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Effects of the neuromuscular bandage as rehabilitative treatment of patients with drooling and intellectual disability: an interventional study

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Abstract

Background The aim of this work was to assess the effect of neurological bandages (Kinesio Taping) for managing saliva flow in patients with drooling and intellectual disability.

Methods Quasi-experimental study included 30 patients (20 male and 10 female participants) mean age of 15 years with intellectual disability and drooling [Public Special Education Centre in Cartagena (Murcia, Spain)]. Treatment consisted of the application of a strip of neuromuscular bandage applied in the suprahyoid area for a 3-month period. Efficacy was assessed by means of three clinical scales: the Sialorrhea clinical scale, the drooling rating scale and the drooling impact scale. These evaluations were performed at baseline, after 1 and 3 months of intervention.

Results Clinical improvements were obtained, showing statistically significant reductions in drooling after 1 month ($P < 0.001$) and 3 months ($P < 0.001$).

Conclusions The application of neuromuscular bandages in the suprahyoid muscle area can be a useful option for managing drooling in patients with intellectual disability.

Keywords drooling, intellectual disability, Kinesio Taping, sialorrhea clinical scale

Introduction

Drooling is defined as the unintentional loss of saliva from the oral cavity. It is considered normal in children up to the age of 18–24 months, in other words before neuromuscular control of the mouth has developed. In some cases, this may persist until the age of 4 years, although beyond the age of four, drooling is considered pathological (Mato *et al.* 2010; Silvestre-Rangil *et al.* 2011; Tello *et al.* 2012; Zeller *et al.* 2012; Dias *et al.* 2016). The causes of drooling include deficient motor control of the oral area, lip incompetence, certain malocclusions or tongue mobility disorders and neurological deficits including intellectual disability (Meningaud *et al.* 2006; Mato *et al.* 2008; Morales *et al.* 2008; Hornibrook and Cochrane 2012). Drooling has very negative consequences for the patient's life, as it requires constant attention, not only in the mouth area but also on clothing and other dampened objects, which in turn can provoke hygiene problems and an unpleasant odour. In addition, skin may suffer

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irritation and abrasions, accompanied by the increased probability of oral and peri-oral infections, especially *Candida albicans*, and in severe cases, excessive loss of body fluid, which can lead to dehydration (Chang *et al.* 2012; Lakraj *et al.* 2013; Silvestre Donat and Silvestre Rangil 2014; Taş and Çankaya 2015)

Drooling affects physical, psychological and social conditions and is difficult to treat. Its management demands a multidisciplinary approach. A number of therapeutic options have been described in the literature including conservative treatment, anticholinergic drugs (scopolamine), botulinum toxin, acupuncture and myofunctional therapy. Invasive treatments such as surgery that has been used in the past are reserved for those cases that do not respond to conservative treatment, or when collateral effects or interactions with other drugs render conservative treatment unacceptable (Tello *et al.* 2012; Silvestre-Rangil *et al.* 2011; Lakraj *et al* 2013). In this context, research seeks new and more effective techniques such as neuromuscular bandages.

In 1996, Kenzo Kase developed the Kinesio Taping (KT) method or neuromuscular bandage (Bicici *et al.* 2012; Estrada and Echevarría González 2013; Kaya Kara *et al.* 2015). The KT has been demonstrated to increase local circulation, reduce local oedema and provide a positional stimulus to the muscle, skin or facial structures due to its mechanism on exteroceptive and proprioceptive receptors (Bicici *et al.* 2012; Estrada and Echevarría González 2013; Caneschi *et al.* 2014; Kaya Kara *et al.* 2015; Mika*mi et al.* 2017).

The neuromuscular bandage is now being used to improve oral control in children with neurological and neuromuscular disorders and causes reductions in salivation and the frequency of episodes (Tello *et al.* 2012; Caneschi *et al.* 2014; Mikami *et al.* 2017). However, knowledge of the potential use of neuromuscular bandages for managing drooling remains limited. This study set out to assess the effect of the neuromuscular bandage in the management of saliva flow in patients with drooling and intellectual disability.

Materials and methods

The study protocol followed principles established in the Declaration of Helsinki and was approved by the University of Murcia Research Ethics Committee (approval granted 16/10/2014). Full information about the study design and purposes was provided to the participants' parents and caregivers.

Identification and recruitment of participants

Of 143 eligible special education pupils, informed consent to take part was granted by the representatives of 62 subjects. Of these, only 30 presented drooling inclusion criteria.

This single-centre, longitudinal and prospective study was performed among 30 subjects diagnosed with intellectual disability and drooling, all attending the *Primitiva López* Public Special Education Centre in Cartagena (Murcia, Spain). Inclusion criteria were intellectual disability as defined by WHO criteria 2001 and the presence of drooling, as well as no allergy to any of the components of the product assessed in the study, and provision of informed consent to take part by parents. Exclusion criteria were subjects already in treatment for drooling or other treatments that might interfere with salivation, non-compliant subjects and the presence of active infections.

A clinical history was prepared for each subject on the basis of oral examination performed by an experienced clinician (Maria Lorca Larrosa), registering socio-demographic characteristics including gender, the number of drugs administered, the degree of disability (slight, moderate and severe) and oral/occlusal variables such as molar class, the presence of lip incompetence, open bite or increased overjet.

Intervention

Treatment for drooling was consisted of the application of Kinesio Taping (KT) a neuromuscular bandage tape in the area of the hyoid bones, 5 cm long and 1.6 cm wide. The tape remained in place for three consecutive days, with a break on the fourth day; this cycle continued for 3 months. The procedure was standardised, cleaning the skin in the area with alcohol before applying the tape, in order to eliminate oils, lotions and damp, which can limit the tapes adhesive capacity. The neuromuscular bandage used (Spol Kinematics Tex® Korea) comprises elastic polymer wrapped in cotton fibre; it does not contain latex. The adhesive is 100% medical acrylic and activated by the heat of the skin, is water resistant and

adapts to the muscles contours allowing natural mobility (Bicici *et al.* 2012; Estrada and Echevarría González 2013; Kaya Kara *et al.* 2015; Coskun Benlidayi *et al.* 2016)

The study was conducted at three visits carried out in a period of 3 months. Assessment of the efficacy of this treatment on drooling was performed by means of three validated questionnaires; assessments were made at baseline, after 1 and 3 months of treatment.

Outcome measures severity drooling (Reid *et al.* 2010)

Test 1: sialorrhea clinical scale

This clinical scale consists of seven questions that evaluate the severity and frequency, clothing changes of drooling and social and functional impairment. Sialorrhea clinical scale for PD (Evatt *et al.* 2009) is designed to assess subjective perception of discomfort related to drooling. The scale assesses the relationship between drooling and foods, degrees of nocturnal and diurnal drooling, difficulties of speech and eating, the rate of severe drooling and levels of discomfort. Values vary between 0 (minimum) and 21 (maximum intensity).

Test 2: drooling rating scale

This scale is for individuals with Parkinson's disease that has been selected for use in the current study although not originally designed for young people with intellectual disability (Perez-Lloret *et al.* 2007).

Patients are scored from 0 to 3 ('excessive dryness/no excess of saliva' to 'continuous drooling, wet clothes, or constant use of handkerchief or tissue') for severity of drooling over the preceding week in the following situations: sitting, standing, in bed, talking and while eating or drinking.

Test 2: drooling impact scale

The drooling impact scale quantifies the benefits of saliva management obtained by short and medium term treatments. It consists of 10 items chosen for their capacity to change as the result of intervention, scored from 1 to 10 (De Ru 2009).

The necessary materials were delivered to parents/caregivers who were instructed in the correct application and position of the neuromuscular bandages, stressing the importance of adherence to treatment and the detection of possible adverse events. The questionnaires were completed (parents/caregivers) at baseline, the day before the first application of the neuromuscular bandage, after 1 month and lastly after 3 months of treatment. The researchers' contact details were provided to allow the participating parents/caregivers to clear up any queries arising during treatment. To assess the level of adherence to treatment, parents were asked to return any unused material at the end of treatment. As none was returned, it was understood that all the neuromuscular bandages had been applied.

Data analysis

Statistical analysis was performed using IBM SPSS Statistics 21 software (SPSS Inc., Chicago, IL, USA). For general analysis of qualitative variables, the number of cases present in each category and corresponding percentages were calculated; for quantitative variables, maximum and minimum values were registered and means and standard deviation calculated. A general linear model was designed to evaluate intra-observer effect between the measurements obtained by the different drooling evaluation scales. Statistical significance was established as a *P*-value ($P < 0.05$).

Results

The study sample was made up of 20 male (66.7%) and 10 female (33.3%) patients, with a mean age of 15.03 ± 4.61 years. During the follow-up, one patient was lost from the study failed to complete a questionnaire.

Table 1 shows means and standard deviations obtained by the questionnaires applied at baseline, after 1 and 3 months of treatment. All three clinical scales showed significant reductions in drooling ($P < 0.001$) after 3 months of use of the neuromuscular bandage; drooling scores improved as treatment time advanced.

Table 2 shows the values of the sialorrhea clinical scale for PD on the different periods of the study (day 0, 1 and 3 months later). Research indicated that these values are not influenced by factors such as gender ($P = 0.89$), medication ($P = 0.49$), disability range ($P = 0.22$), occlusion ($P = 0.90$) and overjet

Table 1 Mean and standard deviation (SD) obtained in the three questionnaires used to assess drooling at baseline, after 1 and 3 months of treatment.

	Baseline mean ± SD *N* = 30	**1 month mean ± SD *N* = 30**	**3 months mean ± SD *N* = 29**	***P*-value**
Test 1: sialorrhea clinical scale	11.13 ± 7.587	11.13 ± 7.574	8.38 ± 5.728	<0.001
Test 2: drooling rating scale	10.23 ± 4.911	7.83 ± 4.496	5.67 ± 3.790	<0.001
Test 3: drooling impact scale	47.03 ± 28.791	44.93 ± 27.289	40.87 ± 24.181	<0.001

Table 2 Variations in scores obtained by sialorrhea clinical scale in relation to time and socio-demographic and oral variables

	Measure			**Effects intra-subject**	
	Baseline mean ± S.T	**1 month T1 Mean ± S.T**	**3 months T3 Mean ± S.T**	**Time F (g.l) *P*-value**	**Treatment time F (g.l) *P*-value**
Gender					
Male (*n* = 19)	10.1 ± 7.5	10.2 ± 7.6	7.6 ± 5.5	29.736 ($P < 0.01$)	0.018 ($P < 0.89$)
Female (*n* = 10)	12.3 ± 7.9	12.2 ± 7.8	9.7 ± 6.1		
Medication					
0 (*n* = 10)	6.5 ± 7.9	6.4 ± 7.7	4.7 ± 5.5	33.06 ($P < 0.01$)	0.724 ($P < 0.49$)
1 (*n* = 10)	13.6 ± 6.6	13.5 ± 6.5	10.6 ± 4.7		
>1 (*n* = 9)	12.7 ± 6.6	13 ± 6.8	10 ± 5.2		
Disability					
Slight (*n* = 4)	11.5 ± 8	11.5 ± 8	8 ± 5.5	31.75 ($P < 0.01$)	1.57 ($P < 0.22$)
Moderate (*n* = 13)	7.9 ± 6.7	8 ± 6.9	6.2 ± 4.9		
Severe (*n* = 12)	13.9 ± 7.7	13.7 ± 7.5	10.8 ± 5.9		
Lip competence	8.7 ± 7.9	8.6 ± 7.8	6.8 ± 6		
Yes (*n* = 17)				40.32 ($P < 0.01$)	3.99 (**$P < 0.05$**)
Lip competence	14 ± 6.1	14 ± 6.1	10.5 ± 4.6		
No (*n* = 12)					
Occlusion	10.5 ± 7.7	10.4 ± 7.6	7.9 ± 5.6		
Dental class I (*n* = 24)				17.81 ($P < 0.01$)	**0.015** (**$P < 0.90$**)
Occlusion	12.8 ± 7.5	13.2 ± 7.8	10.4 ± 6.3		
Dental class II (*n* = 5)					
Normal bite (*n* = 26)	10.6 ± 7.3	10.7 ± 7.4	8.1 ± 5.5	12.65 ($P < 0.01$)	0.013 ($P < 0.90$)
Open bite (*n* = 3)	12.6 ± 11	12.3 ± 10.6	10 ± 8.6		
Overjet normal (*n* = 20)	9.1 ± 7.7	9 ± 7.6	7 ± 5.6	34.85 ($P < 0.01$)	1.623 ($P < 0.21$)
Overjet increased (*n* = 9)	14.7 ± 5.8	15 ± 5.9	11.4 ± 4.7		

($P = 0.22$); however, differences were found regarding lip competence ($P \leq 0.05$).

Discussion

The findings support the use of the neuromuscular bandage as an alternative treatment in drooling management. Drooling is an incapacitating condition that negatively affects physical appearance, daily life, social interaction and self-esteem and may demand constant attention. Treatments for drooling take different approaches – oral and topical medication, or surgical techniques – all of which have considerable secondary effects in the long term. For this reason, it is important to investigate any procedure that might prove less invasive and/or have fewer secondary effects.

The benefits of KT are still in debate; the method assessed in this study was the neuromuscular bandage, often used in other situations, although

literature dealing with its use for treating drooling or other orofacial dysfunctions in patients with disabilities and special educational needs remains scarce (Tello *et al.* 2012; Caneschi *et al.* 2014; Mikami *et al.* 2017). Studies of neuromuscular bandages indicate that it produces an increase in local propioception and strengthens weak muscles by stimulating the skin to boost muscle contraction (Mikami *et al.* 2017). Unlike other methods used for treating drooling, neuromuscular bandages enjoy the advantage of not provoking any secondary effects, although occasional skin hypersensitivity has been reported in some cases (Caneschi *et al.* 2014).

The tape is applied to the suprahyoid muscle area (De Ru 2009. González-Sánchez *et al.* 2015). The dimensions of the bandage is variable. In the present study, as in Tello *et al.* 2012, the tape measured 5 cm × 1.6 cm. Other authors have used tapes of 5 cm × 2.5 cm or 4 × 2 cm (González-Sánchez *et al.* 2015). The present study used a smaller area of tape in order to seek a technique that would be as discreet as possible while achieving effective results. The duration of neuromuscular bandage application – three consecutive days followed by a day off. Removing the bandage for 1 day in four aimed to allow the skin to recover, making it possible to maintain treatment for a longer duration. In agreement with other authors (Tello *et al.* 2012; Nieves Estrada and Echevarría González 2013; Mikami *et al.* 2017), the present study obtained a statistically significant improvement in drooling according to the three tests performed after 1 and 3 months of treatment.

When subjects with lip incompetence were assessed, higher salivation values were obtained, a finding that concurs with other studies by such as Marulanda *et al.* 2013 and Barrionuevo and Solís 2008.

Caneshi *et al* 2014 performed a study of the neuromuscular bandage, monitoring subjects before, during and after treatment; they observed that 3 months after the bandage had been removed, and the benefits were not maintained. One of the limitations of the present study was that it did not include any follow-up beyond the 3-month treatment period, and so it remains unclear. We do not know if the changes are maintained after removing the bandages. Limitations of this study include the design used in the reported study is open to several biases and the lack of a control group who did not receive the intervention.

The present study's strong points were that it used three different point-scoring systems to classify drooling and that treatment was of 3-month duration. The data obtained in the different questionnaires demonstrated the efficacy of the treatment protocol, which was well tolerated by the participants and had an excellent safety profile. It was shown to be a simple method, non-traumatic and economical.

In conclusion, rehabilitative treatment of drooling with the neuromuscular bandage in the suprahyoid muscle area produces clinical improvement after application in persons with drooling and intellectual disability. Further research is required to investigate this promising technique in greater depth.

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