PAULO ANDRÉ TEIXEIRA KIMAID

Este exemplar corresponde à versão final da **Tese de Doutorado** apresentada ao Programa de Pós-Graduação Ciências Médicas da Faculdade de Ciências Médicas da UNICAMP, para obtenção do título de Doutor em Ciências Médicas, área de Neurologia do(a) aluno(a) **Paulo André Teixeira Kimaid.**
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Prof(a). Dr(a). Elizabeth Quagliato
Orientador(a)

ELETROMIOGRAFIA DA LARINGE: ASPECTOS TÉCNICOS, ESTUDO NORMATIVO E CONTRIBUIÇÃO AO DIAGNÓSTICO E TRATAMENTO DAS ALTERAÇÕES DA MOBILIDADE DAS PREGAS VOCAIS

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Tese de Doutorado apresentada à Pós-Graduação da Faculdade de Ciências Médicas da Universidade Estadual de Campinas para obtenção do título de Doutor em Ciências Médicas, área de Neurologia.

ORIENTADORA: *PROFA. DRA. ELIZABETH MARIA B. QUAGLIATO*

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Data:

DEDICATÓRIA

À minha esposa Renata, e aos meus filhos Giovanna e Thiago, por compreenderem minha ausência em momentos preciosos de suas vidas para tornar possível a realização desta tese.

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CAL	cricoaritenoideus lateralis
CAP	cricoaritenoideus posterioris
CT	*Cricotireoideus*
DE	*disfonia espasmódica*
EMGL	*eletromiografia da laringe*
GTS	Síndrome de Gilles de La Tourette
Hz	Hertz
ms	Milissegundos
PAUM	potenciais de ação da unidade motora
TA	*Tireoaritenoideus*
uV	microvolts

PÁG.

RESUMO

Eletromiografia da Laringe (EMGL) é método auxiliar utilizado na compreensão e diagnóstico de diferentes doenças neurológicas que comprometem a função da laringe.

Esta tese consiste de 4 capítulos: 1) Eletromiografia da laringe: aspectos técnicos; 2) Eletromiografia da laringe: estudo normativo; 3) Eletromiografia da laringe: contribuição ao diagnóstico na imobilidade de pregas vocais; e 4) Eletromiografia da laringe nos distúrbios dos movimentos - dados preliminares.

1) Descrevem-se as técnicas de inserção percutânea de eletrodos de agulha nos músculos tireoaritenoideus (TA), cricotireoideus (CT), cricoaritenoideus lateralis (CAL) e cricoaritenoideus posterioris (CAP) em 80 pacientes, 47 do sexo feminino e 33 do masculino, com idades entre 18 a 86 anos (média 52,7). Para a abordagem do músculo TA utilizaram-se a inserção percutânea via membrana cricotireóidea em 68 pacientes, e a via cartilagem tireóidea em 12. Para abordagem do músculo CT utilizou-se a inserção percutânea direta em 58 pacientes, enquanto a do CAL utilizou a inserção percutânea via membrana cricotireóidea. Na abordagem do CAP utilizou-se inserção percutânea direta por rotação digital em 32 pacientes e via membrana cricotireóidea atravessando a luz da laringe em 24. Dos 80 pacientes estudados, 55 apresentavam imobilidade de pregas vocais e 25 eram portadores de distúrbios dos movimentos.

2) Descrevem-se os valores de duração e amplitude dos potenciais de ação das unidades motoras (PAUM) destes músculos em 14 voluntários sem alterações vocais, 9 do sexo feminino e 5 do masculino, com idades entre 18 e 55 anos (média 35,6);

3) Descrevem-se as contribuições da EMGL ao diagnóstico de 55 pacientes, 27 do sexo feminino e 28 do masculino, com idades entre 18 e 79 anos (média 53,4), com imobilidade de pregas vocais à laringoscopia, 32 à esquerda, 14 à direita e 9 bilateralmente. Os pacientes foram agrupados conforme a causa provável da imobilidade à anamnese: 1) Desconhecida (30 pacientes); 2) Traumatismo (14 pacientes); e 3) Tumor (11 pacientes).

4) Descrevem-se dados preliminares da EMGL em 25 pacientes, 18 do sexo feminino e 7 do masculino, com idades entre 21 e 86 anos (média 51,4), apresentando disfonia por distúrbios dos movimentos. A avaliação clínica e laringoscopia sugeriam diagnóstico de

distonia laríngea em 19 pacientes, tremor vocal em 5 e síndrome de Gilles de la Tourette em 1. Dos 25 pacientes, 18 apresentavam indicação para tratamento com toxina botulínica: 14 com distonia laríngea, 3 com tremor essencial e 1 com GTS. Utilizou-se a aplicação unilateral de 2,5U de BOTOXR , diluído em solução fisiológica 0,9%, nos músculos TA nos 12 pacientes com distonia em adução, nos 3 com tremor vocal e no único paciente com GTS. Noutros 2 pacientes com distonia em abdução, o músculo alvo era o CAP. AS respostas foram consideradas satisfatórias em 15 pacientes e insatisfatório em 3 (2 com distonia laríngea em abdução e 1 com tremor vocal essencial).

Os 80 pacientes foram avaliados clinicamente pelo otorrinolaringologista, pela fonoaudióloga e por endoscopia da laringe antes da indicação da EMGL. Para os registros foram utilizados equipamento Nihon Kohden m de 4 canais e eletrodos concêntricos nos pacientes com imobilidade de pregas vocais e nos voluntários, e eletrodos monopolares nos pacientes com distúrbios dos movimentos.

Conclui-se:

1) As técnicas de inserção percutânea permitem a localização correta dos músculos laríngeos nos pacientes que necessitam do exame. A abordagem do CAP, por rotação digital da cartilagem tireóidea mostrou-se a mais difícil, seguida da abordagem do CAL. Abordagens do TA e CT não representaram dificuldades, exceto em poucos pacientes idosos e obesos, respectivamente. Em apenas 1 caso observou-se complicação significativa na abordagem do TA através da cartilagem tireóidea: um hematoma obstruindo parcialmente a luz da laringe.

2) No estudo normativo, são descritas pela primeira vez em nosso meio as médias de duração e amplitude dos PAUM em voluntários sem alterações vocais, que foram respectivamente 3.8ms e 413µV para o TA, 4.9ms e 585µV para o CT, 4.1ms e 388µV para o CAL, e 4.5ms e 475µV para o CAP. Os valores encontrados não diferem dos apresentados na literatura para os músculos TA e CT.

3) A EMGL contribuiu para o diagnóstico nos 55 pacientes com imobilidade de pregas vocais, sendo consistente com o comprometimento do nervo periférico em 25 casos do grupo 1, 12 do grupo 2 e 11 do grupo 3. A EMGL foi normal em 4 pacientes, sugerindo fixação da articulação cricoaritenóidea. Em 2 pacientes a EMGL sugeriu comprometimento do SNC e em 1 miopatia.

4) Nos distúrbios dos movimentos, dos 25 pacientes estudados, a EMGL foi consistente com distonia laríngea em 14 (normal em 5), tremor essencial em 3 e Parkinson em 2. O tratamento com aplicação de toxina botulínica guiada por EMGL foi realizada em 18 pacientes, e mostrou resultados satisfatórios em 15 e insatisfatórios apenas em 2 pacientes com distonia em abdução e 1 com tremor essencial.

Conclui-se ainda que a relação risco benefício justifica a utilização da EMGL para o diagnóstico clínico e para o tratamento nos pacientes com alterações da mobilidade da laringe.

ABSTRACT

Laryngeal Electromyography (LEMG) is an auxiliary method used for the comprehension and diagnosis of different neurological diseases that compromise laryngeal function.

This thesis was wrote in 4 chapters: 1) Laryngeal electromyography: technical features; 2) Laryngeal electromyography in normal brazilian population; 3) Laryngeal eletromyography contribution to vocal fold immobility diagnosis; 4) Laryngeal electromyography in movement disorders: preliminary data.

1) There were described techniques for inserting needle electrodes percutaneously into the tireoaritenoideus (TA), cricotireoideus (CT), cricoaritenoideus lateralis (CAL) and cricoaritenoideus posterioris (CAP) muscles in 80 patients, 47 female and 33 male, aged between 18 to 86 years (mean 52,7y). The TA technique achieved correct location in all patients, via cricothyroid membrane technique in 68 cases, and via thyroid cartilage technique in 12 cases. CT direct approach was performed in 58, CAP approach in 56, with digital rotation technique in 32, and through laryngeal lumen in 24 cases. In 80 patients, 55 presents with vocal fold immobility and 25 with movement disorders.

2) There were described normal values of motor unit action potentials duration and amplitude of these muscles in 14 adult volunteers with no vocal disturbs, 9 female and 5 male, aged between 18 to 55 years (mean 35,6y).

3) There were described the LEMG contribution to diagnosis in 55 patients, 27 female and 28 male, aged between 18 to 86 years (mean 53,4), with vocal fold immobility, 32 left-hand side, 14 right-hand side and 9 bilateral. Patients were grouped accord to prior clinical diagnosis: 1) unknown (30 patients) ; 2) traumatic (14 patients); or 3) tumoral (11 patients).

4) There were described preliminary LEMG data in 25 patients, 18 female and 7 male, aged between 21 to 86 years (mean 51,4), with dysphonia due to movement disorders. Laryngoscopy and clinical evaluation suggests sapasmodic dysphonia (SD) in 19 patients, vocal tremor (VT) in 5 and Gilles de la Tourette syndrome in 1. There were described also the response to botulinum toxin A treatment in 18 patients selected to this treatment, 14 with SD, 3 with essential VT and 1 GTS patient. There was used unilateral 2,5 U of botulinum toxin A (BOTOXR) diluted in 0,9% saline solution. In 12 aduction SD, 3 essential VT and 1 GTS patients, TA was the target muscle. In 2 patients with abduction SD, CAP was the target muscle. The improvement was significant in 11, mild in 4 and poor

in 3 patients. The response to botulinum toxin A treatment was poor in both patients with abduction SD.

All of 80 dysphonic patients were submitted to otorhinolaryngological, phonoaudiological and laryngeal endoscopy before LEMG. The recordings were obtained by the four channel Nihon Kohden m using percutaneously inserted concentric needle electrode in volunteers and in patients with vocal fold immobility; and monopolar needle electrode in patients with movement disorders.

There were concluded:

1) The percutaneous techniques allow the correct location of the laryngeal in patients who require this examination. The CAP approach, by digital rotation of the thyroid cartilage was found to be the most difficult, followed by the CAL approach. TA and CT approaches gave no major problems, except with some older and obese patients. A significant complication of the TA approach via thyroid cartilage was a hematoma in one patient which partially obstructed the laryngeal lumen.

2) There were described at first time in our mean the normal values for duration and amplitude of PAUM, respectively 3.8ms and 413μV for TA, 4.9ms and 585μV for CT, 4.1ms and 388μV for CAL and 4.5ms and 475μV in CAP.

3) LEMG contributed to diagnosis in all 55 patients with vocal fold immobility. LEMG showed peripheral nerve injury in 25 patients in group 1, 12 in group 2 and 11 in group 3. LEMG was normal in 4 patients, suggesting crico-arythenoid joint fixation. In 2 patients LEMG suggests central nervous system injury and myopathy in one.

4) In the 25 patients with movement disorders LEMG was consistent with SD in 14 (normal in 5), essential VT in 3, Parkinson VT in 2 and GTS in one. Botulinum toxin treatment guided by LEMG showed good response in 15 patients.

In general, the risk-benefit relation justifies laryngeal electromyography for clinical diagnosis and treatment.

1- INTRODUÇÃO

Originada em 1929 após a introdução do eletrodo cencêntrico de agulha por Adrian e Bronk, a eletromiografia é método de diagnóstico que consiste do registro da atividade elétrica obtida através de eletrodos de agulha inseridos no tecido muscular (Dumitru, 1995). É método que necessita de conhecimento minucioso da anatomia do sistema nervoso periférico, possibilitando a investigação funcional da unidade motora e seus constituintes: neurônio motor, axônio, junções neuromusculares e fibras musculares (Dumitru, 1995).

A precisão e o sincronismo das estruturas laríngeas responsáveis pela produção vocal podem ser comprometidas por diversas doenças neuromusculares ou distúrbios de movimentos (Lovelace et al, 1992; Brin et al, 1992b). A eletromiografia da laringe é importante método diagnóstico capaz de distinguir neuropatias, doenças do neurônio motor, miopatias, e sugerir o comprometimento do sistema nervoso central e fixação da articulação cricoaritenóidea (Hirano et al, 1974; Blitzer et al, 1985; Blitzer et al, 1988a; Blitzer et al, 1988b; Rodriquez et al, 1990; Schaefer, 1991; Traissac et al 1991; Brin et al, 1992b; Kotby et al, 1992; Lovelace et al, 1992; Gupta & Bastian, 1993; Rontal et al, 1993; Simpson et al, 1993; Verhulst et al, 1995; Yin et al, 1996; Yin et al, 1997; Schweizer et al, 1999; Koufman et al, 2001); pode ainda evidenciar atividade muscular anormal nos pacientes com distúrbios dos movimentos (Blitzer et al, 1985; Lovelace et al, 1992). É utilizada também para estabelecer o prognóstico nos casos de paralisia de pregas vocais (Parnes e Satya-Murti, 1985; Lovelace et al, 1992; Munin et al 2000; Sittel et al, 2001).

Embora a técnica tenha sido utilizada pela primeira vez por Weddell et al, em 1944, há nítida lacuna na literatura científica até meados dos anos 70, quando se observa progressivo aumento do número de trabalhos científicos, atingindo o auge dos anos 90 em diante. Inicialmente restritas a poucos centros de pesquisa, a modernização dos equipamentos, a padronização de técnicas de abordagem percutâneas dos músculos da laringe, dispensando o uso de anestésicos e endoscópios, bem como a importância cada vez maior atribuída à técnica permitiram maior difusão do método.

Em nosso meio a técnica ainda é pouco utilizada, embora sua comprovada importância. O grupo de estudos de eletromiografia da laringe na UNICAMP utiliza a técnica desde 1999 na investigação rotineira das disfonias associadas aos distúrbios da mobilidade da laringe.

Este trabalho foi dividido em quatro capítulos: conforme modelo alternativo de dissertação de tese da FCM-UNICAMP: 1) Eletromiografia da Laringe: Aspectos Técnicos; 2) Eletromiografia da Laringe: Estudo Normativo; 3) Eletromiografia da Laringe: Contribuição ao Diagnóstico das Imobilidades de Pregas Vocais; 4) Eletromiografia da Laringe: Distúrbios dos Movimentos - Dados Preliminares.

2- REVISÃO DA LITERATURA

REVISÃO DA LITERATURA (ANATOMIA)

É necessária a revisão da anatomia da laringe para a compreensão das técnicas e a realização da EMGL:

A laringe no adulto localiza-se na região anterior do pescoço, no nível das vértebras C3 a C6, e conecta a hipofaringe com a traquéia. Abordaremos nesta revisão apenas as cartilagens e seus principais acidentes anatômicos, os músculos íntrinsecos da laringe e os nervos laríngeos (Cooper, 1992).

1) Cartilagens e membranas (Cooper, 1992):

A laringe é formada por 9 cartilagens: a cartilagem tireóidea a cricóidea e a epiglote são únicas, enquanto as aritenóideas, cuneiformes e corniculadas são pareadas. Apresentam importância para EMGL apenas as cartilagens tireóidea, cricóidea e as aritenóideas. Embora não faça parte da laringe o osso hióide participa na movimentação da laringe, além do que pode ser palpado como referencial de superfície facilmente identificável.

A cartilagem tireóidea é a maior, constituída por 2 lâminas quadrilaterais fundidas na linha média onde formam a proeminência laríngea, importante acidente anatômico no reconhecimento dos referenciais de superfície da laringe, facilmente visualizado no sexo masculino. Outros referenciais importantes são os cornos superior e inferior, palpáveis nos bordos látero-posteriores de cada lado, acime e abaixo, respectivamente (Figura-1).

A cartilagem cricóidea localizada entre a traquéia e a cartilagem tireóidea possui formato de cunha, com uma parte posterior maior, a lâmina da cartilagem cricóidea e uma parte anterior formando o arco da cartilagem cricóidea, também de importância relevante na identificação dos referenciais de superfície, este costuma ser o acidente anatômico mais facilmente identificado no sexo feminino (Figura-1).

As cartilagens aritenóideas são paeadas e têm o formato de pirâmide. Localizam-se internamente e posteriormente, e articulam-se com a lâmina posterior da cartilagem cricóidea. Embora não apresentem referenciais palpáveis à superfície, a rotação destas cartilagens em torno do próprio eixo, desencadeado pelos músculos intrínsecos da laringe, promovem a abertura (abdução) e fechamento (adução) das pregas vocais (Figura-1.B).

Dentre as membranas e ligamentos abordaremos apenas a membrana cricotireóidea, que delimita a "janela" de acesso ao lado interno da laringe (Figura-1).

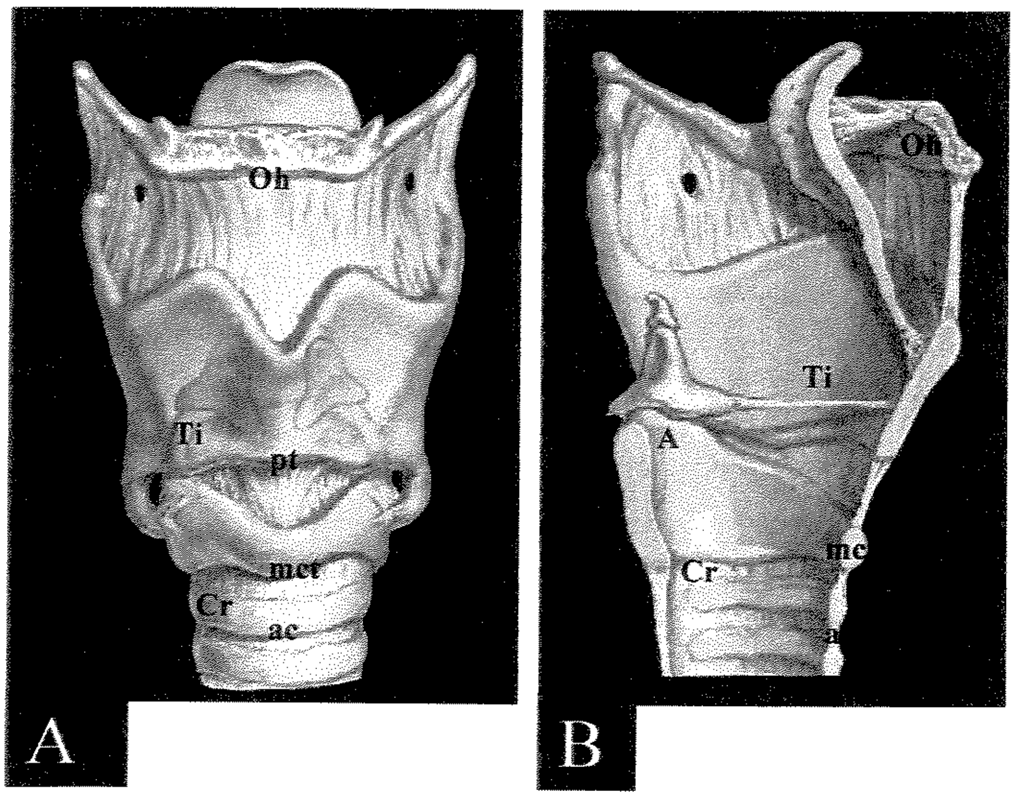

Figura 1- Anatomia da Laringe (esqueleto cartilaginoso): A) vista frontal e B) corte sagital. Oh – osso hióide; Ti – cartilagem tireóidea; Cr – cartilagem cricóidea; A – cartilagem aritenóidea; pt - proeminência tireóidea; mct – membrana cricotireóidea; ac – arco da cartilagem cricóidea; (Modificado de Netter, 1986).

2) Músculos intrínsecos da laringe (Cooper, 1992):

Abordaremos apenas os músculos intrínsecos da laringe que foram objetos desta dissertação: *tireoiaritenoideus* (TA), *cricotireoideus* (CT), *cricoaritenoideus lateralis* (CAL) e *cricoaritenoideus posterioris* (CAP).

O TA origina-se da face interna do ângulo da cartilagem tireóidea até a face antero-lateral da cartilagem aritenóidea (Figura – 2). A contração do TA altera o comprimento das pregas vocais promovendo seu relaxamento e adução. O TA é inervado pelo laríngeo recorrente (Figura – 3).

O CT origina-se na face ântero-lateral do arco da cartilagem cricóidea externamente e se insere na face ínfero-posterior da cartilagem tireóidea internamente (Figura – 2). A contração do CT abaixa a cartilagem tireóidea (anteriormente) e a lâmina posterior da cartilagem cricóidea (posteriormente), elevando o arco anterior da cricóidea e consequentemente afastando as cartilagens aritenóideas da tireóidea, tensionando as pregas vocais. O CT é inervado pelo laríngeo superior (Figura – 3).

O CAL origina-se do bordo superior da face lateral da cartilagem cricóidea e insere-se na face anterior da cartilagem aritenóidea (Figura – 2). A contração do CAL promove a rotação da cartilagem aritenóidea e conseqüente adução das pregas vocais. O CAL é inervado pelo laríngeo recorrente (Figura – 3).

O CAP origina-se da lâmina posterior da cartilagem cricóidea externamente e insere-se na face posterior da cartilagem aritenóidea (Figura – 2). A contração do CAP promove a rotação da cartilagem aritenóidea antagonizando a ação do CAL e conseqüentemente abduzindo as pregas vocais. O CAP também é inervado pelo laríngeo recorrente (Figura – 3).

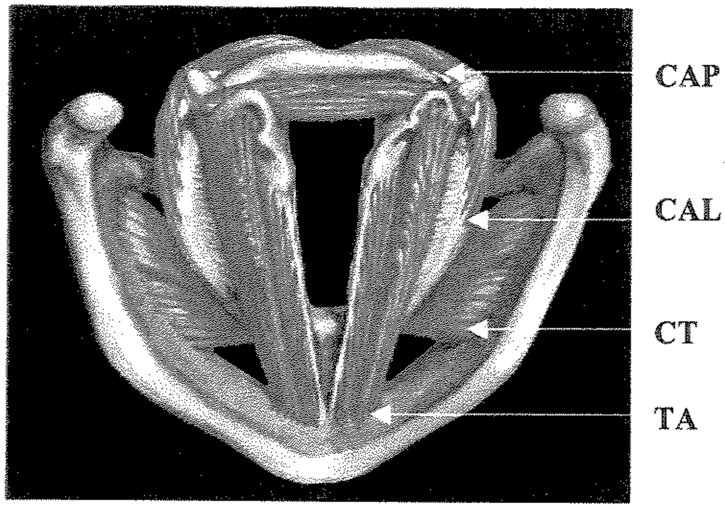

Figura 2- Anatomia da Laringe (músculos intrínsecos): vista superior. CAP – *cricoaritenoideus posterioris*; CAL – *cricoaritenoideus lateralis*; CT – *cricotireoideus*; TA– *tireoaritenoideus*; (Modificado de Netter, 1986).

3) Nervos laríngeos (Dumitru, 1995):

Os ramos laríngeos superior e recorrente originam-se do nervo vago, e conduzem as fibras eferentes viscerais especiais originárias do núcleo ambíguo para os músculos intrínsecos da laringe.

O ramo laríngeo superior deixa o tronco do nervo vago logo abaixo do gânglio inferior, descendo profundamente à artéria carótida interna para inervar o músculo CT.

O ramo laríngeo recorrente apresenta origens diferentes conforma o lado: à esquerda se origina do tronco do nervo vago próximo ao arco da aorta, contornando-o por baixo e ascendendo junto à traquéia até a laringe; à direita se origina do tronco do nervo vago próximo à artéria subclávia, contornando-a por baixo e ascendendo em trajeto semelhante ao esquerdo, junto à traquéia, até a laringe. Os ramos laríngeos recorrentes inervam os músculos CAP, CAL e TA.

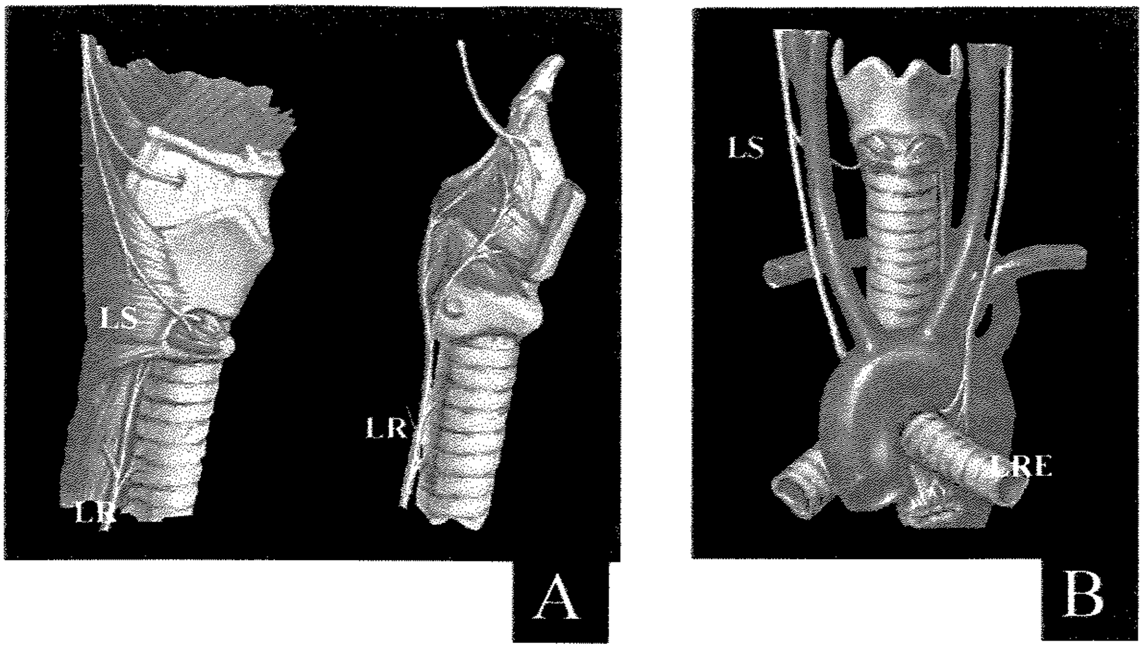

Figura 3- Anatomia da Laringe (nervos laríngeos): A- vista lateral; B- vista frontal. LR - laríngeo recorrente; LRE – esquerdo; LS – laríngeo superior; (Modificado de Netter, 1986).

REVISÃO DA LITERATURA (TÉCNICA)

Em revisão da literatura encontraram-se as seguintes técnicas de EMGL utilizadas para fins diagnósticos: a) punção direta através de faringostomia ou fissura laríngea, realizadas cirurgicamente (Katsuki, 1950; Portmann et al, 1955; Spoor & VanDisheck, 1958); b) punções diretas guiadas por laringoscopia direta (Weddell et al, 1944; Feinstein, 1946; Macbeth, 1946; Kotby & Haugen, 1970); c) punções diretas guiadas por laringoscopia indireta (Faaborg-Andersen & Buchthal, 1956; Faaborg-Andersen, 1957; Buchthal, 1959; Guerrier & Basseres, 1965); e d) punções percutâneas orientadas por referenciais de superfície (Fink et al, 1956; Greiner et al, 1960; Kotby, 1975).

As punções diretas através de faringostomia ou fissura laríngea realizadas cirurgicamente foram técnicas utilizadas por Katsuki, Portmann e Spoor na década de 50, que apresentam apenas interesse histórico (Katsuki, 1950; Portmann et al, 1955; Spoor & VanDisheck, 1958).

As punções diretas guiadas por laringoscopia direta (Weddell et al, 1944; Feinstein, 1946; Macbeth, 1946; Kotby & Haugen, 1970) ou indireta (Faaborg-Andersen & Buchthal, 1956; Faaborg-Andersen, 1957; Buchthal, 1959; Guerrier & Basseres, 1965) foram utilizadas apenas nos trabalhos iniciais. Utilizaram enorme aparato necessário à realização do exame, anestésico tópico, e precisavam de muita cooperação do paciente.

As punções percutâneas foram realizadas pela primeira vez em 1956 (Fink et al, 1956), e após padronização das técnicas de abordagem dos músculos (Kotby, 1975), têm sido indiscutivelmente as técnicas de eleição para o diagnóstico clínico (Parnes & Satya-Murti, 1985; Traissac et al 1991; Kotby et al, 1992; Lovelace et al, 1992; Verhulst et al, 1995; Yin et al, 1997; Munin et al, 2000; Koufman et al, 2001), e para aplicação de toxina botulínica (Blitzer et al, 1988a; Blitzer et al, 1988b). Foram utilizadas na maioria dos trabalhos revisados (Fink et al, 1956; Greiner et al, 1960; Hirano et al, 1974; Kotby, 1975; Parnes & Satya-Murti, 1985; Blitzer et al, 1985; Blitzer et al, 1988a; Blitzer et al, 1988b; Rodriquez et al, 1990; Schaefer, 1991; Traissac et al 1991; Brin et al, 1992b; Kotby et al, 1992; Lovelace et al, 1992; Gupta & Bastian, 1993; Rontal et al, 1993; Simpson et al, 1993; Verhulst et al, 1995; Yin et al, 1996; Yin et al, 1997; Schweizer et al, 1999; Munin et al, 2000; Koufman et al, 2001; Sittel et al, 2001). São técnicas de fácil realização e melhor toleradas pelos pacientes, não necessitando a utilização de anestésicos.

Nos trabalhos revisados, raramente se menciona a posição do paciente (deitado ou sentado) não há referência ao reconhecimento anatômico dos referenciais de superfície e às variáveis como a idade, sexo, características antropométricas, presença de deformidades ou variações anatômicas, entre outros possíveis fatores que deveriam ser analisados na abordagem dos músculos laríngeos.

REVISÃO DA LITERATURA (NORMATIVO)

EMGL é método de estudo dos músculos laríngeos, cuja análise rotineira se baseia muitas vezes na avaliação subjetiva dos PAUM por um neurofisiologista experiente (Woodson, 1998). A quantificação de parâmetros como duração e amplitude dos PAUM foi padronizada em trabalhos clássicos (Buchthal, 1957), para permitir a comparação objetiva entre diferentes músculos de um mesmo indivíduo e entre diferentes indivíduos no mesmo músculo. A normatização destes parâmetros é fundamental para definir PAUM normal, neurogênico e miopático (Buchthal, 1957).

Os primeiros estudos normativos de EMGL foram realizados no final da década de 50 (Faaborg-Andersen & Buchthal, 1956; Faaborg-Andersen, 1957 e Buchthal, 1959). Utilizaram eletrodos concêntricos e técnicas de inserção por laringoscopia indireta. Encontraram duração média dos PAUM de 3,5 ms (milisegundos) para o TA e 5,3 ms para o CT. As amplitudes variaram de 224 a 358 uV para o TA. Utilizando-se de eletrodos monopolares e técnicas de inserção percutâneas autores demonstram potenciais com amplitudes maiores e duração também maior, embora não façam menção aos valores encontrados. Consideram 6 milissegundos como limite superior da normalidade e amplitudes normais entre 100 e 400uV (Lovelace et al, 1986; Lovelace et al, 1992). Artigo recente menciona valores normais semelhantes aos de Faaborg-Andersen & Buchthal, utilizando eletrodos monopolares (Rodriquez et al, 1990). Há referência ao aumento da duração dos PAUM das pregas vocais em idosos normais, principalmente à esquerda (Takeda et al, 2000). Não há estudos normativos em nosso meio.

REVISÃO DA LITERATURA (IMOBILIDADE DE PREGAS VOCAIS)

Desde a descrição original (Weddel et al, 1944), muitos trabalhos têm mostrado a importância da EMGL na investigação neurolaringológica, seja para conclusão diagnóstica como para avaliação do prognóstico (Hirano et al, 1974; Parnes & Satya-Murti, 1985; Blitzer et al, 1985; Blitzer et al, 1988a; Blitzer et al, 1988b; Rodriquez et al, 1990; Schaefer, 1991; Traissac et al 1991; Brin et al, 1992b; Kotby et al, 1992; Lovelace et al, 1992; Gupta & Bastian, 1993; Rontal et al, 1993; Simpson et al, 1993; Verhulst et al, 1995; Yin et al, 1996; Yin et al, 1997; Schweizer et al, 1999; Munin et al, 2000; Koufman et al, 2001; Sittel et al, 2001). Em nosso meio, poucos estão familiarizados com a técnica. Em diversos trabalhos descritos na literatura observamos poucos grupos constituídos por laringologistas, neurologistas, neurofisiologistas e fonoaudiólogos. A necessidade da avaliação clínica laringológica, exame neurológico detalhado e estudo neurofisiológico que muitas vezes não se restringe à laringe demonstra a complexidade que a investigação neurológica da laringe requer (Tucker, 1980; Simpson, 1993).

Os padrões EMGL mais freqüentemente encontrados nos pacientes com imobilidade das pregas vocais que permitem diferenciar comprometimento do sistema nervoso central do periférico, muscular e de fixação articular são descritos por vários autores (Hirano et al, 1974; Schaefer, 1991; Traissac et al, 1991; Lovelace et al, 1992; Kotby et al, 1992; Rontal et al, 1993; Koufman et al, 2001) e encontram-se resumidas no quadro I.

Quadro I- Padrões de EMGL e interpretação (Traissac et al, 1991).

1 - EMGL normal (PAUM com duração e amplitude iguais às do grupo controle, sem atividade espontânea) – anquilose ou luxação crico-aritenóidea.

2 - EMGL com evidências de desnervação (PAUM polifásicos de longa duração, ou PAUM com amplitude e duração aumentadas, PAUM com recrutamento em freqüência elevada, e/ou atividade espontânea) – comprometimento do nervo periférico.

3 - EMGL com traçado pobre e PAUM com morfologia normal, sem evidências de desnervação – comprometimento do SNC.

4 - EMGL com evidência de miopatia (PAUM polifásicos com duração reduzida e amplitudes reduzidas com freqüência de recrutamento reduzida) – comprometimento muscular.

EMGL consistente com miopatia pode ocorrer por traumatismo local das fibras musculares devido intubação orotraqueal (Yin et al,1996). Vários autores utilizaram a EMGL para estabelecer critérios de prognóstico (Hirano et al, 1974; Parnes & Satya-Murti, 1985; Kotby et al, 1992; Lovelace et al, 1992; Gupta & Bastian, 1993; Munin et al, 2000; Sittel et al, 2001). Doenças crônicas do neurônio motor e neuropatias crônicas podem apresentar padrão neurogênico crônico com desnervação recente e antiga coexistente (Desmedt & Borenstein, 1973; Gorio et al, 1983a; Gorio et al, 1983b).

REVISÃO DA LITERATURA (DISTÚRBIOS DOS MOVIMENTOS)

Dentre as diferentes condições clínicas que ocasionam distúrbios dos movimentos da laringe, destacam-se: distonia laríngea (disfonia espasmódica), tremores vocais, tics vocais e mioclonias (Brin et al, 1992b).

A distonia laríngea é a mais comum e caracteriza-se por espasmos musculares em adução ou abdução induzidos pelos movimentos fonatórios (Blitzer et al, 1988a; Blitzer et al, 1988b; Brin et al, 1992b). As distonias laríngeas podem ser em adução, quando há contração síncrona involuntária inapropriada da musculatura adutora (Aronson et al, 1968a; Brin et al, 1992b); ou em abdução, quando há contração síncrona involuntária inapropriada da musculatura abdutora (Aronson et al, 1968a; Brin et al, 1992b). Muitos pacientes com disfonia espasmódica podem cursar com voz trêmula, tornando o tremor essencial um importante diagnóstico diferencial (Aronson et al, 1968b; Brin et al, 1992b). A EMGL pode auxiliar na localização precisa do músculo no qual deve ser aplicada a toxina botulínica, tornando mais eficaz o tratamento, alcançando até 90% de resultados normais, com menos efeitos adversos (Blitzer et al, 1988a; Blitzer et al, 1988b; Brin et al, 1992a).

Os tremores vocais são caracterizados por movimentos involuntários rítmicos, oscilatórios, dos músculos laríngeos originando voz trêmula, podendo estar associados a distonias, doença de Parkinson, tremores essenciais, tremores cerebelares, mioclonias, entre outros (Brown & Simonson, 1963; Brin et al, 1992b). A associação mais comum é com tremor essencial (Brin et al, 1992b). O tremor essencial caracteriza-se por movimento oscilatório rítmico originado pela contração síncrona dos músculos agonistas e antagonistas em freqüência variável de 6 a 12 Hz durante a fonação (Ardran e al, 1966; Koda & Ludlow, 1992; Deuschl et al, 2001; Milanov, 2001). Na doença de Parkinson o tremor freqüentemente se caracteriza por contração alternante entre os músculos agonistas e antagonistas em freqüência de 5-6Hz, com oscilações de amplitude e freqüência (Hunker & Abbs, 1984; Ramig et al, 1988; Philippbar et al, 1991; Koda & Ludlow, 1992; Milanov, 2001). Os tremores irregulares ocorrem em casos de ataxia cerebelar (Brin et al, 1992b). O tratamento com toxina botulínica nos pacientes com tremores vocais apresenta excelentes resultados na literatura revisada (Brin et al, 1992b).

Tiques vocais são movimentos breves que envolvem grupos musculares relacionados à fonação, contraindo de forma repetitiva, estereotipada, súbita e involuntariamente (Brin et al, 1992b; Jankovic, 1997). Podem ser suprimidos voluntariamente por horas e podem apresentar períodos de melhora ou piora ao longo da vida do paciente (Brin et al, 1992b). Podem ser simples (motor ou fônico), ou complexo (motor ou vocalização) (Brin et al, 1992b). Relato de caso encontrado na literatura tratado com toxina botulínica mostra melhora significativa (Brin et al, 1992b).

3- OBJETIVOS

1) Descrever as técnicas de inserção percutânea de eletrodos de agulha nos músculos tireoaritenoideus (TA), cricotireoideus (CT), cricoaritenoideus lateralis (CAL) e cricoaritenoideus posterioris (CAP) utilizadas na UNICAMP;

2) Descrever os valores normais de duração e amplitude dos potenciais de ação de unidades motoras nos músculos tireoaritenoideus (TA), cricotireoideus (CT), cricoaritenoideus lateralis (CAL) e cricoaritenoideus posterioris (CAP) em voluntários Brasileiros;

3) Descrever a contribuição da EMGL ao diagnóstico em pacientes com imobilidade de pregas vocais assistidos na UNICAMP; e

4) Descrever o padrão da EMGL e a resposta ao tratamento com toxina botulínica em pacientes com disfonia por distúrbios dos movimentos avaliados na UNICAMP.

4- CAPÍTULOS

CAPÍTULO 1

Eletromiografia da Laringe: Aspectos Técnicos

Laryngeal Electromyography: Technical Features.

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Abstract

Laryngeal Electromyography (LEMG) is an auxiliary diagnostic method used for the comprehension and diagnosis of different neurological diseases that compromise laryngeal function. The most common LEMG technique is the percutaneous insertion of needle electrodes guided by surface anatomical references. We describe techniques for inserting needle electrodes into the *tireoaritenoideus* (TA), *cricotireoideus* (CT), *cricoari-tenoideus lateralis* (CAL) and *cricoaritenoideus posterioris* (CAP) muscles; these are used at UNICAMP laryngology ambulatory; we discuss difficulties found and their proposed solutions. All patients were submitted to otorhinolaryngological, phonoaudiological and laryngeal endoscopy before LEMG. The CAP approach, by digital rotation of the thyroid cartilage was found to be the most difficult, followed by the CAL approach. TA and CT approaches gave no major problems, except with some older and obese patients. A significant complication of the TA approach via thyroid cartilage was a hematoma in one patient which partially obstructed the laryngeal lumen.

Key-words: Laringeal electromyography, techniques.

Introduction

LEMG is of interest to both neurologists and otorhinolaryngologists. The small size and location of the intrinsic laryngeal muscles requires needle electrode insertion techniques guided by surface anatomical references, which present frequent variations. Since Weddel's (20) original description in 1944, many authors have reported electrode insertion techniques (3-11,13,17-19), but have not referred to difficulties in approaching these muscles. We describe techniques for electrode insertion in the *tireoaritenoideus* (TA), *cricotireoideus* (CT), *cricoaritenoideus lateralis* (CAL), and *cricoaritenoideus posterioris* (CAP) muscles, used at the laryngology ambulatory of UNICAMP School of Medicine and discuss the difficulties of each technique and their possible solutions.

Materials and methods

Patients

This study examined 80 patients complaining of dysphonia between January 2000 and January 2003 at UNICAMP School of Medicine. After consent from the ethical medical committee for human research, all patients were submitted to otorhinolaryngological, phonoaudiological and laryngeal endoscopic evaluation before undergoing laryngeal electromyography. They were all submitted to skin asepsis with alcohol before the procedure; anaesthesia was not necessary.

There were two patient positions.

a) Comfortably seated, back support slightly inclined, head supported and slightly extended, with arms hanging beside the body and shoulders and cervical musculature relaxed; or
b) In dorsal decubitus, cushion under dorsal region near the cervical column for neck extension, better comfort, and exposure of the laryngeal anatomic references; these were palpated for further deeper relaxation of the laryngeal extrinsic musculature and cervical region.

Recognition of anatomic structures

Palpation for location of the surface anatomic references: anterior arc of the cricoid cartilage, protuberance of the thyroid cartilage, and cricothyroid membrane (Figure 1). Recognition of anatomic references to locate the laryngeal intrinsic muscles was performed by the same laryngologist. In all cases there was difficulty in recognizing the anatomical structures previously described by the laryngologist during pre-approach palpation. Patients were analyzed for: a) age; b) sex; c) anthropometric characteristics (brevilineal, longilineal); d) thyroid gland and thorax morphology; e) previous cervical surgeries; tracheotomy.

Percutaneous approach techniques of the laryngeal muscles:

TA approach via cricothyroid membrane (VCTM): In the middle line through the cricothyroid membrane, 30° laterally and 45° degrees in the upper side. Recording of motor unit potentials at spontaneous breathing and during /a/ sound (Figure 2).

TA approach via thyroid cartilage (VTC): through the thyroid cartilage, and 1.0cm laterally and 0.5cm on the lower side of the middle point between the upper and lower edges of the thyroid cartilage. Recording of motor unit potentials at spontaneous breathing and during /a/ sound (Figure 3).

CT direct approach (CTD): about 1.5 cm from the middle line, half way between the lower edge of the thyroid cartilage and the upper edge of the cricoid cartilage. Deglutition is required to make sure the electrode is not placed in the laryngeal extrinsic muscles. Recording of motor unit potentials during spontaneous breathing and at emission of /e/ sound in an elevated *pith* (Figure 4).

CAL approach via cricothyroid membrane (CAL): at 1cm laterally to the middle line through the cricothyroid membrane, in the horizontal plane, looking for the posterior and lateral region of the vocal chord. The sound /a/ is required, and motor unit potentials were recorded, which were attenuated during deep breathing (Figure 5).

CAP approach with digital rotation (DR): Digital rotation of the thyroid cartilage and needle insertion in the lower third of the thyroid cartilage posterior edge. The electrode is oriented to the midline at the posterior aspect of the cricoid cartilage posterior lamina. Motor unit potentials were recorded during deep breathing (Figure 6).

CAP approach via cricothyroid membrane through laryngeal lumen (VLL): Through the cricothyroid membrane, on the midline and horizontal plane, with a 20° lateral inclination, passing through the laryngeal lumen and crossing the cricoid cartilage posterior lamina. Motor unit potentials were recorded during deep breathing (Figure 7).

Results

LEMG were obtained from 47 female and 33 male patients aged between 18 and 86 years; twenty-six (26) comfortably seated and fifty-four (54) dorsal decubitus with neck extension. The neck extension position was easier and more comfortable for the patient. Needle insertion was easier in male patients. Needle insertion was difficult in only 8 patients.

The TA technique achieved correct location in all patients, VCTM technique in 68 cases, and VTC technique in 12 cases. CT direct approach was performed in 58, CAP approach in 56, DR technique in 32, and VLL in 24 cases.

There was a significant complication in an old patient with intense thyroid cartilage calcification; this was a hematoma partially obstructing the laryngeal lumen. In this patient 4 TA approaches were necessary for correct positioning of the electrode.

Some patients were brevilineal and some were longilineal. In some patients, obesity, thorax and thyroid abnormalities, such as goiter, previous cervical surgery, and tracheotomy made laryngeal electromyography difficult.

Discussion

The following LEMG diagnosis techniques were found: a) direct approach through pharyngostoma or laryngofissure surgically performed (11,18,19); these techniques are of historical interest; b) direct approach with direct laryngoscopy (6,12,17,20) presented difficulties because of the large equipment required, the need for topical anesthetic, and cooperation from the patient, which is not always given; c) direct approach with indirect laryngoscopy (3-5,9) ; and d) percutaneous approaches oriented by surface anatomic references (7,8,13).

The percutaneous approaches were first performed by Fink (7) in 1956; and then standardized by Kotby (13) in 1975, they were the preferred techniques in clinical diagnosis (1,2,10,14-16) and were useful in botulinum toxin administration (1,2). They are commonly found in literature (1,2,7,8,10,12-16), easy to perform, better tolerated by patients, and do not need anesthetic drugs.

The most frequently used position was in decubitus, without precise descriptions of patient head and neck positions. Neck extension position was more comfortable and preferred by the patients. Seated position must be used when dorsal decubitus is not possible. Needle electrodes were better tolerated in dorsal decubitus. Laryngeal stability was better with shoulder support helping constant head extension.

We observed that some surface anatomical variability made LEMG difficult.

a) Senility may facilitate the identification of laryngeal cartilages due to atrophy of the cervical musculature and loss of skin elasticity, in contrast with obese individuals. However, the occurrence of laryngeal cartilage calcification can make TA approach by VTC technique and mobilization through laryngeal rotation for CAP approach difficult or impossible. Only CT direct approach does not present difficulties.

b) Sex was considered a determining factor for anatomical location, more defined in men. Women's cartilages are smaller, less defined and with less prominent limits.

c) Anthropometric characteristics. The thyroid and cricoid cartilages of brevilineal short-necked individuals are much closer together, making palpation of the cricothyroid membrane difficult. Proximity of the external manubrium, usually more elevated, makes TA approach by VCTM difficult. In obese and athletic individuals, all techniques presented some difficulty, with CT being the most difficult; no alternative technique is available. In patients with poor laryngeal mobilization we suggest the CAP approach by VLL. TA approach may be performed through VCTM or VTC.

d) Thorax and thyroid gland morphologies may partially obstruct the laryngeal surface anatomic references making LEMG very difficult. When the hyperinsufflated thorax does not allow electrode angling for TA approach by means of VCTM, VTC must be used instead; CT or CAP approach is not used being difficult in those patients. However, goiter makes location of the cricotiroideus membrane, CT, and laryngeal mobilization for the CAP approach through DR very difficult, but does not prevent TA approach through VTC or CAP through VLL.

e) Previous cervical surgery, scars, or tracheotomy can make recognition of the anatomic references difficult due to alterations in normal anatomy. In patients with tracheotomy we use the VTC techniques for the TA and VLL for CAP.

LEMG is reasonably well tolerated. Usually, just after examination, patients have reported feeling a little discomfort. However, in rare instances where sensitivity to pain was extreme, tension and moving, always with cough and deglutition, rendered LEMG difficult. DR is considered the most uncomfortable of all the techniques, followed by VLL, VTC and VCTM. CT approach is better tolerated.

Despite all the technical difficulties, we observed only one significant complication arising from TA approach through VTC; this spontaneously reverted 3 weeks after examination. We believe that the risk-benefit relation justifies laryngeal electromyography for clinical diagnosis.

We are convinced that the above percutaneous techniques allow correct location of the laryngeal muscles in patients who require this type of examination.

References

1. Blitzer, A., Brin, M.F., Fahn, S., Lovelace, R.E.: Localized injection of botulinum toxin for the treatment of focal laryngeal dystonia (spastic dysphonia). *Laryngoscope,* 98:193-197, 1988.

2. Blitzer, A., Brin, M.F., Fahn, S., Lovelace, R.E.: Clinical and laboratory characteristics of focal laryngeal dystonia: study of 110 cases. *Laryngoscope,* 98:636-640, 1988.

3. Buchthal, F.: Electromyography of intrinsic laryngeal muscles. *J. Exp. Physiol.,* 44:137-148, 1959.

4. Faaborg-Andersen, K.C., Buchthal, F.: Action potentials from internal laryngeal muscles during phonation. *Nature,* 177:340-341, 1956.

5. Faaborg-Andersen, K.: Electromyographic investigation of intrinsic laryngeal muscles in humans. *Acta Physiol. Scand. (suppl),* 41:140, 1957.

6. Feinstein, B.: The application of electromyography to affections of the facial and the intrinsic laryngeal muscles. *Proc. R. Soc. Med.,* 39:817-8, 1946.

7. Fink, B.R., Basch, M., Epanchin, V.: The mechanism of opening of the human larynx. *Laryngoscope* 66:410-25, 1956.

8. Greiner, G.F., Isch-Treussard, C., Ebtinger-Jouffroy, J., Klotz, G., Champy, M.: L'electromiografie appliquee a la pathologie du larynx. *Acta Otolaryngol.,* 51:319-31, 1960.

9. Guerrier, Y., Basseres, F.: Electromyographic pharyngolaryngee. Presentation d'appareiiage. *Ann. Otolaryngol. (Paris),* 82:589-94, 1965.

10. Hirano, M., Nozoe, I., Shin, T., Maeyama, T.: Electromyographic findings in recurrent laryngeal nerve paralysis. A study of 130 cases. *Practice Otologia Kyoto,* 67:231-242, 1974.

11. Katsuki, Y.: The function of the phonatory muscle. *Jpn. J. Physiol.,* 1:29-36, 1950.

12. Kotby, M.N., Haugen, L.K. Clinical application of electromyography in vocal fold mobility disorders. *Acta Otolaryngol.,* 70:428-37, 1970.

13. Kotby, M.N. Percutaneous Laryngeal electromyography. Standardization of the technique. *Folia Phoniatr.,* 27: 116-27, 1975.

14. Kotby, M.N., Fadly, E., Madkour, O., Barakah, M., Khidr, A., Alloush, T., Saleh, M.: Electroyography and Neurography in Neurolaryngology. *Journal of Voice,* 6:159-87, 1992.

15. Koufman, J.A., Postma, G.N., Whang, C.S., Rees, C.J., Amin, M.R., Belafsky, P.C., Johnson, P.E., Connoly, K.M., Walker, F.O.: Diagnostic laryngeal electromyography: The Wake Forest experience 1995-1999. *Otolaryngol. Head Neck Surg.* 124:603-606, 2001.

16. Lovelace, R.E., Blitzer, A., Szmidt-Salkowska, E.: Percutaneous laryngeal alectromyography for evaluation of neurologic disorders, myopathies and spastic dysphonia. *Electroenceph. Clin. Neurophysiol.,* 61:57-65, 1986.

17. Macbeth, R.G.: *Proc. R. Soc. Med.,* 39:819, 1946.

18. Portmann, G., Humbert, R., Robin, J.L., Laget, P., Husson, R., Monnier, A.M.: Étude electromyographic des cordes vocals chez l'homme. *C. R. Soc. Biol. (Paris),* 149:296-300, 1955.

19. Spoor, A., VanDisheck, H.A.E.: Electromyography of the human vocal cords and the theory of Husson. *Practica Otorhinolaryngol.,* 20:253-360, 1958.

20. Weddell, G., Feinstein, B., Pattle, R.E. The electrical activity of voluntary muscle in man under normal and pathological conditions. *Brain* 67:178-257, 1944.

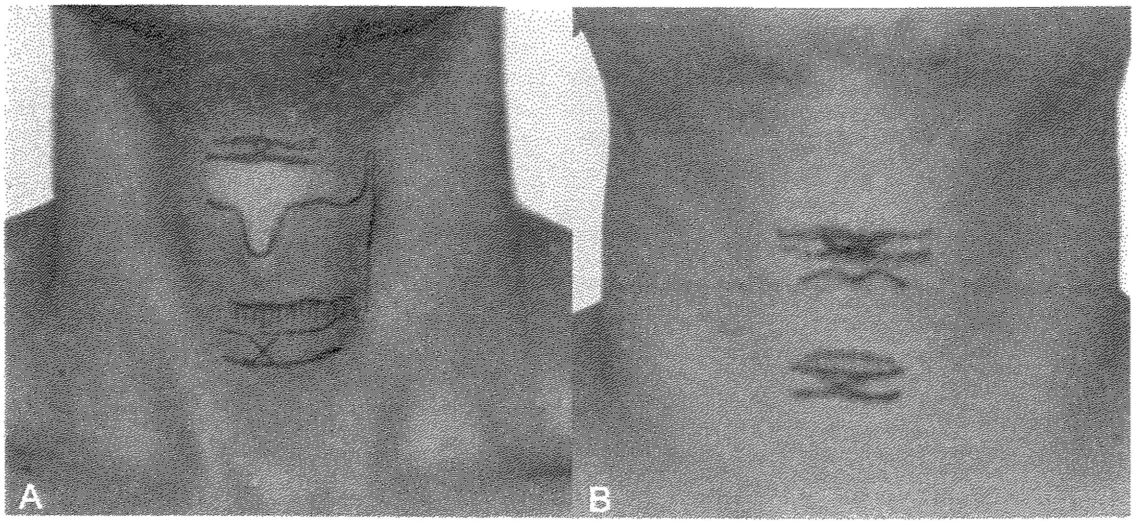

Fig. 1. - Neck frontal view of longilineal male (A) and brevilineal female (B), and surface anatomical references (hyoid arc, thyroid cartilage, cricothyroid membrane and cricoid arc).

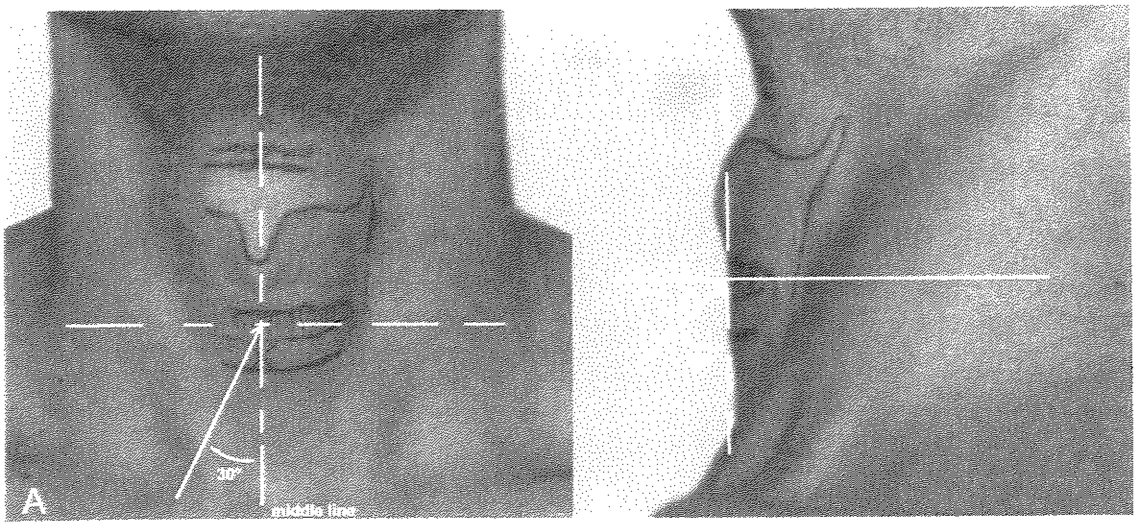

Fig. 2. - *Tireoaritenoideus* Approach via cricothyroid membrane (VCTM). Frontal view (A) and lateral view (B). See details in the text.

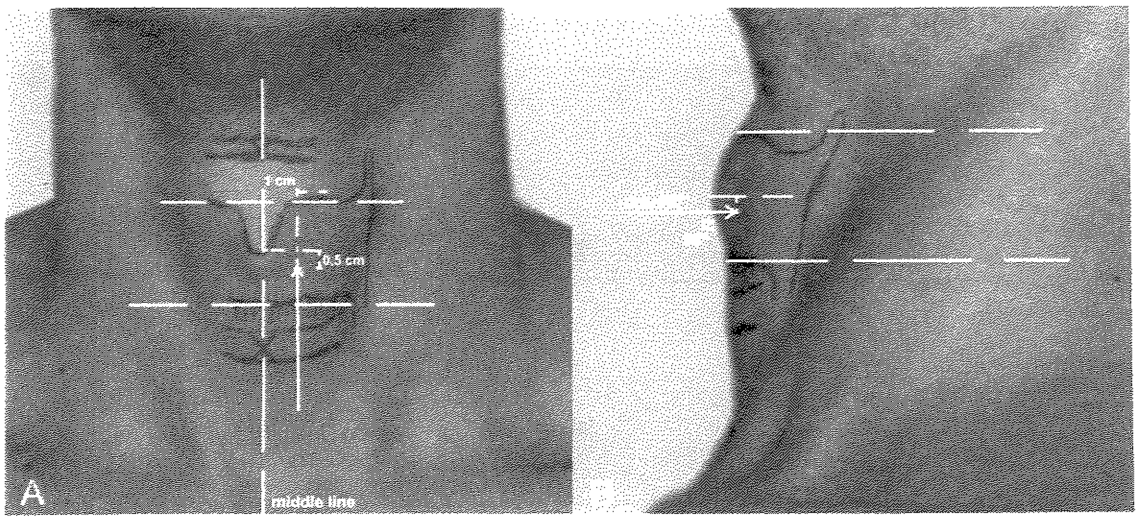

Fig. 3. - *Tireoaritenoideus* Approach via thyroid cartilage (VTC). Frontal view (A) and lateral view (B). See details in the text.

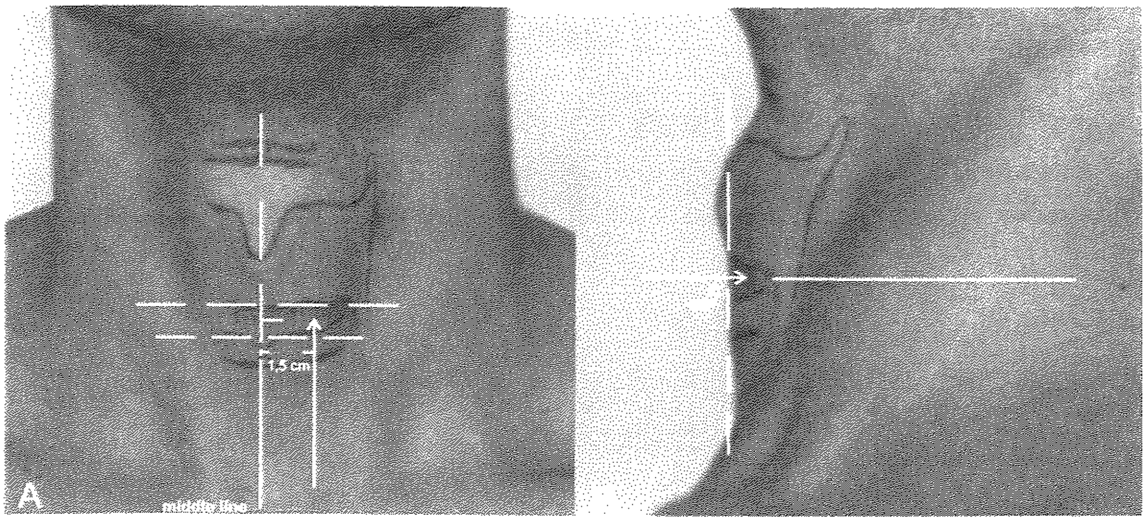

Fig. 4. - *Cricotireoideus* Direct Approach (CTD). Frontal view (A) and lateral view (B). See details in the text.

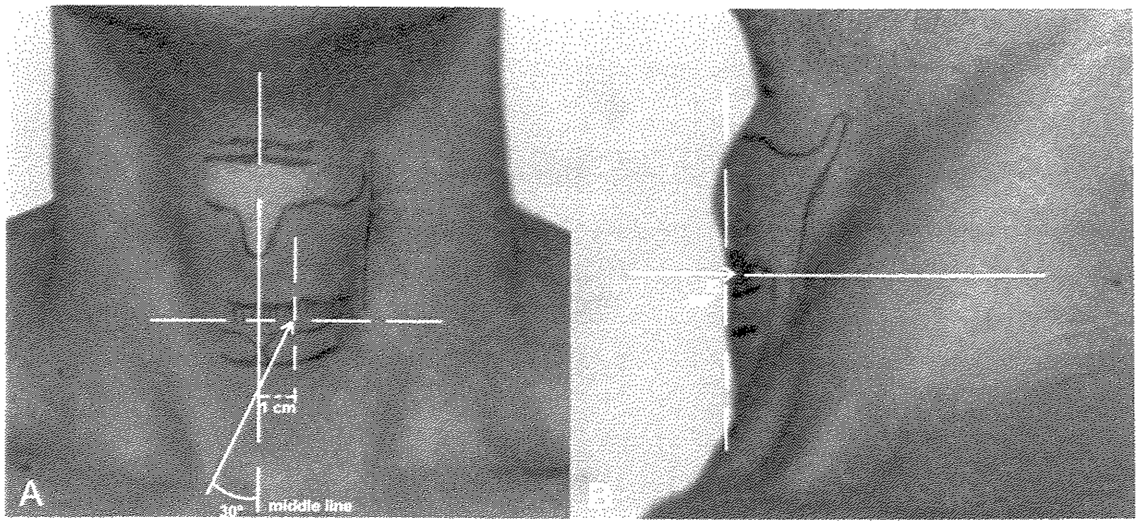

Fig. 5. - *Cricoaritenoideus lateralis* Approach via cricothyroid membrane(CAL). Frontal view (A) and lateral view (B). See details in the text.

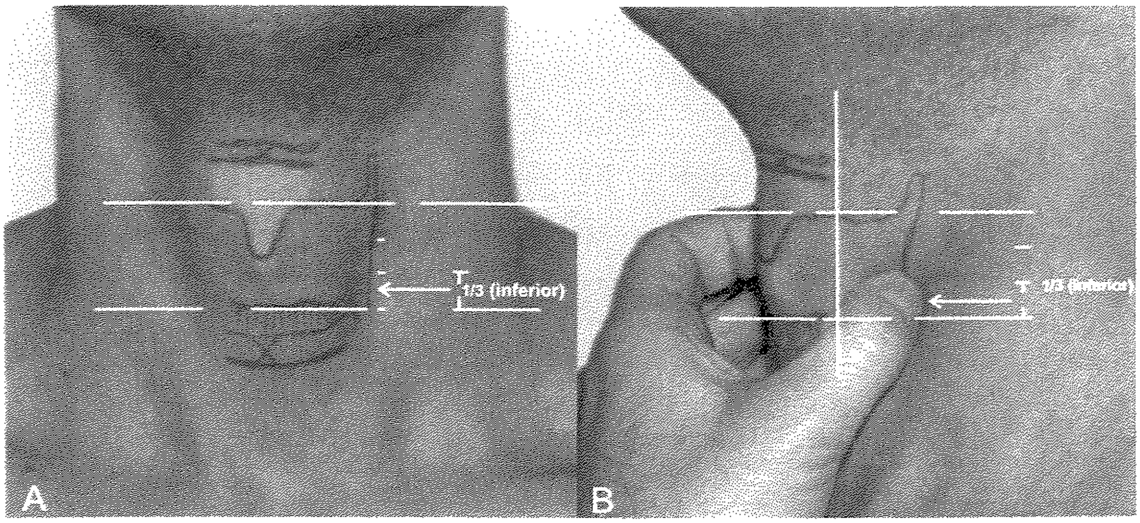

Fig. 6. - *Cricoaritenoideus posterioris* Approach with digital rotation (DR). Frontal view (A) and lateral view (B). See details in the text.

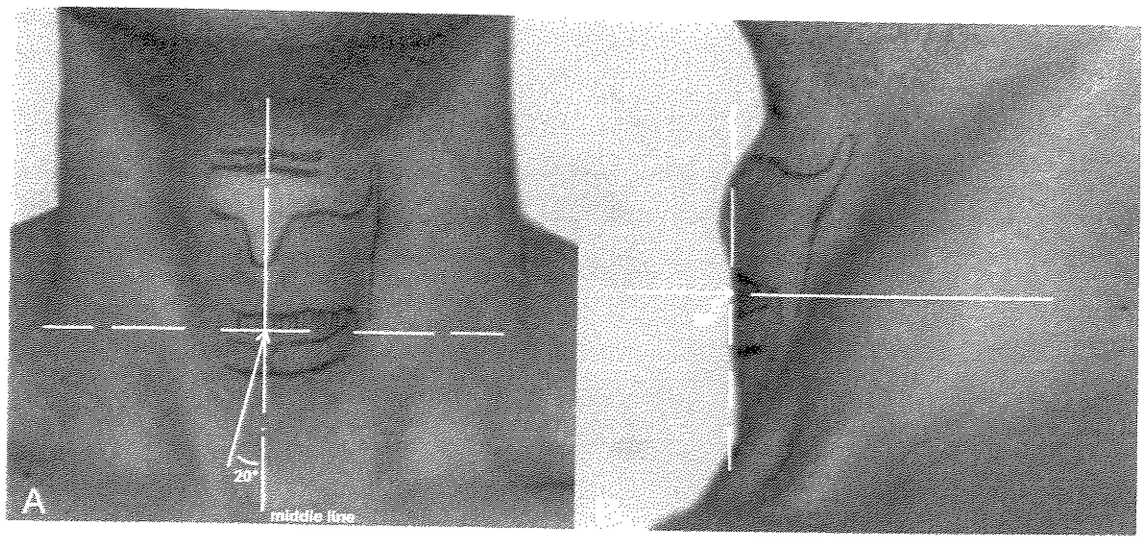

Fig. 7. - *Cricoaritenoideus posterioris* Approach via cricothyroid membrane through laringeal lumen(VLL). Frontal view (A) and lateral view (B). See details in the text.

CAPÍTULO 2

Eletromiografia da Laringe: Estudo Normativo

Laryngeal Electromyography in Normal Brazilian Population.

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Abstract

Quantitative analysis of normal values of motor unit action potentials duration and amplitude of muscles *tireoaritenoideus* (TA), *cricotireoideus* (CT), *cricoaritenoideus lateralis* (CAL), and *cricoaritenoideus posterioris* (CAP) was performed in 14 adult normal Brazilian volunteers. The recordings were obtained by percutaneously inserted concentric needle electrode. Different motor unit action potentials were manually selected in each muscle for quantitative computerized analysis of duration and amplitude. The mean values for duration and amplitude were respectively 3.8ms and 413μV for TA, 4.9ms and 585μV for CT, 4.1ms and 388μV for CAL and 4.5ms and 475μV in CAP. There were no similar reports of normal values of motor unit action potentials in Brazilian subjects.

Key-words: Laringeal electromyography, normative data.

Introduction

Electromyographical analysis of laryngeal muscles is of multidisciplinary interest (5,6,7,8,15); this includes assessment of laryngeal nerve injury after laryngeal paralysis (12,16), monitoring of the vagal nerve during thyroid surgery (10), and monitoring of laryngeral muscle during botulinum toxin injection (15). There are both conventional (1,3,4) and single-fiber techniques in use (13); however, data on normal duration and amplitude of laryngeal muscle motor unity action potentials (MUAP) are rare. The first reports used manual quantitative analysis to determine the normal duration and amplitude values of the motor unit action potentials (MUAP) of the laryngeal intrinsic muscles (3,4). These authors recorded 20 different MUAP in each muscle to establish mean duration and amplitude. In this study we report normal values of MUAP duration and amplitude of the *tireoaritenoideus* (TA), *cricotireoideus* (CT), *cricoaritenoideus lateralis* (CAL), and *cricoaritenoideus posterioris* (CAP) muscles using a similar method in 14 Brazilian normal adult volunteers. Normative data are basic for the diagnosis of the different clinical conditions that compromise the larynge. As far as we known, this is the first report of laryngeal muscle normative MUAP data from a Brazilian population.

Materials and methods

Fourteen normal adult volunteers were examined: 10 TA, 10 CT, 8 CAL, and 10 CAP. Twenty random MUAP were obtained for each muscle. Special attention was paid to examine 5 TA in the left hand side and 5 in the right hand side for left/right comparison. All volunteers were examined in dorsal decubitus, with a cushion under dorsal region for better exposure of the laryngeal anatomic references used to guide electrode insertion.

The MUAP recordings were obtained from a 4-channel Nihon Kohden Neuropack μ apparatus with minimum common mode rejection ratio 112dB, noise level 0.6uVrms, and amplifier input impedance 1000MΩ. The filter band-pass was set to10 - 10000Hz, sensitivity to 200uV/cm, and analysis time to 5ms/cm. A concentric needle electrode with 0.07mm^2 contact area was inserted by percutaneous technique. Series of 20 MUAP were selected and manually marked considering classical Buchthal (1) MUAP criteria and then submitted to computerized analysis to calculate means and standard deviations (SD) of duration and amplitude. Left/right comparison of TA MUAP was analyzed by paired student t test.

Results

There were 5 male and 9 female volunteers aged between 18 and 55 years (mean 35.6).

A total of 200 MUAP were analyzed for each muscle, except CAL with 160 MUAP. Mean MUAP durations were 3.8ms in TA, 4.9ms in CT, 4.1ms in CAL, and 4.5ms in CAP. Left/right TA MUAP comparison was not statistically significant (means 3.81 left/ 3.78 right). Mean MUAP amplitudes were 413μV in TA, 585μV in CT, 388μV in CAL, and 475μV in CAP (Table 1).

Discussion

In early normative studies (3,4) concentric electrodes were inserted into the muscle through indirect laryngoscopy. These authors reported mean durations of 3.5ms and 5.3ms for the TA and CT muscles, respectively. We consider these similar to our study (3.8 and 4.9 – Table 1); the small differences could be explained by the different equipment used. Amplitude values were also similar (Table 1). In the 5 bilateral TA analyses, there was no left/right significant difference.

Other normative studies used monopolar electrodes (9,11) or bipolar electrodes (14), but values obtained in these studies cannot be compared to concentric needle studies, because duration and amplitude varies when different electrode types are used (2).

We did not find normative values of CAL muscle duration and amplitude in literature. The values from our study were a mean of 4.1ms and 388 μV respectively.

References

1. Buchtal., F.: An Introduction to Electromyography. Copenhagen, Glydenol, 1957.

2. Dumitru, D.: Electrodiagnostic Medicine. Hanley & Belfus – Mosby, Philadelphia, 1995.

3. Faaborg-Andersen, K.C., Buchtal, F.: Action potentials from internal laryngeal muscles during phonation. *Nature*, 177:340-341, 1956.

4. Faaborg-Andersen, K.: Electromyographic investigation of intrinsic laryngeal muscles in humans. *Acata Physiol. Scand. (suppl),* 41:140, 1957.

5. Fink, B.R., Basch, M., Epanchin, V.: The mechanism of opening of the human larynx. *Laryngoscope* 66:410-25, 1956.

6. Greiner, G.F., Isch-Treussard, C., Ebtinger-Jouffroy, J., Klotz, G., Champy, M.: L'electromiografie appliquee a la pathologie du larynx. *Acta Otolaryngol.,* 51:319-31, 1960.

7. Hillel, A.D.: The study of laryngeal muscle activity in normal human subjects and in patients with laryngeal dystonia using multiple fine-wire electromyography. *Laryngoscope,* 111(4 Pt 2 Suppl 97):1-47, 2001.

8. Kotby, M.N.: Percutaneous laryngeal electromyography. Standardization of the technique. *Folia Phoniatr.,* 27:116-127, 1975.

9. Lovelace, R.E., Blitzer, A., Szmidt-Salkowska, E.: Percutaneous laryngeal electromyography for evaluation of neurologic disorders, myopathies and spastic dysphonia. *Electroenceph. clin. Neurophysiol.,* 61(suppl.):s76.

10. Mermelstein, M., Nonweiller, R., Rubinstein, E.H.: Intraoperative identification of laryngeal nerves with laryngeal electromyography. *Laryngoscope,* 106:752-756, 1996.

11. Rodriguez, A.A., Myers, B.R., Ford, C.N.: Laryngeal Electromyography in the Diagnosis of Laryngeal Nerve Injuries. *Arch. Phys. Med. Rehabil.,* 71:587-590, 1990.

12. Rontal, E., Rontal, M., Silversman, B., Kileny, P.R.: The clinical differentiation between vocal cord paralysis and vocal cord fixation using EMG. *Laryngoscope,* 103:133-137, 1993.

13. Schweizer, V., Woodson, G.E., Bertorini, T.E.: Single-fiber electromyography of the laryngeal muscles. *Muscle & Nerve,* 22(1):111-114, 1999.

14. Takeda, N., Thomas, G.R., Ludlow, C.L.: Aging Effects on Motor Units in the Human Thyroarytenoid Muscle. *Laryngoscope,* 110:1018-1025, 2000.

15. Woo, P.: Laryngeal Electromyography is a Cost-effective Clinically Useful Tool in the Evaluation of Vocal Fold Function. *Arch. Otolaryngol. Head Neck Surg.,* 124(4):472-475, 1998.

16. Yin, S.S., Qiu, W.W., Stucker, F.J.: Major patterns of laryngeal electromyography and their clinical application. *Laryngoscope,* 107:126-136, 1997.

Table 1. - MUAP duration (ms) and amplitude (µv) for tireoaritenoideus *(TA)*, cricotireoideus *(CT)*, cricoaritenoideus lateralis *(CAL), and* cricoaritenoideus posterioris *(CAP)* muscles from literature compared with this study. SD: standard deviation.

	TA		CT		CAL		CAP	
	Duration	Amplitude	Duration	Amplitude	Duration	Amplitude	Duration	Amplitude
Faaborg-Andersen	3.5 (SD=0.1)	224 - 358	5.3 (SD=0.1)	224 - 358	-	-	4.4 (SD=0.2)	-
Rodriguez et al	3.5 (SD=1.0)	426 (SD=194)	4.4 (SD=1.6)	500 (SD=224)	-	-	-	-
Lovelace et al	3 - 6	100 - 400	3 - 6	100 - 400	-	-	-	-
Kimaid et al	3.8 (SD=0.4)	413 (160-630)	4.9 (SD=0.6)	585 (360-780)	4.1 (SD=0.4)	388 (256-580)	4.5 (SD=0.5)	475 (373-610)

CAPÍTULO 3

Eletromiografia da Laringe: Contribuição ao Diagnóstico na Imobilidade de Pregas Vocais

Laryngeal Electromyography: Contribution to Vocal Fold Immobility Diagnosis

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Abstract

Laryngeal Electromyography (LEMG) is a diagnostic test commonly used in patients with vocal fold movement disorder. The aim of this study is to describe LEMG in patients with vocal fold immobility. A total of 55 dysphonic patients with vocal fold immobility diagnosed by laryngeal endoscopy were grouped according to probable clinical cause: 1) unknown; 2) traumatic; or 3) tumoral compression. They were submitted to LEMG by percutaneous insertion of concentric needle electrode. LEMG was conclusive in all patients and showed a majority with peripheral nerve injury. LEMG diagnosed peripheral nerve damage in 25 group 1, 12 group 2, and 11 group 3 patients. LEMG was normal in 4 patients, suggesting cricoarytenoid joint fixation. Central nervous system disorders was suggested in 2 and myopathic pattern in 1. As the major cause of vocal fold immobility is peripheral nerve damage, LEMG is an important test to confirm diagnosis.

Key words: laryngeal, electromyography.

Introduction

Laryngeal electromyography (LEMG) is a diagnostic test used to distinguish diseases that affect vocal fold movement[1,8,9,13,15]. Although described in 1944[27] as an important complementary test after clinical examination, its use is restricted to some services of laryngology[4,8,11,13,15-32].

There is some abuse in use of the term "vocal fold paralysis" for any vocal fold immobility found clinically or by endoscopy[24]. There is a consensus that vocal fold immobility is a consequence of central neural pathway disorders, peripheral nerve injury, muscular disease, or cricoarytenoid joint fixation[13,15-32]. LEMG differentiates the causes of laryngeal immobility, confirms or changes diagnosis, permits prognostic inferences and helps decisions in treatment[4,7,8,11,13,15-32].

Standardization of percutaneous electrode insertion techniques[10,14] allows the correct identification of intrinsic laryngeal muscles. The neurology and otorhinolaryngology services of UNICAMP have been using LEMG since January 2000 in routine vocal fold immobility and laryngeal movement disorders. The aim of this study is to describe LEMG in vocal fold immobility diagnosis.

Patients and methods

After consent by the human research ethical medical committee, 55 patients from UNICAMP laryngology ambulatory with vocal fold immobility diagnosed by laryngeal endoscopy were submitted to LEMG between January 2000 and January 2003. They were grouped according to prior clinical diagnosis: 1) unknown; 2) traumatic; or 3) tumoral compression.

LEMG was performed in dorsal decubitus, after skin asepsis with alcohol and electrode insertion guided by laryngeal anatomic references. Anaesthesia was not necessary.

The readings were obtained using a four-channel Nihon Kohden Neuropack μ apparatus, with 112dB minimum common mode rejection ratio, 0.6μVrms noise level and 1000 MΩ input impedance amplifiers. The band-pass filter was set to 10 - 10000 Hz, sensitivity to 200μV/cm, and analysis time to 5ms/cm. A concentric needle electrode with 0.07 mm^2 contact area was inserted by percutaneous laryngeal muscle approach technique.

LEMG patterns of peripheral nerve damage, muscular disease, cricoarytenoid joint fixation, and central nervous system disorders were obtained for each group according to proposed criteria[15,24]. Peripheral nerve injuries were classified by nerve and side in each group.

Results

LEMG were obtained from 27 female and 28 male patients aged between 18-79 years; 32 with left vocal fold immobility, 14 with right immobility, and 9 bilateral. There were 30 patients in the idiopathic, 14 in the traumatic and 11 in the tumoral compression group. LEMG was abnormal in 51 and normal in 4 patients. Peripheral nerve injury was the most common cause of vocal fold immobility. For group 1, LEMG diagnosed recurrent laryngeal nerve injury in 21 patients, 14 left hand side, 6 right hand side, and 1 bilateral; no gender predominance was observed (1:1). In 4 patients LEMG diagnosed mixed recurrent and superior laryngeal nerve injury, 3 left hand side, and 1 right hand side. There were 3 normal patients, and 2 with probable central nervous system disorder. For group 2, LEMG diagnosed peripheral nerve lesion in 12 patients, one was normal, and one myopathic. For all group 3 patients LEMG diagnosed nerve impairment. Table 1 summarizes the different peripheral nerve diagnosis in each group.

Discussion

Many reports describe the importance of LEMG in neurological and laryngological diagnosis and prognosis in vocal fold paralysis[4,7,8,11,13-32]. Traissac et al[24] summarized LEMG patterns in patients with laryngeal immobility allowing differentiation between muscular and peripheral nerve disorders and suggested central nervous system or cricoarytenoid joint disorders.

Idiopathic recurrent laryngeal nerve injury can account for 10-50% of vocal fold immobility patients and is more common on the left hand side (21). This is in accordance with our data. We found a total of 4 patients with normal LEMG, 3 patients in group 1, and one in group 2, suggesting cricoarytenoid joint fixation; this is found in 10% of vocal fold immobility patients (13,19). Two patients presented normal MUAP with reduced interference pattern suggesting central nervous system disorders, probably stroke.

In group 2, all 14 patients had probable traumatic laryngeal nerve injury; 12 showed peripheral nerve injury as previously suspected; normal LEMG was found in one and myopathic pattern in the other. There was no difference in left-to-right recurrent laryngeal nerve injury. One patient had superior laryngeal nerve injury due to external compression; a singer who lost the high frequencies. Immobility in this case was probably due to cricoarytenoid joint fixation or luxation, as laryngeal superior nerve injury does not determine vocal fold paralysis[13]. In the normal patient, cricoarytenoid joint fixation occurred after 3 unsuccessful attempts at forking. In the myopathic patient, it occurred immediately after VIII nerve schwannoma surgery suggesting traumatic lesion, but the myopathic pattern suggested inflammatory direct lesion probably due to oral intubation. It was reported as inflammatory local myopathy due to intubation [30].

In group 3, all 11 patients had been diagnosed with cervical tumor; they all had LEMG patterns of peripheral nerve injury. A left-to-right predominance in idiopathic recurrent laryngeal nerve injury was observed in group 1. Takeda[23] showed that in ageing remodeling, increased MUAP duration was more frequent in the left hand side.

There were a higher number of bilateral nerve injuries in group 3, probably due to thyroid gland tumors.

Considering evolution time and LEMG pattern, 2 patients in group 2 presented some discrepancy; both complained of dysphonia for 1 month before the exam – one after thoracic surgery and the other after thyroidectomy. LEMG from both these patients showed long duration, stable, poliphasic MUAP, suggesting disease duration of more than 1 month. Therefore tumoral compression of the laryngeal nerves prior to surgery could be the cause of their nerve injuries. The slow partial axon compromise could have been compensated for by collateral sprouting up until the time of surgery[2,5,6]. Like others group 3 patients, their LEMG pattern showed chronic peripheral nerve injury. Group 2 patients with 1 month history of trauma showed signs of acute peripheral nerve damage at LEMG.

The increased frequency of vocal fold immobility with no clinical cause but with peripheral nerve injury diagnosed at LEMG shows the importance of this exam in such cases.

References

1. Brin, M.F., Fahn, S., Blitzer, A., Ramig, L., Stewart, C.: Movement Disorders of the Larynx. In: Blitzer, A., Brin, M., Sasaki, C.T., Fahn, S., Harris, K.S.: Neurologic Disorders of the Larynx. Thieme Medical Publishings, New York, 1992.

2. Desmedt, J.E., Borenstein, S.: Collateral innervation of muscle fibres by motor axons of dystrophic motor units. *Nature*, 246:500-501, 1973.

3. Dumitru, D.: Electrodiagnostic medicine. Hanley-Belfus Mosby, Philadelphia, 1995.

4. Faaborg-Andersen, K.: Electromyographic investigation of intrinsic laryngeal muscles in humans. *Acta Physiol Scand*,41(suppl):9-148, 1957.

5. Gorio, A., Carmignoto, G., Finesso, M., Polato, P., Nunzi, M.G.: Muscle reinnervation II. Sprouting, synapse formation and repression. *Neuroscience*, 8: 403-416, 1983.

6. Gorio, A., Marini, P., Zanoni, R.: Muscle reinnervation III. Motoneuron sprouting capacity, enhancement by exogenous gangliosides. *Neuroscience*, 8: 417-429, 1983.

7. Gupta, S.R., Bastian, R.W.: Use of laryngeal electromyography in prediction of recovery after vocal cord paralysis. *Muscle Nerve*, 16:977-978, 1993.

8. Hirano, M., Nozoe, I., Shin, T., Maeyama, T.: Electromyographic findings in recurrent laryngeal nerve paralysis. A study of 130 cases. *Practice Otologia Kyoto*, 67:231-242, 1974.

9. Kotby, M.N., Haugen, L.K.: Clinical application of electromyography in vocal fold mobility disorders. *Acta Otolaryngol*, 70:428-437, 1970.

10. Kotby, M.N.: Percutaneous Laryngeal electromyography. Standardization of the technique. *Folia Phoniatr*, 27: 116-122, 1975.

11. Kotby, M.N., Fadly, E., Madkour, O., Barakah, M., Khidr, A., Alloush, T., Saleh, M.: Electromyography and Neurography in Neurolaryngology. *Journal of Voice*, 6:159-187, 1992.

12. Koufman, J.A., Walker, F.O., Johardji, G.M.: The cricothyroid muscle does not influence vocal fold position in laryngeal paralysis. *Laryngoscope*, 105:368-372, 1995.

13. Koufman, J.A., Postma, G.N., Whang, C.S., Rees, C.J., Amin, M.R., Belafsky, P.C., Johnson, P.E., Connoly, K.M., Walker, F.O.: Diagnostic laryngeal electromyography: The Wake Forest experience 1995-1999. *Otolaryngol Head Neck Surg*, 124:603-606, 2001.

14. Lovelace, R.E., Blitzer, A., Szmidt-Salkowska, E.: Percutaneous laryngeal electromyography for evaluation of neurologic disorders, myopathies and spastic dysphonia. *Electroenceph Clin Neurophysiol*, 61(suppl):S76, 1986.

15. Lovelace, R.E., Blitzer, A., Ludlow, C.L.: Clinical laryngeal electromyography. In Blitzer, A., Brin, M., Sasaki C.T., Fahn, S., Harris, K.S.: Neurologic Disorders of the Larynx. Thieme Medical Publishings. New York, 1992.

16. Munin, M.C., Murry, T., Rosen, C.A.: Laryngeal electromyography. Diagnosis and prognostic applications. *Otolaryngologic Clinics of North America*, 4:759-771, 2000.

17. Parnes, S.M., Satya-Murti, S.: Predictive Value of Laryngeal Eletromyography in Patients with Vocal Cord Paralysis of Neurogenic Origin. *Laryngoscope*, 95:1323-1326, 1985.

18. Rodriquez, A.A., Myers, B.R., Ford, C.N.: Larygeal Electromyography in the Diagnosis of Laryngeal Nerve Injuries. *Arch Phys Med Rehabil*, 71:587-590, 1990.

19. Rontal, E., Rontal, M., Silverman, B., Kileny, P.R.: The clinical differentiation between vocal cord paralysis and vocal cord fixation using electromyography. *Laryngoscope*, 103:133-137, 1993.

20. Schaefer, S.D.: Laryngeal electromyography. *Otholaryngologic Clinics of North America*, 5:1053-1057, 1991.

21. Simpson, D.M., Sternman, D., Graves-Wrigth, J., Sanders, I.: Vocal Cord paralysis: clinical and electrophysiological features. *Muscle Nerve*, 16:952-957, 1993.

22. Sittel, C., Stennert, E., Thumfart, W.T., Dapunt, U., Ecke, H.E.: Prognostic value of laryngeal electromyography in vocal fold paralysis. *Arch Otolaryngol Head Neck Surg*, 127:155-160, 2001.

23. Takeda, N., Thomas, G.R., Ludlow, C.L.: Aging Effects on Motor Units in the Human Thyroarytenoid Muscle. *Laryngoscope*, 110:1018-1025, 2000.

24.Traissac, L., Gioux, M., Rovira, H.P., Henry, C., Bertrand, B.: L'Electromyographie (EMG) du larynx dans le diagnostic des immobilités larynges spontanées ou post-thyroïdectomie. *Revue de Laryngologie*, 112: 205-207, 1991.

25. Tucker, H.M.: Vocal Cord Paralisis-1979: Etiology and Management. *Laryngoscope*, 89:504-507, 1980.

26. Verhulst, J., Gioux, M., Castro, E., Quintero, R., Traissac, L.: Intérêt et role de l'electromyographie dans l'evaluation d'um trouble de la mobilité laringe et son pronostic. *Rev Laryngol Otol Rhinol*, 116:289-292, 1995.

27. Weddell, G., Feinstein, B., Pattle, R.E.: The electrical activity of voluntary muscle in man under normal and pathological conditions. *Brain*, 67:178-257 1944.

28. Woo, P.: Laryngeal Electromyography Is a Cost-effective Clinically Useful Tool in the Evaluation of Vocal Fold Function. *Arch Otolaryngol Head Neck Surg*, 124:472-475, 1998.

29. Woodson, G.F.: Clinical value of laryngeal EMG is dependent on experience of the clinician. *Arch Otolaryngol Head Neck Surg*, 124:476, 1998.

30. Yin, S.S., Qiu, W.W., Stucker, F.J.: Value of electromyography in differential diagnosis of laringeal joint injuries after intubation. *Ann Otol Rhinol Laryngol*, 105:446-451, 1996.

31. Yin, S.S., Qiu, W.W., Stucker, F.J.: Major patterns of laryngeal electromyography and their clinical application. *Laryngoscope*, 107:126-136, 1997.

32. Yin SS, Stucker FJ, Qiu WW, Batchelor BM. Clinical evaluation of Neurolaryngological Disorders – Ann Otol Rhinol Laryngol 2000; 109:832-838.

Table-1: Peripheral nerve diagnosis in the three groups. RLN – recurrent laryngeal nerve; SLN – superior laryngeal nerve; R – right and L – left.

NERVES	G1 IDIOPATHIC (n=30)	G2 TRAUMATIC (n=14)	G3 TUMORAL COMP. (n=11)
RLN R	6	2	1
RLN L	14	2	2
SLN R	0	0	0
SLN L	0	1	0
RLN + SLN bilateral	0	1	2
RLN bilateral	1	0	2
RLN + SLN R	1	2	2
RLN + SLN L	3	4	2
TOTAL	25	12	11

CAPÍTULO 4

Eletromiografia da Laringe nos Distúrbios dos Movimentos: Dados Preliminares

Laryngeal Electromyography in Movement Disorders: Preliminary Data.

Eletromiografia laríngea e distúrbios do movimento: dados preliminares.

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Abstract

This study describes preliminary laryngeal electromyography (LEMG) data and botulinum toxin treatment in patients with dysphonia due to movement disorders. Twenty-five patients who had been clinically selected for botulinum toxin administration were examined, 19 with suspected laryngeal dystonia or spasmodic dysphonia (SD), 5 with vocal tremor, and 1 with Gilles de la Tourette syndrome (GTS). LEMG evaluations were performed before botulinum toxin administration using monopolar electrodes. Electromyography was consistent with dystonia in 14 patients and normal in 5, and differences in frequency suggesting essential tremor in 3 and Parkinson tremors in 2. The different LEMG patterns and significant improvement in our patients from botulinum toxin therapy has led us to perform laryngeal electromyography as a routine in UNICAMP movement disorders ambulatory.

Key words: laryngeal electromyography; movement disorders.

Resumo

Este trabalho descreve dados preliminares de eletromiografia laríngea (LEMG) e tratamento com toxina botulínica em pacientes com disfonia associada a distúrbios do movimento. Foram estudados 25 pacientes, 19 com distonia laríngea ou disfonia espasmódica, 5 com tremor vocal e 1 com síndrome de Gilles de la Tourette. LEMG realizada com eletrodos monopolares, antes da administração de toxina botulínica, foi compatível com distonia em 14 pacientes (normal em 5), sugeriu tremor essencial em 3 e Parkinson em 2. Os diferentes padrões de LEMG e melhora considerável obtida com administração de toxina botulínica instituíram LEMG como rotina no ambulatório de distúrbios do movimento da UNICAMP.

Palavras-chave: eletromiografia, laringe.

Dysphonia is a speech problem caused by abnormalities in the sound generator, such as laryngeal structures[8]. The production of sound requires fine and precise motor synchronism of the laryngeal muscles; this is often affected in movement disorder patients[8]. Laryngeal electromyography (LEMG) is a useful diagnostic method for motor unit disorders[12,16,18-20,22,27]; it can be used to establish the cause of laryngeal immobility[11,23,26] and help guide the needle to the correct location for botulinum toxin administration in laryngeal hyper-kinetic movement disorder patients[4,5,7]. We describe preliminary LEMG pattern data from 25 patients complaining of dysphonia attending UNICAMP movement disorders ambulatory whose clinical examinations and laryngeal endoscopies suggested vocal fold hyper-kinetic movement disorders.

Methods

A total of 25 patients complaining of dysphonia were seen at UNICAMP movement disorders and laryngology ambulatories between January 2000 and January 2003. After consent from the ethical medical committee for human research, all patients were submitted to clinical and endoscopic evaluation, and selected for botulinum toxin treatment due to the diagnosis of hyper-kinetic vocal fold movement disorder. Patients with normal LEMG or Parkinson's disease tremors were not treated with botulinum toxin.

LEMG was performed before botulinum toxin administration, with patient in seated position, slightly inclined back support, head supported and slightly extended, arms hanging beside the body, and shoulders and cervical musculature relaxed.

Records were made using a four-channel Nihon Kohden Neuropack μ, with 112dB minimum common mode rejection ratio, 0.6μVrms noise level, and 1000 MΩ input impedance. Filter band-pass was set to 10 - 10000 Hz, sensitivity to 200μV/cm, and analysis time to 50ms/cm. After skin asepsia with alcohol, a monopolar electrode was inserted by percutaneous technique for laryngeal muscles approach[5,7,17]. The *tireoaritenoideus* muscle (TA) was studied in all patients and *cricoaritenoideus posterioris* muscle (CAP) in just 2 with abduction spasmodic dysphonia (SD).

Botulinum toxin, 2.5U of BOTOX^{R}, diluted in 0.9% saline solution was administered unilaterally in TA muscle of all adduction SD patients, 3 with essential tremor (ET), and 1 with GTS. For 2 abduction SD patients, botulinum toxin was unilaterally administered in CAP muscle. Botulinum toxin was not administered in 2 patients with Parkinson tremor or the 5 normal LEMG patients. The 0-10 scale of improvement was used for treatment evaluation. Improvement was considered significant between 8-10, mild between 5-7, poor between 2-4, and insignificant or without improvement between 0-1.

Results

Of the 25 patients, 18 were female and 7 male, ages were between 21 and 86 years (mean 51.4). Endoscopy and clinical examination were consistent with SD in 19 patients, vocal tremor in 5, and GTS in 1. LEMG results were consistent with SD in 14 (12 adduction and 2 abduction), normal in 5, vocal tremor in 5 (3 essential tremor and 2 Parkinson), and GTS in 1. Results are shown in Table 1.

All patients with adduction SD showed increased TA muscle rest activity with irregular bursts during muscle contraction. In abduction SD patients, this abnormal muscle activity was found in CAP. Tremor was not observed in SD patients.

Essential tremor was diagnosed in 3 patients with normal TA activity at rest and rhythmic bursts of muscle activity of 8 - 11 Hz during sustained phonation. Tremor was bilateral in these patients.

The 2 Parkinson tremor patients had rhythmic bursts of 5-6 Hz muscle activity at rest that disappeared with phonation; one patient was right hand side unilateral, the other bilateral.

The GTS patient had sporadic subtle bursts of involuntary muscle activity independent of voluntary phonation.

Botulinum toxin was administered to 18 patients: 14 with SD, 3 with essential tremor and 1 with GTS.

In 14 SD patients treated with botulinum toxin, 9 showed significant improvement, 3 mild, and 2 poor. The 2 poor results were in abduction SD patients.

In 3 patients with essential tremor, 1 showed significant improvement, the other 2 mild.

In the GTS patient improvement was significant.

Discussion

The most common movement disorders affecting laryngeal muscles were reviewed by Brin et al[8]. They were classified as hypo-kinetic, hyper-kinetic, and mixed according to muscle abnormality[8]. LEMG can help differentiate patterns in abnormal muscle activity and identify the muscles to be treated with botulinum toxin[4-8,20].

Although tremor is the most common movement disorder, the most frequent type of hyper-kinetic laryngeal movement disorder encountered in our service is SD; this is similar to other authors[8,20].

SD patients commonly display normal function at rest with abnormal involuntary adductor (adduction SD) or abductor muscle (abduction SD) co-activation during phonation[2,6,8,20]. LEMG showed increased muscle activity in the apparently normal muscles at rest, and during phonation co-activation manifested as bursts of adductor or abductor muscle activity.

In this work, as in literature, the SD group were predominantly of adduction type[4-8]. Although 25 to 30 % of patients presented tremor[8], we found no tremor in our SD patients. In the past SD was thought to be a psychogenic disorder, but Aronson[2,3] reported no difference between SD patients and normal subjects using psychiatric tests. Interestingly we found 5 patients with mildly elevated rest activity in TA muscles which was interpreted as psychogenic dysphonia. Brin et al[8] considered psychogenic dystonia as a form of secondary dystonia with dystonic phenomenology and psychiatric etiology. They also considered it a rare condition because patients were referred to a psychiatrist and not a movement disorders service. We suggested speech therapy to our patients before any other type of treatment. In accordance with many authors[4-8] the majority of our SD patients showed improvement after botulinum toxin administration; results were poor in abduction SD. Brin et al[7] reported an average of 50% improvement in abduction SD patients.

Tremor is a rhythmic body segment oscillatory movement, such as in the laryngeal sound generator, with relatively stable periodicity[8-10]. After Ardran et al[1], other authors have studied vocal tremor using LEMG[8,9,15]. In ET patients, LEMG generally shows normal activity at rest and 4-12 Hz muscle rhythm during sustained phonation[15]. The most common EMG pattern in ET is agonist-antagonist muscle co-activation[21]. In our patients there was a higher frequency of muscle activity but the other characteristics were similar. According to Brin et al[7,8], treatment with botulinum toxin showed mild to significant improvement in all our patients.

In Parkinson's disease, vocal tremors are seen as a 4-7 Hz rest rhythmic muscle activity[24,25] similar to oral and jaw tremor[13], which can oscillate[24,25], and disappear with phonation[8]. Tremor can be unilateral in Parkinson's disease[8] with the most frequent EMG pattern being alternating agonist-antagonist muscle activation[21]. Our

2 PD patients showed similar characteristics. Botulinum toxin was not administered in our patients at the time of research, because speech therapy was suggested as the first treatment.

Tics are brief, purposeless, stereotyped and repetitive movements of muscle groups[8,14]. GTS, considered the most severe form of tic, can present with vocal tics[8,14]. We did not find any reports of LEMG evaluation for GTS. Our only patient presented subtle bursts of TA activity at rest or during phonation.

In all 25 patients motor unit action potentials were of normal amplitude and duration.

References

1. Ardran G, Kinsbourne M, Rushworth G. Dysphonia due to tremor. J Neurol Neurosurg Psychiatry 1966;29:219-223.

2. Aronson AE, Brown JR, Litin EM, Pearson JS. Spastic dysphonia. I. Voice, neurologic, and psychiatric aspects. J Speech Hear Disord 1968;33:203-218.

3. Aronson AE, Brown JR, Litin EM, Pearson JS. Spastic dysphonia. II. Comparison with essential (voice) tremor and other neurologic and psychogenic dysphonias. J Speech Hear Disord 1968;33:219-231.

4. Blitzer A, Lovelace RE, Brin MF, Fahn S, Fink ME. Electromyographic findings in focal laryngeal dystonia (spastic dysphonia). Ann Otol Rhinol Laryngol 1985;94:591-594.

5. Blitzer A, Brin MF, Fahn S, Lovelace RE. Localized injection of botulinum toxin for the treatment of focal laryngeal dystonia (spastic dysphonia). Laryngoscope 1988;98:193-197.

6. Blitzer A, Brin MF, Fahn S, Lovelace RE. Clinical and laboratory characteristics of focal laryngeal dystonia: study of 110 cases. Laryngoscope 1988;98:636-640.

7. Brin MF, Blitzer A, Stewart C, Fahn S. Treatment of spasmodic dysphonia (laryngeal dystonia) with local injections of botulinum toxin: review and technical aspects. In: Blitzer A, Sasaki CT, Fahn S, Brin A, Harris KS. Neurologic Disorders of the Larynx. New York: Thieme, 1992:214-228.

8. Brin MF, Fahn S, Blitzer A, Ramig L, Stewart C. Movement Disorders of the Larynx. In: Blitzer A, Sasaki CT, Fahn S, Brin A, Harris KS (Eds). Neurologic Disorders of the Larynx. New York: Thieme Medical Publishings, 1992:248-278.

9. Brown JR, Simonson J. Organic voice tremor: a tremor of phonation. Neurology 1963;13: 520-525.

10. Deuschl G, Raethjen J, Lindemann M, Krack P. The Pathophysiology of tremor. Muscle & Nerve 2001;24:716-735.

11. Gupta SR, Bastian RW. Use of laryngeal electromyography in prediction of recovery after vocal cord paralysis. Muscle & Nerve 1993; 16, 977-978.

12. Hirano M, Nozoe I, Shin T, Maeyama T. Electromyographic findings in recurrent laryngeal nerve paralysis. A study of 130 cases. Pract Otol Kyoto 1974;67:231-242.

13. Hunker C, Abbs J. Physiological analysis of Parkinsonian tremors in the oral facial system. In Anonymous The Dysarthrias. San Diego: College Hill Press, 1984:69-100.

14. Jankovic J. Phenomenology and Classification of Tics. Neurol Clin 1997;15:267-276.

15. Koda J, Ludlow CL. An evaluation of laryngeal muscle activation in patients with voice tremor. Otolaryngol Head Neck Surg 1992;107:684-696.

16. Kotby MN, Haugen LK. Clinical application of electromyography in vocal fold mobility disorders. Acta Otolaryngol 1970;70:428-37.

17. Kotby MN. Percutaneous Laryngeal electromyography. Standardization of the technique. Folia Phoniatr 1975;27: 116-27.

18. Kotby MN, Fadly E, Madkour O, Barakah M,Khidr A, Alloush T, Saleh M. Electromyography and Neurography in Neurolaryngology. J Voice 1992;6:159-87.

19. Koufman JA, Postma GN, Whang CS, Rees CJ, Amin MR, Belafsky PC, Johnson PE, Connoly KM, Walker FO. Diagnostic laryngeal electromyography: The Wake Forest experience 1995-1999. Otolaryngol Head Neck Surg 2001;124:603-606.

20. Lovelace RE, Blitzer A, Ludlow CL. Clinical laryngeal electromyography. In Blitzer A, Sasaki CT, Fahn S, Brin A, Harris KS. Neurologic Disorders of the Larynx. New York: Thieme Medical Publishings; 1992:66-81.

21. Milanov I. Electromyographic differentiation of tremors. Clin Neurophysiol 2001;112:1626-1632.

22. Munin MC, Murry T, Rosen CA. Laryngeal electromyography. Diagnosis and prognostic applications. Otolaryngologic Clin North Am 2000;4, 759-771.

23. Parnes SM, Satya-Murti S. Predictive Value of Laryngeal Electromyography in Patients with Vocal Cord Paralysis of Neurogenic Origin. Laryngoscope, 1985; 95, 1323-1326.

24. Philippbar SA, Robin DA, Luschesi ES. Limb, jaw and vocal tremor in Parkinson's patients. In Yorkston K, Beukelman D. Recent Advances in Clinical Dysarthria. San Diego: College Hill Press, 1991.

25. Ramig LA, Scherer RC, Titze IR, Ringel SP. Acoustic analysis of voices of patients with neurologic disease: rationale and preliminary data. Ann Otol Rhinol Laryngol 1988;97:164-172.

26. Sittel C, Stennert E, Thumfart WT, Dapunt U, Ecke HE. Prognostic value of laryngeal electromyography in vocal fold paralysis. Arch Otolaryngol Head Neck Surg, 2001; 127, 155-160.

27. Yin SS, Qiu WW, Stucker FJ. Major patterns of laryngeal electromyography and their clinical application. Laryngoscope 1997; 107: 126-136.

Table 1: LEMG findings and botulinum toxin treatment in patients with movement disorders. SD: spasmodic dysphonia; TA: *tireoaritenoideus* muscle, CAP: *cricoaritenoideus posterioris* muscle; P: Parkinson, ET: essencial tremor GTS: Gilles de la Tourette syndrome.

Case Number	Sex	Age	Diagnosis before LEMG	LEMG findings	Improvement with Botox^R (2,5U)
1	F	58	SD adduction	Increased TA rest activity. Bursts with phonation	8
2	F	57	SD adduction	Increased TA rest activity. Bursts with phonation	9
3	F	38	SD adduction	Increased TA rest activity. Bursts with phonation	7
4	F	57	SD adduction	Increased TA rest activity. Bursts with phonation	8
5	F	55	SD adduction	Increased TA rest activity. Bursts with phonation	8
6	F	38	SD adduction	Increased TA rest activity. Bursts with phonation	8
7	F	48	SD adduction	Increased TA rest activity. Bursts with phonation	10
8	F	73	SD adduction	Increased TA rest activity. Bursts with phonation	5
9	F	67	SD adduction	Increased TA rest activity. Bursts with phonation	7
10	F	59	SD adduction	Increased TA rest activity. Bursts with phonation	8
11	F	38	SD abduction	Increased CAP rest activity. Bursts with phonation	4
12	M	37	SD adduction	Increased TA rest activity. Bursts with phonation	8
13	M	54	SD adduction	Increased TA rest activity. Bursts with phonation	10
14	M	33	SD abduction	Increased CAP rest activity. Bursts with phonation	2
15	F	21	SD adduction	Increased TA rest activity with normal activity during phonation	-
16	F	32	SD adduction	Increased TA rest activity with normal activity during phonation	-
17	M	38	SD adduction	Increased TA rest activity with normal activity during phonation	-
18	M	58	SD adduction	Increased TA rest activity with normal activity during phonation	-
19	M	25	SD adduction	Increased TA rest activity with normal activity during phonation	-
20	M	65	Vocal tremor (P)	Rest: 5-6Hz rhythmic TA activity. Action: Normal	-
21	F	69	Vocal tremor (P)	Rest: 6Hz rhythmic TA activity. Action: Normal	-
22	F	70	Vocal tremor (ET)	Rest: Normal Action: 9-11 Hz rhythmic TA activity.	8
23	F	81	Vocal Tremor (ET)	Rest: Normal Action: 8-9 Hz rhythmic TA activity.	4
24	F	86	Vocal Tremor (ET)	Rest: Normal Action: 10Hz rhythmic TA activity.	6
25	F	27	Tic Vocal (GTS)	Subtle bursts of TA activity at rest or during phonation	8

5- DISCUSSÃO

A técnica de EMGL realizada pela primeira vez utilizou abordagem trans-oral monitorada por laringoscopia direta (Weddell et al, 1944), o que requer anestesia superficial, muitas vezes associada ao anestésico tópico (Weddell et al, 1944; Feinstein, 1946; Macbeth, 1946). Na década de 50 alguns autores realizaram abordagens através de acessos cirúrgicos (Katsuki, 1950; Portmann et al, 1955; Spoor & VanDisheck, 1958), o que logo foi abandonado com aperfeiçoamento das técnicas de EMGL guiadas por laringoscopia indireta (Faaborg-Andersen, 1957; Guerrier & Basseres, 1965). Esta técnica permitia a realização do exame apenas sob anestesia tópica. Na mesma época, descrevia-se a técnica de inserção percutânea dos eletrodos guiada por referenciais de superfície (Fink, 1956). A padronização das técnicas de inserção percutânea permitiu a realização do procedimento sem a necessidade de anestésicos e do imenso aparato utilizado nas demais técnicas (Lovelace et al, 1992). A facilidade e segurança na realização do procedimento tornaram a EMGL técnica amplamente difundida em diversos centros de referência em laringologia (Parnes & Satya-Murti, 1985; Traissac et al 1991; Kotby et al, 1992; Lovelace et al, 1992; Verhulst et al, 1995; Yin et al, 1997; Munin et al, 2000; Koufman et al, 2001). As técnicas percutâneas de EMGL são utilizadas no serviço de laringologia da UNICAMP há mais de 4 anos. A experiência adquirida neste período nos permitiu observar algumas variáveis que dificultavam a identificação dos referenciais de superfícies não mencionadas na literatura, e aperfeiçoar a técnica com soluções para estas dificuldades. Com as técnicas apresentadas em nosso estudo observamos relativa facilidade e segurança na realização do procedimento. Também não houve necessidade de anestesias em nossos pacientes com a utilização da técnica.

A localização dos músculos intrínsecos da laringe, protegidos por escudos cartilaginosos, o tamanho reduzido destes músculos, e a razão de inervação reduzida, originando PAUM com duração e amplitude também reduzidas, tornam a EMGL um exame bastante peculiar. Foram necessárias técnicas específicas de abordagem destes músculos e estudos normativos dos PAUM. A interpretação correta da EMGL depende não apenas do posicionamento adequado do eletrodo nos músculos laríngeos, mas da definição do que é normal e o que não é normal. Entretanto, há poucos trabalhos abordando valores de PAUM normais em seus ensaios clínicos com EMGL (Faaborg-Andersen & Buchthal, 1956; Faaborg-Andersen, 1957; Lovelace et al, 1986; Rodriquez et al, 1990).

Chamaram a atenção dos autores na primeira descrição de EMGL (Weddell et al, 1944) a duração e a amplitude reduzidas dos PAUM. Os estudos normativos realizados por Faaborg-Andersen com eletrodos concêntricos confirmaram duração e amplitude inferiores aos demais músculos do corpo. Estudos com eletrodos concêntricos sugerem durações semelhantes, com ligeiro aumento da amplitude (Lovelace et al, 1986; Rodriquez et al, 1990; Lovelace et al, 1992). Utilizando eletrodos concêntricos em voluntários normais da população brasileira observamos duração e amplitude semelhantes aos descritos na literatura (Faaborg-Andersen, 1957). As técnicas para medição dos PAUM foram descritas em trabalhos clássicos (Buchthal, 1957).

Padronizadas as técnicas de abordagem dos músculos laríngeos e conhecidos os valores dos PAUM normais para estes músculos, a utilização clínica nas alterações da mobilidade das pregas vocais pode ser utilizada rotineiramente como método auxiliar ao diagnóstico. Na descrição original de Weddell et al em 1944 foi relatada a importância da EMGL para o diagnóstico da imobilidade de pregas vocais. Diversos outros trabalhos mostraram a importância da EMGL não apenas para o diagnóstico nos casos de imobilidade de pregas vocais, mas para qualquer alteração da mobilidade destas estruturas (Hirano et al, 1974; Parnes & Satya-Murti, 1985; Blitzer et al, 1985; Blitzer et al, 1988a; Blitzer et al, 1988b; Rodriquez et al, 1990; Schaefer, 1991; Traissac et al 1991; Brin et al, 1992b; Kotby et al, 1992; Lovelace et al, 1992; Gupta & Bastian, 1993; Rontal et al, 1993; Simpson et al, 1993; Verhulst et al, 1995; Yin et al, 1996; Yin et al, 1997; Schweizer et al, 1999; Munin et al, 2000; Koufman et al, 2001; Sittel et al, 2001). Nossos estudos abordaram as imobilidades de pregas vocais e os distúrbios de movimentos hipercinéticos que se manifestaram como disfonia, salientando a importância da EMGL na prática laringológica. De acordo com a literatura, 80 a 90% das imobilidades de pregas vocais são decorrentes de lesões dos nervos laríngeos, dos quais 10 a 50% idiopáticas (Simpson et al, 1993). Encontramos lesão dos nervos laríngeos em 87% dos pacientes, sendo idiopáticas em 45, como descrito na literatura (Simson et al, 1993). Autores relatam 10% de EMGL normais (Rontal et al, 1993; Koufman et al, 2001), sugerindo distúrbios das articulações cricoaritenóideas. Apenas 7% de nossas EMGL estavam normais. A elevada freqüência de pacientes com imobilidade de pregas vocais que apresentam lesão de nervos periféricos confirma a importância do método.

A utilização da EMGL nos distúrbios dos movimentos é mais recente, e mantém estreita relação com a introdução do tratamento com toxina botulínica (Blitzer et al, 1985).

O distúrbio do movimento da laringe mais comum descrito na literatura é a disfonia espasmódica (Lovelace, 1992). Os padrões de EMGL permitem definir se a disfonia é do tipo adutora ou abdutora, que é fundamental para o tratamento (Brin et al, 1992a). Outros autores descrevem os padrões da EMGL nos tremores, que se assemelham aos encontrados em outras partes do corpo (Brin et al, 1992b; Brown & Simonson, 1963; Koda & Ludlow, 1992). A identificação exata dos músculos laríngeos e o padrão e intensidade do comprometimento destes músculos é importante para o tratamento com toxina botulínica.

Em nossos pacientes o padrão da EMGL permitiu distinguir os distúrbios dos movimentos estudados e identificar o músculo alvo para aplicação de toxina botulínica. Nos pacientes submetidos à aplicação de toxina botulínica os resultados mostraram melhora significativa dos sintomas em quase todos os casos, como em outros trabalhos encontrados da literatura (Blitzer et al, 1988a; Brin et al, 1992a).

Pudemos observar durante a realização dos trabalhos que a EMGL representa importante método na investigação do diagnóstico das alterações da mobilidade das pregas vocais.

6- CONCLUSÃO

1) As técnicas percutâneas permitem a localização correta dos músculos laríngeos para a realização da EMGL.

2) Os valores normativos dos PAUM dos músculos laríngeos de voluntários sem distúrbios vocais foram descritos pela primeira vez em nosso meio, e não diferem dos apresentados na literatura.

3) As causas mais freqüentes de imobilidade de pregas vocais foram as lesões dos nervos periféricos, tornando a EMGL um exame importante ao diagnóstico nestes pacientes.

4) Em cerca de 10% dos pacientes com imobilidade de prega vocal a causa é a fixação ou luxação da articulação cricoaritenóidea. Nestes pacientes a EMGL normal é útil ao diagnóstico.

5) Os diferentes padrões da EMGL e a significante melhora dos pacientes tratados com toxina botulínica nos permite utilizar a EMGL como método de investigação e tratamento nos ambulatórios de distúrbios de movimentos.

6) Observou-se em um caso, complicação na abordagem do TA.

7) A relação risco-benefício justifica a utilização da EMGL para o diagnóstico clínico e tratamento.

7- REFERÊNCIAS BIBLIOGRÁFICAS

ARDRAN, G.; KINSBOURNE, M.; RUSHWORTH, G. Dysphonia due to tremor. **J Neurol Neurosurg Psychiatry** 29: 219-223, 1966.

ARONSON, A. E.; BROWN, J. R.; LITIN, E. M.; PEARSON, J.S. Spastic dysphonia. I. Voice, neurologic, and psychiatric aspects. **J Speech Hear Disord** 33: 203-218, 1968.

ARONSON, A. E.; BROWN, J. R.; LITIN, E. M.; PEARSON, J. S. Spastic dysphonia. II. Comparison with essential (voice) tremor and other neurologic and psychogenic dysphonias. **J Speech Hear Disord** 33: 219-231, 1968.

BLITZER, A.; LOVELACE, R. E.; BRIN, M. F.; FAHN, S.; FINK, M. E. Electromyographic findings in focal laryngeal dystonia (spastic dysphonia). **Ann Otol Rhinol Laryngol** 94: 591-594, 1985.

BLITZER, A.; BRIN, M. F.; FAHN, S.; LOVELACE, R. E. Localized injection of botulinum toxin for the treatment of focal laryngeal dystonia (spastic dysphonia). **Laryngoscope** 98: 193-197, 1988.

BLITZER, A.; BRIN, M. F.; FAHN, S.; LOVELACE, R. E. Clinical and laboratory characteristics of focal laryngeal dystonia: study of 110 cases. **Laryngoscope** 98: 636-640, 1988.

BRIN, M. F.; BLITZER, A., STEWART, C., FAHN, S. Treatment of spasmodic dysphonia (laryngeal dystonia) with local injections of botulinum toxin: review and technical aspects. In: BLITZER, A.; SASAKI, C. T.; FAHN, S.; BRIN, A.; HARRIS, K. S. **Neurologic Disorders of the Larynx.** New York: Thieme, 1992: p. 214-228.

BRIN, M. F.; FAHN, S.; BLITZER, A.; RAMIG, L.; STEWART, C. Movement Disorders of the Larynx. In: BLITZER, A.; SASAKI, C. T.; FAHN, S.; BRIN, A.; HARRIS, K. S. **Neurologic Disorders of the Larynx.** New York: Thieme, 1992: p. 248-278.

BROWN, J. R.; SIMONSON, J. Organic voice tremor: a tremor of phonation. **Neurology** 13: 520-525, 1963.

BUCHTHAL, F. **An Introduction to Electromyography.** Copenhagen: Glydenol, 1957.

BUCHTHAL, F. Electromyography of intrinsic laryngeal muscles. **J Exp Physiol** 44: 137-148, 1959.

COOPER, M. H. Anatomy of the Larynx. In: BLITZER, A.; SASAKI, C. T.; FAHN, S.; BRIN, A.; HARRIS, K. S. **Neurologic Disorders of the Larynx.** New York: Thieme, 1992: p. 3-11.

DEDO, H. H. The Paralyzed Larynx: An Electromyography Study in Dogs and Humans. **Laryngoscope** 80: 1455-1517, 1970.

DESMEDT, J. E.; BORENSTEIN, S. Collateral innervation of muscle fibres by motor axons of dystrophic motor units. **Nature** 246: 500-501, 1973.

DEUSCHL, G.; RAETHJEN, J.; LINDEMANN, M.; KRACK, P. The Pathophysiology of tremor. **Muscle & Nerve** 24: 716-735, 2001.

DUMITRU, D. **Electrodiagnostic Medicine.** Philadelphia: Hanley & Belfus – Mosby, 1995.

FAABORG-ANDERSEN, K. C.; BUCHTHAL, F. Action potentials from internal laryngeal muscles during phonation. **Nature** 177: 340-341, 1956.

FAABORG-ANDERSEN, K. Electromyographic investigation of intrinsic laryngeal muscles in humans. **Acta Physiol Scand** (suppl)41: 9-140, 1957.

FEINSTEIN, B. The application of electromyography to affections of the facial and the intrinsic laryngeal muscles. **Proc R Soc Med** 39: 817-818, 1946.

FINK, B. R.; BASCH, M.; EPANCHIN, V. The mechanism of opening of the human larynx. **Laryngoscope** 66: 410-425, 1956.

GORIO, A.; CARMIGNOTO, G.; FINESSO, M.; POLATO, P.; NUNZI, M. G. Muscle reinnervation II. Sprouting, synapse formation and repression. **Neuroscience** 8: 403-416, 1983.

GORIO, A.; MARINI, P.; ZANONI, R. Muscle reinnervation III. Motoneuron sprouting capacity, enhancement by exogenous gangliosides. **Neuroscience**, 8: 417-429, 1983.

GREINER, G. F.; ISCH-TREUSSARD, C.; EBTINGER-JOUFFROY, J.; KLOTZ, G.; CHAMPY, M. L'electromiografie appliquee a la pathologie du larynx. **Acta Otolaryngol** 51: 319-331, 1960.

GUERRIER, Y.; BASSERES, F. Electromyographic pharyngolaryngee. Presentation d'appareiiage. **Ann Otolaryngol** (Paris) 82:589-594, 1965.

GUPTA, S. R.; BASTIAN, R. W. Use of laryngeal electromyography in prediction of recovery after vocal cord paralysis. **Muscle & Nerve** 16, 977-978, 1993.

HIRANO, M.; NOZOE, I.; SHIN, T.; MAEYAMA, T. Electromyographic findings in recurrent laryngeal nerve paralysis. A study of 130 cases. **Practice Otologia Kyoto** 67: 231-242, 1974.

HUNKER, C.; ABBS, J. Physiological analysis of Parkinsonian tremors in the oral facial system. In Anonymous **The Dysarthrias**. San Diego: College Hill Press, 1984: p 69-100.

JANKOVIC, J. Phenomenology and Classification of Tics. **Neurol Clin** 15: 267-276, 1997.

KATSUKI, Y. The function of the phonatory muscle. **Jpn J Physiol**, 1: 29-36, 1950.

KODA, J.; LUDLOW, C. L. An evaluation of laryngeal muscle activation in patients with voice tremor. **Otolaryngol Head Neck Surg** 107: 684-696, 1992.

KOTBY, M. N.; HAUGEN, L. K. Clinical application of electromyography in vocal fold mobility disorders. **Acta Otolaryngol** 70: 428-437, 1970.

KOTBY, M. N. Percutaneous Laryngeal electromyography. Standardization of the technique. **Folia Phoniatr** 27: 116-127, 1975.

KOTBY, M. N.; FADLY, E.; MADKOUR, O.; BARAKAH, M.; KHIDR, A.; ALLOUSH, T. et al. Electromyography and Neurography in Neurolaryngology. **Journal of Voice** 6: 159-187, 1992.

KOUFMAN, J. A.; WALKER, F. O.; JOHARDJI, G. M. The cricothyroid muscle does not influence vocal fold position in laryngeal paralysis. **Laryngoscope** 105: 368-372, 1995.

KOUFMAN, J. A.; POSTMA, G. N.; WHANG, C. S.; REES, C. J.; AMIN, M. R.; BELAFSKY, P. C. et al. Diagnostic laryngeal electromyography: The Wake Forest experience 1995-1999. **Otolaryngol Head Neck Surg** 124: 603-606, 2001.

LOVELACE, R. E.; BLITZER, A.; SZMIDT-SALKOWSKA, E. Percutaneous laryngeal electromyography for evaluation of neurologic disorders, myopathies and spastic dysphonia. **Electroenceph Clin Neurophysiol** (supp) 61: 765, 1986.

LOVELACE, R. E.; BLITZER, A.; LUDLOW, C. L. Clinical laryngeal electromyography. In: BLITZER, A.; SASAKI, C. T.; FAHN, S.; BRIN, A.; HARRIS, K. S. **Neurologic Disorders of the Larynx.** New York: Thieme, 1992: 66-81.

MACBETH, R.G. **Proc R Soc Med** 39: 819, 1946.

MILANOV, I. Electromyographic differentiation of tremors. **Clin Neurophysiol** 112: 1626-1632, 2001.

MUNIN, M. C.; MURRY, T.; ROSEN, C. A. Laryngeal electromyography. Diagnosis and prognostic applications. **Otolaryngologic Clin North Am** 4, 759-771, 2000.

NETTER, F.H. Respiratory System. **The Ciba Collection of Medical Illustrations.** West Caldwell: R.R. Donnelley & Sons Company, 1986.

PARNES, S. M.; SATYA-MURTI, S. Predictive Value of Laryngeal Electromyography in Patients with Vocal Cord Paralysis of Neurogenic Origin. **Laryngoscope** 95, 1323-1326, 1985.

PHILIPPBAR, S. A.; ROBIN, D. A.; LUSCHESI, E. S. Limb, jaw and vocal tremor in Parkinson's patients. In YORKSTON, K., BEUKELMAN, D. **Recent Advances in Clinical Dysarthria**. San Diego: College Hill Press, 1991.

PORTMANN, G.; HUMBERT, R.; ROBIN, J. L.; LAGET, P.; HUSSON, R.; MONNIER, A. M. Étude electromyographic des cordes vocals chez l'homme. **C R Soc Biol (Paris)** 149: 296-300, 1955.

RAMIG, L. A.; SCHERER, R. C.; TITZE, I. R.; RINGEL, S. P. Acoustic analysis of voices of patients with neurologic disease: rationale and preliminary data. **Ann Otol Rhinol Laryngol** 97: 164-172, 1988.

RODRIQUEZ, A. A.; MYERS, B. R.; FORD, C. N. Larygeal Electromyography in the Diagnosis of Laryngeal Nerve Injuries. **Arch Phys Med Rehabil** 71: 587-590, 1990.

RONTAL, E.; RONTAL, M.; SILVERMAN, B.; KILENY, P. R. The clinical differentiation between vocal cord paralysis and vocal cord fixation using electromyography. **Laryngoscope** 103: 133-137, 1993.

SCHAEFER, S.D. Laryngeal electromyography. **Otholaryngol Clin of North Am** 5: 1053-1057, 1991.

SCHWEIZER, V.; WOODSON, G. E.; BERTORINI, T. E. Single-fiber electromyography of the laryngeal muscles. **Muscle & Nerve** 22: 111-114, 1999.

SIMPSON, D. M.; STERNMAN, D.; GRAVES-WRIGTH, J.; SANDERS, I. Vocal Cord paralysis: clinical and electrophysiological features. **Muscle Nerve** 16: 952-957, 1993.

SITTEL, C.; STENNERT, E.; THUMFART, W. T.; DAPUNT, U.; ECKE, H. E.; Prognostic value of laryngeal electromyography in vocal fold paralysis. **Arch Otolaryngol Head Neck Surg** 127: 155-160, 2001.

SPOOR, A.; VANDISHECK, H. A. E. Electromyography of the human vocal cords and the theory of Husson. **Practica Otorhinolaryngol** 20: 253-360, 1958.

TAKEDA, N.; THOMAS, G. R.; LUDLOW, C. L. Aging Effects on Motor Units in the Human Thyroarytenoid Muscle. **Laryngoscope**, 110: 1018-1025, 2000.

TRAISSAC, L.; GIOUX, M.; ROVIRA, H. P.; HENRY, C.; BERTRAND, B. L'Electromyographie (EMG) du larynx dans le diagnostic des immobilités larynges spontanées ou post-thyroïdectomie. **Revue de Laryngologie**, 112: 205-207, 1991.

TUCKER, H. M. Vocal Cord Paralisis-1979: Etiology and Management. **Laryngoscope** 89: 504-507, 1980.

VERHULST, J.; GIOUX, M.; CASTRO, E.; QUINTERO, R.; TRAISSAC, L. Intérêt et role de l'electromyographie dans l'evaluation d'um trouble de la mobilité laringe et son pronostic. **Rev Laryngol Otol Rhinol** 116: 289-292, 1995.

WEDDELL, G.; FEINSTEIN, B.; PATTLE, R. E. The electrical activity of voluntary muscle in man under normal and pathological conditions. **Brain** 67: 178-257, 1944.

WOO, P. Laryngeal Electromyography Is a Cost-effective Clinically Useful Tool in the Evaluation of Vocal Fold Function. **Arch Otolaryngol Head Neck Surg** 124: 472-475, 1998.

WOODSON, G. F. Clinical value of laryngeal EMG is dependent on experience of the clinician. **Arch Otolaryngol Head Neck Surg** 124: 476, 1998.

YIN, S. S.; QIU, W. W.; STUCKER, F. J. Value of electromyography in differential diagnosis of laringeal joint injuries after intubation. **Ann Otol Rhinol Laryngol** 105: 446-451, 1996.

YIN, S. S., QIU, W. W., STUCKER, F. J. Major patterns of laryngeal electromyography and their clinical application. **Laryngoscope** 107: 126-136, 1997.

YIN, S. S.; STUCKER, F. J.; QIU, W. W.; BATCHELOR, B. M. Clinical evaluation of Neurolaryngological Disorders – **Ann Otol Rhinol Laryngol** 109: 832-838, 2000.