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CASE REPORT

Intraoral device for sociodigital inclusion of patient with quadriplegia

Dispositivo intraoral para inclusão sócio-digital de paciente com tetraplegia

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Abstract

Introduction: The use of computers, tablets, and cell phones with the Internet by people with quadriplegia from spinal cord injuries is much lower when compared to the general population. The quality of life of these people can be substantially improved through access to these technologies, which would allow a quadriplegic to take advantage of the rapid evolution of information and communication. Many of these individuals have the function of preserved neck and mouth muscles, and it is possible to manipulate intraoral devices as an adaptation tool. **Case Report:** We report an intraoral device installation in a patient with quadriplegia, a victim of a firearm accident, who had a great desire to reuse the tablet for internet access. A device made of acrylic resin, similar to a myorelaxant plate, was designed to allow the use of a computer that was comfortable and at the same time, the patient could talk and not harm the dental structures. The person responsible agreed to participate in the research and signed the consent form. In addition, the work was submitted to an ethics committee. **Considerations**: The ideal intra-oral device for patient rehabilitation should be inexpensive, easy to adapt and promote muscle relaxation besides allowing the patient to expand their abilities and digitally increase their autonomy for society.

Keywords: Quadriplegia; Physical Disability; Quality of Life; Inclusion; Intraoral; Device.

Resumo

Introdução: O uso de computadores, tablets e celulares com internet por pessoas com tetraplegia por lesão medular é muito menor quando comparado à população geral. A qualidade de vida dessas pessoas pode ser, substancialmente, melhorada por meio do acesso a essas tecnologias, o que permitiria aos tetraplégicos aproveitar a rápida evolução da informação e da comunicação. Muitos desses indivíduos têm a função de músculos cervicais e bucais preservados, sendo possível a manipulação de dispositivos intraorais como ferramenta de adaptação. **Relato de Caso:** Relatamos a instalação de um dispositivo intraoral em um paciente com tetraplegia, vítima de acidente com arma de fogo, que tinha grande desejo de reutilizar o tablet para acesso à internet. Um dispositivo feito de resina acrílica, semelhante a uma placa miorrelaxante, foi projetado para permitir o uso de um computador que fosse confortável e, ao mesmo tempo, o paciente pudesse falar e não prejudicar as estruturas dentárias. O responsável concordou em participar da pesquisa e assinou o termo de consentimento. Além disso, o trabalho foi submetido a um comitê de ética. **Considerações**: O dispositivo intraoral ideal para a reabilitação do paciente deve ser barato, de fácil adaptação e promover o relaxamento muscular, além de permitir que o paciente amplie suas habilidades e aumente sua autonomia pessoal, digitalmente para a sociedade.

Palavras-chave: Tetraplegia; Deficiência Física; Qualidade de Vida; Inclusão; Dispositivo Intraoral.

INTRODUCTION

Information and communication technology have redefined the way of life in modern society. Computers are present in almost every aspect of life, whether through games, communication, information, and education, among many others. However, the level of use of the computer and the Internet by people with disabilities is still low when compared to that of the general population[1,2]. It may be partially because individuals with disabilities need special methods and tools to access computers 1. Loss of motor control significantly reduces the quality of life and conditions the injured person to continuous care[3,4].

In the United States, it is estimated that there are 259,000 people with some type of spinal cord injury, with approximately 12,000 new cases appearing each year 5. About 1 in 50 individuals in the United States are living with some form of paralysis in the upper or lower extremities[2]. About 20% of these individuals are under the age of 40 and need lifelong care by dedicated caregivers or family members[2]. Quadriplegia usually results from accidents involving essential neurological structures or debilitating diseases such as polio, spinal cord tumors, congenital anomalies, such as multiple sclerosis, or cerebral palsy 6. These conditions result in varying degrees and types of incapacitation 6,7. Such differences allow some individuals to still have mastery of neck and oral musculature functions and, consequently, to manipulate intraoral devices through assistive technology[6].

Among the various types of assistive technologies, those that provide alternative control for access to computers and wheelchairs are the most important for today's lifestyle, as they can improve the quality of life of users by allowing independent communication and mobility[7,8]. There is a wide variety of

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assistive technologies available commercially. However, each of these devices has limitations that make it inadequate or unsafe both for access to the computer and for wheelchair control in certain environments or for certain tasks. This is due to the necessary inputs for these devices, in addition to the size, weight, functionality, ease of use, maintenance, cost, and even appearance of the devices[7]. These assistive technologies are abandoned due to low performance, difficulty in maintenance, environmental barriers, and low customer support from the developer companies. Changes in the user's functional abilities may also require constant device updates, as well as changes in the type of technology. As users have special needs, it is imperative to develop user-friendly and easy-to-use assistive technologies that provide broader functionality and coverage[2].

Currently, individuals with quadriplegia can use these devices through eye signals, brain signals, head movements, voice, and tongue control. Thus, the quality of life for people with large spinal cord injuries can be substantially improved through access to technology, allowing quadriplegics to take advantage of rapid evolution within information and communication 4. These technological innovations are invaluable for quadriplegic individuals, but the advantages of this technology may be compromised by the lack of adherence of people with severe disabilities[4]. Eye signal devices depend on eye movements and may interfere with the normal visual activities of their users. They are affected by ambient light and cannot be used in direct or dark sunlight. Voice controllers need a quiet environment because they are highly sensitive to noise and external interference 9. In- addition, there are restrictions, such as neck pain, head movement control, and intrusiveness related to brain-to-brain interface computers. Language-based control systems require a high capacity for selective manipulation of interface sensors and are often inconvenient[4].

Thus, the objective of this work is to report a case of manufacturing, adaptation, and installation of an intraoral device to approximate the universe of digital devices in a patient with quadriplegia, to increase their independence and self-sufficiency.

CASE REPORT

Patient, male, 19 years old, leucoderma, conscious, oriented, restricted to the bed due to quadriplegia due to firearm injury, with consequent cervical spinal cord injury (TRM), tracheostomized and mechanically ventilated vertebrae C3 and C4 (figure 01). He is accompanied two years ago by a multi-professional team of home care linked to the Dr. Waldemar de Alcântara General Hospital in Fortaleza, Ceará, Brazil, consisting of a physician, dentist, nurse, social worker, psychologist, speech therapist, physiotherapist, occupational therapist, pharmacist, and nutritionist.

In an initial consultation or evaluation, the patient, family, and multidisciplinary health team are considered as part of the therapeutic plan to plan actions that would improve the patient's communication. Dentists and occupational therapists developed an intra-oral device that enabled the use of digital communication tools through assistive technology.

At the dental clinic examination, the absence of the central incisors, left lateral incisor, left canine in the upper arch, and the use of removable upper partial denture was observed. The remaining teeth were present, showing gingivitis compatible with bacterial plaque (figure 02). The patient did not show any signs of temporomandibular dysfunction. As an initial dental practice, oral hygiene instruction and upper and lower molding with alginate hydrogum 5 (Zhermack Spa @, Badia Polesine, Rovigo, Italy) and bite registration with utility wax (Asfer @ Indústria Química, São Caetano do Sul, São Paulo, Brazil) for making an intraoral communication device.

Figure 1. Patient during first home visit

Figure 2. Extraoral view of the patient with the prosthesis

A removable occlusal device made of acrylic resin, tailor-made, similar to a myorelaxant plate, was designed that would fit into the lower arch + upper PPR and the dentate type. It was conceived that this device allowed the use of equipment with touch screens that were comfortable and that, at the same time, the patient could speak and that did not harm the dental structures, which would improve the patient's quality of life and social inclusion.

In the laboratory stage, the device was made in Vipicril Plus (VIPI @, Pirassununga, São Paulo, Brazil) thermoportable acrylic resin on the gypsum models obtained from the patient. In the most anterior region of the device, a niche was adapted to fit a 20cm wand, having a specific tip end for use in touch screen devices. This rod was removable, which allowed for exchange after breaking (figure 03). The material chosen was justified because it had an acceptable texture, neutral flavor, and low cost.

To enable the application of the intraoral device it was necessary to develop a support apparatus for the digital equipment. Such support was made using CPVC tubes joined by specific joints to provide a structure adapted to the patient's reality and the electronic equipment used to be supported in the patient's bed (figure 04).

The device and the support structure were installed on the patient by a multidisciplinary team composed of a surgeon-dentist, and occupational therapist.

Figure 3. Intraoral device attached from the pen

Figure 4. Patient using tablet attached to table

DISCUSSION

Intraoral communication devices improve or expand the functional abilities of people with complete or partial motor paralyzes, which favors their personal autonomy 2. These people have problems in their daily activities, which can lead to a decrease in their quality of life 4. Currently, the use of computers is a form of social participation 10. This case report describes the use of a device similar to a toothed myorelaxant plate associated with a tablet pen, which enabled the use of digital equipment with touch screens. The patient reported in this clinical case has quadriplegia, had no cognitive impairment or complaints of TMD, and did not use any intraoral device for digital inclusion.

In the literature, some devices were found by assistive technology [2,4,6,8,10,11,12,13]. However, most of the auxiliary input tools related to tongue movement are invasive[4]. The tongue is less likely to be affected in quadriplegia because the tongue is directly connected to the brain via the cranial nerves rather than through the spine. Cranial nerves are not affected by spinal cord injuries and are not affected by neuromuscular conditions[14]. Thus, most assistive technologies are oral cavity implants. Due to the limitations and cost of these invasive devices, more research on the use of non-invasive devices has been carried out in recent years[4].

An example is a device called a mouthguard, a kind of modified and customized mouth guard developed in the laboratory and adapted by the dentist. Its design consisted of an intraoral bite plate of acrylic or thermoplastic designed to be used between the maxillary and mandibular arches for occlusion of the teeth. Attached to it was a mechanical retention device, which allowed different functions depending on the object inserted (pencils, pens, brushes)[6].

Also described was a computer structure in which there was no need for special computer software or drivers. The structure was based on a language control system, called a framework, which provided a simulation of a standard USB keyboard and mouse and allowed the control of any computer using standard USB drivers available in all modern operating systems[4].

Another device is the graphic software, Tongue Wise, which

had the functionalities of a wireless language computer with an inductive interface, which provided most of the standard functions available on the keyboard and mouse without requiring great physical and cognitive efforts of the user[12]. Tongue Drive System (TDS) is a minimally invasive, wireless assistive technology that allows people with severe disabilities to control their environments using language. The TDS translated specific gestures of the tongue into commands, detecting the position through a small permanent magnetic marker in the language of the users and connected to a smartphone[15].

Laumann and contributors (2015)[16] developed and tested a protocol for installing and using a magnet-containing tongue bar for use with the Tongue Drive System (TDS) in people with quadriplegia. There were no serious adverse events related to the use of the device on the tongue, and with strict selection criteria, patients could use the TDS through the magnet installed on the tongue.

Chou and contributors (2016)[8] developed a non-invasive language movement computer mouse system that allowed the patient to use tongue movements to control a computer and communicate with the external environment using a pressure sensor that was inferior to the milo-hyoid muscle. Changes in milo-hyoid muscle pressure were converted into mouse control signals to control a computer and communicate with the external environment. This study used simple and non-invasive tongue movements that corresponded to the stretching and shrinking of the milo-hyoid muscle to control the computer mouse. An alternative computer interface was implemented that was fully incorporated into the oral cavity and provided multiple control commands with the development of an intraoral and wireless inductive lingual computer.

Ns Andreasen Sttrijk and contributors (2017)[4] demonstrated the use of a wireless, intraoral and tongue-inductive computer in two quadriplegic individuals and two healthy individuals. Its interface comprised a 10-key keyboard area and a mouse pad area. This wireless system was installed in the user's oral cavity. The results showed that this type of technology, being invisible, was aesthetically acceptable and functionally efficient for these types of users.

A device with some similarities to that performed in our report was made by Mesquita et al. (2016)10 in a patient with generalized, congenital, and idiopathic dystonia. The patient had speech, sensory, stiffness, and tremor deficits, acute muscle contractions, and anticonvulsive actions. However, he already had mobility in the region of the upper incisors and TMD signs, due to the use of a brush and pencil for computer use. A myorelaxation device was created, using assistive technology, with the help of a multidisciplinary team, so that it was possible to paint and press, with consequent elimination of tooth mobility and improvement of quality of life and social inclusion. After installation and use, there was a better distribution of chewing forces, discontinuation of tooth mobility, periodontal disease, and relief of symptoms of temporomandibular dysfunction.

The multidisciplinary treatment in this case of quadriplegia was performed through a simple technique, low cost, and easy adaptation, giving the patient an improvement in the quality of life, by expansion and their abilities, personal autonomy, and socio-digital inclusion. The material used was lightweight, of acceptable texture and neutral flavor, odor-free, and easy to manufacture. The device was stabilized by the opposite dentition. Lateral stabilization was achieved by covering the occlusal surfaces of all lower teeth to prevent orthodontic movement.

According to Ns Andreasen Sttrijk and contributors (2017)[4], esthetics also play an important role in the acceptability of assistive technology devices, as these devices tend to become part of the individual's self-identity. The device used in this case report consisted of acrylic resin and it met those criteria. However, we suggest that more work in the literature should be performed so that devices of this nature are more studied and made.

FINAL CONSIDERATIONS

The intraoral device designed for the rehabilitation of the patient with quadriplegia had low cost, was easy to adapt, and promoted muscle relaxation. In addition, it allowed the patient to expand his skills, increase his autonomy, and be included socio-digitally in society.

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ETHICS STATEMENT

The person responsible for the patient reported in this case authorized the participation and signed the Model of the image authorization term.

CONTRIBUTION TO THE FIELD STATEMENT

In the present article, we report a clinical case of confection and installation of an intraoral communication device in a patient with quadriplegia accompanied by a home care service to provide socio-digital inclusion. The intraoral communication device was made with acrylic resin and a touch-coupled pen for a 19-year-old male, leucoderma, with cervical spinal trauma. Patient, family, and multidisciplinary health team, during the initial evaluation, considered as part of the therapeutic plan to plan actions that would improve patient communication. This intraoral device was inexpensive, easy to adapt, and promoted muscle relaxation. After use, the device gave more autonomy of functions and allowed the patient to be included socio-digitally in society.

REFERENCES

1. Pousada T, Pereira J,Groba B, Nieto L, Pazos A. Assessing mouse alternatives to access to computer: a case study of a user with cerebral palsy. Assist Technol. 2014; 26(1): 33–44. doi: 10.1080/10400435.2013.792880.

2. Kim J, Park H, Bruce J, Rowles D, Holbrook J, Nardone B, et al. Qualitative assessment of Tongue Drive System by people with high-level spinal cord injury. J Rehabil Res Dev. 2014; 51(3): 451–66. doi: 10.1682/JRRD.2013.08.0178.

3. Lontis ER, Struijk LNSA. Design of inductive sensors for tongue control system for computers and assistive devices. Disabil Rehabil Assist Technol. 2010 Jul; 5(4): 266-27.

4. Struiijk LNS, Lontis ER, Gaihede M, Caltenco HA, Lnd ME, Schioeler H, et al. Development and functional demonstration of a wireless intraoral inductive tongue computer interface for severely disabled persons. Disabil Rehabil Assist Technol. 2017 Aug; 12(6): 631-640. doi: 10.1080/17483107.2016.1217084.

5. Ayala-Acevedo A, Ghovanloo M Quantitative assessment of magnetic sensor signal processing algorithms in a wireless tongue-operated assistive technology. Annu Int Conf IEEE Eng Med Biol Soc. 2012; 2012: 3692-3695. doi: 10.1109/EMBC.2012.6346768.

6. Scott KL, Ranalli D. Adaptations of mouthguards for patients with special needs. Spec Care Dentist. 2005 Nov-Dec; 25(6): 296-301. doi: 10.1111/j.1754-4505.2005.tb01404.x.

7. Manuscript, A.; drive, T.(2011). Technology, A. NIH Public Access.

8. Chou C-H, Hwang Y-S, Chen C-C, Chou S-W, Chen Y-L. Noninvasive tongue-motion controlled computer mouse for the disabled. Technol Health Care. 2016 May; 24(3): 401–408. doi: 10.3233/THC-161137.

9. Kim J, Huo X, Ghovanloo M. Wireless control of smartphones with tongue motion using tongue drive assistive technology. Conf Proc IEEE Eng Med Biol Soc. 2010; 2010: 5250-5253.

10. Mesquita-Guimaraes KSF, Ferreira DCA, Silva RAB, Diaz-Serrano KV, Queiroz AM, Mantovani CPT, et al. (2016). Development of an intraoral device for social inclusion of a physically disabled patient. Spec Care Dentist. 2016 Jan; 36(1): 53–56. doi: 10.1111/scd.12145.

11. Lontis, ER, Struijk LNSA. Design of inductive sensors for tongue control system for computers and assistive devices. Proceeding of the 2en International Convention on Rehabilitation Engineering & Assistive Tecnology; 2008 May. p. 83-86.

12. Caltenco HA, Struijk LNSA, Breidegard B. TongueWise: Tongue-computer interface software for people with tetraplegia. 2010 Annual International Conference of the IEEE Engineering in Medicine and Biology Society; 2010 31 Aug - 4 Sep; Bueno Aires, Argentina; 2010. p. 4534–37.

13. Huo X, Cheng C, Ghovanloo M. Evaluation of the Tongue Drive System by Individuals with High-Level Spinal Cord Injury. Annut Int Conf IEE Eng MEd Biol Soc. 2009; 2009: 555-58. doi: 10.1109/IEMBS.2009.5334555.

14. Horne H, Kelly S, Sharp P. Resistopalatography as an assistive technology for users with spinal cord injuries. 2015 Aug; 2015: 4367-4370. doi: 10.1109/EMBC.2015.7319362.

15. Kim J, Hup X, Minocha J, Holbrook J, Laumann A, Ghovanloo M. Evaluation of a smartphone platform as a wireless interface between tongue drive system and electric-powered wheelchairs. IEEE Trans Biomed Eng. 2012 Jun; 59(6): 1787-96. doi: 10.1109/TBME.2012.2194713.

16. Laumann A, Holbrook J, Minocha J, Rowles D, Nardone B, West D, et al. Safety and Efficacy of Medically Performed Tongue Piercing in People with Tetraplegia for Use with Tongue- Operated Assistive Technology. Top Spinal Cord Inj Rehabil. 2015; 21(1): 61–76. doi: 10.1310/sci2101-61.

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