l'attività del complesso muscolare temporo-mandibolare (TM) e del muscolo massetere (MM) con il rischio di ridurre l'aderenza al trattamento. Alcuni parametri clinici riconosciuti predittivi dell'efficacia del MAD sono già utilizzati per la selezione dei casi e tra questi l'avanzamento mandibolare (MA) simulato durante la "sleep endoscopy" è quello principale. Presentiamo qui i risultati della registrazione EMG del muscolo massetere in tre casi di pazienti normopeso affetti da OSAS non-severa (AHI < 30) sottoposti alla MA durante la "sleep endoscopy" e poi trattati con MAD. La poligrafia dinamica di controllo a distanza, documentava una significativa riduzione dell'AHI. I due casi che avevano mostrato un incremento transitorio dell'attività del MM durante la MA non riferivano effetti collaterali, l'altro, che aveva dimostrato un incremento persistente del segnale, riferiva al follow-up un "discomfort" in regione TM senza alterazioni dell'occlusione. L'EMG del massetere potrebbe contribuire a migliorare la selezione dei casi suscettibili di trattamento con MAD.

PAROLE CHIAVE: *OSAS • Avanzamento mandibolare • Muscolo massetere • EMG*

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Introduction

Obstructive sleep apnoea syndrome (OSAS) is a common sleep disorder characterised by partial to complete collapse of the upper airway despite continued respiratory effort often leading to hypoxia. OSAS affects over 25% of the adult population and is closely related to the obesity epidemic [1]. If untreated, it is recognised as a risk factor for hypertension, ischaemic heart disease and stroke [2 3]. To date, continuous positive airway pressure (C-PAP) therapy is considered the gold standard, but it is estimated that approximately 50% of patients will reject it or discontinue its use even after good initial compliance [4 5]. Surgical treatment has the advantage of 100% adherence, but is not recommended as first-line therapy due to its low success rate in unselected patients [6]. Hence, the choice of treatment, particularly in young individuals, mild or moderate OSAS or severe OSAS who are unwilling or unable to tolerate C-PAP, still remain the biggest challenge. The mandibular advancement device (MAD) is a conservative aid that overtime, thanks to intense research on its effectiveness, has emerged as a viable therapeutic alternative because it is not cumbersome, easily transportable and does not require electricity. The disadvantages are its relatively high costs, side effects (*i.e.* discomfort, excessive salivation and changes in occlusion and/or in the neuromuscular pattern of the face) and, to date, a lower mean success

rate than C-PAP. Therefore, predictors of treatment outcome are of importance in selecting patients who might benefit from MAD without side effects [7 8]. Apart from anthropometric and polysomnographic predictors including cephalometry, low AHI or BMI or age, female gender and supine-dependent-OSA [9 10], the simulation of mandibular advancement (MA) during drug-induced sleep endoscopy (DISE) is recently recommended by the European position paper on DISE [11].

It is well known that the use of MAD during sleep increases significantly the activity of the temporo-mandibular (TM) complex and masseter (MM) muscles [12]. The relationship between recorded forces and MA is almost linear. The pain-related TM disorders could be the result of the strain in the muscles. Moreover, a dose-dependent effect of MAD on occlusal changes has been suggested [13]. Herein, we first introduce the recording of electrical activity of MM during DISE in order to study its behaviour during the MA manoeuvre.

Clinical technique and technology

From May to September 2015, three cases of moderate OSAS (mean AHI: 22 e/h) were enrolled. They were males who refused C-PAP therapy with a mean age of 42 years, mean BMI of 25.5, normal overjet and without comorbidities, especially stomatognathic system disorders, previous treatments for OSAS or occlusion. All patients were submitted to DISE according to the technique described in our recent publication [14]. During DISE, in continuous mode, polysomnography (PSG) monitoring with the addition of the surface electromyography (EMGS) recording of the right and left masseter muscle activities (EMGS-MM) was performed. During the examination, the ENT physician performed the manual MA: for the time necessary to observe the effect by mean of endoscopic view, the mandible is gently advanced (up to 5 mm) by placing the fingers along the ascending ramus and angle [15]. The PSG technician marked on the trace the start and the end of MA (Fig. 1). The effects of MA on the airway and snoring and the electrical activity of the MM were recorded. In all cases, the sites of obstruction were retropalatal and oropharyngeal with a grade and pattern of obstruction > 50% and concentric respectively. During MA the respiratory space, in the sites of closure, is amplified consensually to the increase of blood oxygen level. In two cases, at the beginning of MA, the amplitude of EMG signal increased transiently, about 1-2 seconds. In the other case, the increased amplitude of MM activity lasted for the duration of MA. Basing on DISE findings, we recommended a MAD to all patients. After three months of treatment with a MAD "Bibloc" type (in compliance with the maximum protrusion of 5 mm), all cases were submitted to a PSG using MAD and to a dental visit to evaluate the amount of overjet. Moreover, each patient was questioned about TM discomfort. No significant difference was observed in the mean BMI when comparing the initial findings with that at the repeat investigation (mean BMI: 25). Post-treatment PSG with MAD showed a reduction of AHI ≥ 50% from baseline in all cases. The two cases that revealed a transient increase of electrical activity in MM did not have a change in overjet and did not complain of discomfort. On the other hand, the patient who showed a continuing increased signal of MM activity reported TM discomfort without a change of overjet.

Discussion

Nowadays the importance of treatment to prevent neurobehavioural and cardiovascular sequelae of OSAS is widely accepted. Non-surgical approaches include po-

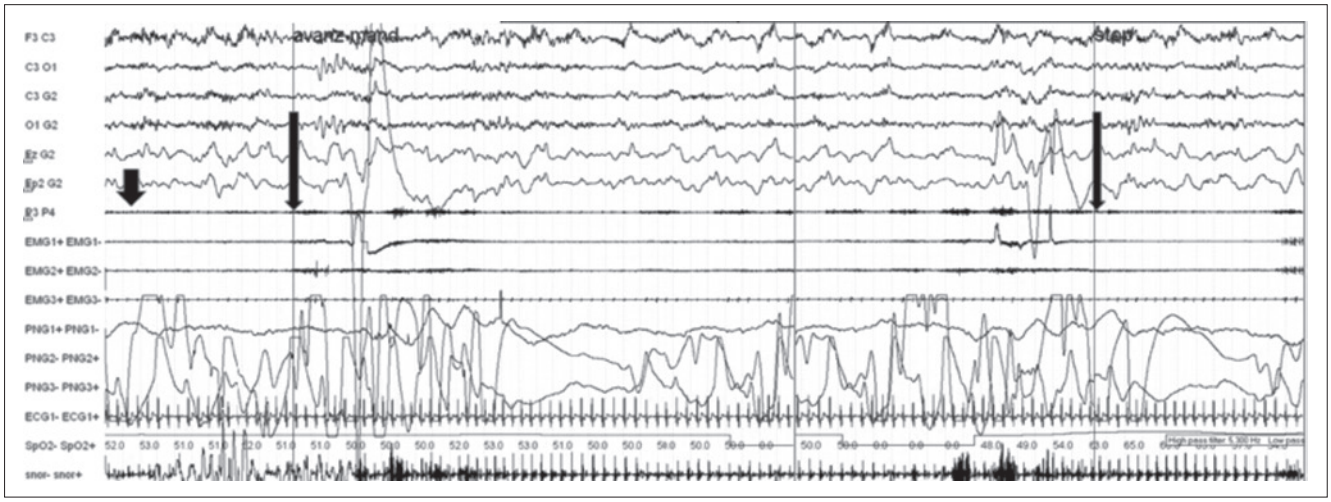

Fig. 1. Electrical activity of the masseter muscle (MM) during advancement of mandible. The short arrow marks the trace of MM-EMG and the longer ones mark, respectively, its beginning and end.

sitional therapy, C-PAP and MAD. In 1995, the *American Academy of Sleep Disorders* defined the following indications for the use of MAD: primary snoring, mild or moderate OSAS, or cases of severe OSAS for individuals who do not tolerate C-PAP [16]. These devices are easy to use, non-invasive and removable. On the other hand, they are expensive and associated with poor compliance [15].

Experimental and clinical studies have demonstrated that the efficacy of MADs depends on the degree of mandibular advancement, with a dose-dependent effect [17]. Nevertheless, in the literature the correlations between the increased activity of the TM complex and MM, due to the MAD use, and the TM discomfort or occlusal change have also been described [13]. Basing on these observations, it seems that the effectiveness of MAD is the result of a tight balance between the degree of mandibular advancement (the more advanced the mandible, the larger respiratory spaces) and muscular activity that determines the onset of side effects.

With the purpose to optimise the predictor value of intra-DISE MA for MAD success, we added the recording of EMGS of MM in the PSG. Herein the MM electrical activity and its behaviour during DISE are described for the first time. Kurtulmus et al. [12] introduced an interesting debate on the relationship between MAD efficacy and MM activity. They demonstrated that MAD during sleep, by activating the MM in mild and moderate OSAS, prevents the upper airway from collapsing. According to their results, all our cases showed an increase of EMG signal and, independently of EMGS-MM behaviour, a significant improvement of AHI. Nevertheless, we observed that the behaviour of MM activity was not unique: the increased EMGS-MM amplitude was transient or continuous. The patient who showed a non-transient EMG-MM increased amplitude, after three months of MAD use, suffered from TM discomfort.

Our results suggest that exist a close relationship between the benefit and disadvantages of MAD and moreover that the amplitude of its effective "field" of action may vary according to the individual. For this reason, the DISE is irreplaceable because it allows to concurrently appreciate the modifications of respiratory spaces and MM activity for extemporaneous integration of the data.

In the light of all these considerations, it is clear that the effectiveness of MAD will be critically dependent on its efficacy. The MAD must be titrated, and the degree of effective MA should be determined not simply on subjective clinical criteria, but also on objective data. In this way, our technique may help to address the need to establish more precise indications for MAD in order to decrease the failure rate by improving compliance and the outcome of treatment.

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