
Mouth Stick Design for the Client With Spinal Cord Injury

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This paper reviews literature on mouth sticks and presents information from a survey of occupational therapists specializing in the treatment of persons with spinal cord injuries. The review discusses the standards of mouth-stick design that have been established by dentists, but the survey suggests that occupational therapy practice is widely discrepant from these standards. The author suggests increased education for occupational therapists to provide knowledge of the key elements of oral safety, and increased collaboration between occupational therapists and dentists in mouth-stick design, fabrication, and training to assure quality care for all persons who require a mouth stick.

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In rehabilitation, clients are helped to use their remaining strengths to compensate for or adapt to losses resulting from various physical dysfunctions. Persons with severe upper extremity limitations often retain mouth, jaw, and neck control. They can be taught to use these parts of their body to operate devices and thereby improve their functional skills. Devices controlled in this manner are referred to as *mouth sticks*, *bite sticks*, or *mouth-operated devices*. Each device includes an extraoral portion, which consists of a shaft, a tip, and a holder, and an intraoral (mouthpiece) portion, which may vary widely in design and complexity, but which is intended to hold the device in the client's mouth.

The use of these devices was first widely reported in the 1950s, when mouth sticks were used extensively with clients who had poliomyelitis (Bastable, 1956; Buckley, 1957; Evans & Cooley, 1956; Ey, 1956; Georgia Warm Springs Foundation, 1957; Moore, 1956; Sniderman & Hollis, 1954). Currently, persons with spinal cord injuries constitute the major population using mouth sticks.

Dental, occupational therapy, and rehabilitation medicine literature contain no follow-up studies on the long-term effects of mouth-stick use. Dental literature reflects general agreement on design standards for the intraoral components of mouth sticks and orthodontic devices and on the commensurate risks associated with mouthpieces that fail to meet those standards. Occupational therapists, who are responsible for recommending individual mouth sticks and for training clients in their use, make key clinical decisions based on knowledge that emphasizes client function rather than oral safety.

Three widely used textbooks on occupational therapy for physical dysfunction introduce mouth-stick use but do not discuss design or precautions, factors that must be considered in occupational therapy treatment (Pedretti, 1985; Spencer, 1983; Trombly, 1983). Wilson, McKenzie, Barber, and Watson (1984) offered information on mouth-stick components and mouth-stick use and stated that a mouth-piece based on a dental impression could "further distribute pressure over the molars" (p. 83). However, they did not describe what circumstances would lead the therapist to use a dental impression in the mouthpiece design. Nawoczinski, Rinehart, Duncanson, and Brown (1987) stated that the mouthpiece should be made by a dentist, but they did not provide the rationale, design, and treatment precautions necessary for the therapist to make well-founded decisions regarding treatment.

This paper's discussion of issues related to mouth-stick use is based on a literature review. The review covers (a) dental theories regarding bite sticks, (b) potential problems related to improper fit, (c) dental

standards for mouthpiece design, and (d) methods of fabrication. The review is related to practice on the basis of a survey of occupational therapists at each of 40 specialized treatment centers for persons with spinal cord injuries in the United States.

Dental Theories

Dental principles of mouthpiece design are based on three orthodontic theories (Hemley, 1938):

1. Functional pressure on teeth stimulates bone development.
2. Excessive pressure retards bone development.
3. Bone grows along the path of least resistance.

Hemley supported the application of these principles to the design of bite plates.

Potential Problems

Improperly fitting mouth sticks, such as a round dowel or an anterior bite stick that contacts only the anterior teeth, can cause several oral problems (Buckley, 1959). Damage to the anterior teeth can result from degenerative and necrotic changes in the supporting periodontal tissue, stretching of the periodontal ligament, and reabsorption of the angular bone. This damage becomes evident when the teeth move, wear unevenly, and abrade (Buckley, 1959; Materson & Lotz, 1975).

A second problem that can result from improperly fitting mouth sticks is "eruption [movement in the direction of no pressure] of the posterior teeth and eventually whole mouth distortion" (Buckley & Slocumski, 1958, p. 24). This problem is often identified by the dentist before the mouth stick user becomes aware of it. A third potential problem relates to the vertical dimension of the mouthpiece. The use of any oral device can cause temporomandibular joint dysfunction if the required mouth opening is greater than that in the physiological resting position (2-mm to 3-mm vertical opening) for extended periods of time (Materson & Lotz, 1975). This disorder generally begins with temporary muscle pain, proceeds to chronic pain, and then makes it difficult for the user to open his or her mouth.

In addition to these oral problems, Buckley (1957) cited the following functional problems that can result from improperly fitting mouth sticks: (a) inability to insert and remove the mouth stick independently, (b) poor retention of the mouth stick, (c) poor lateral stability, (d) unpleasant taste, (e) gagging, and (f) fatigue.

Dental Standards for Mouthpiece Design

To address these problems, Blaine and Nelson (1973) established the following standards for mouthpiece design. A mouthpiece should

1. Not exert pressure on erupting teeth but should fully contact all completely erupted teeth to prevent supereruption and to distribute the biting force
2. Be stabilized on opposing teeth with the jaw in or closed from the physiological resting position
3. Provide wide occlusal coverage for lateral stability
4. Allow for retention without pressure when in use
5. Permit independent insertion and removal
6. Be (a) comfortable, (b) sturdy enough for a variety of functions, and (c) out of the client's line of vision
7. Allow the necessary tongue movement for talking, swallowing, and wetting the lips while in place
8. Not act as an orthodontic device (i.e., function to correct dental irregularities)

Fabrication of a Mouth Stick

Dental literature indicates wide support for these standards and offers detailed descriptions of designs and fabrications for mouthpieces that meet the standards by fully covering all teeth. Some of these mouthpieces cover the palate and some do not. The fabrication of a mouthpiece that provides this coverage and fit requires that maxillary, mandibular, and interocclusal impressions be made and positioned on an articulator to establish the correct interocclusal relationship. Wax onlays are then made on the casts over a metal frame designed to interface with the extraoral portion of the mouth stick. Finally, these onlays are processed in a dental laboratory to remove the wax and produce an acrylic mouthpiece. Blaine and Nelson (1973); Frankel, Hawkesford, and Simonson (1975); Lutwak (1979); Materson and Lotz (1975); Mulligan (1983); O'Donnel, Yen, and Robinson (1985); Olsen, Prentke, and Olsen (1986); and Smokler and Rappaport (1979) presented detailed procedures for the fabrication of a mouth stick and also demonstrated the ability to achieve both safety and function.

A variation reported by Kozole, Gordon, and Hurst (1985) follows the same preparatory steps but creates a metal bite fork that is contoured to the dental arch. This bite fork is coated with a resilient ethyl vinyl acetate thermoplastic shield (mouthguard material), and a heat gun is used to mold the material to the casts to create a mouthpiece that has improved durability and fit.

A mouth stick's extraoral components can provide telescoping action or prehensile function (see Table 1) (Cloran, 1974; Garcia & Greenfield, 1981; Kozole et al., 1985; Lutwak, 1979; O'Donnel et

Table 1
Extraoral Components for Mouth Sticks

Function	Mechanism	Method of Activation
Telescoping action	Extending wand	Tongue activates external battery power to extend shaft
Telescoping action	Interlocking (docking) action	Pressure exerted through the mouthpiece and shaft with a friction grip snap locks shaft to tip portion
Telescoping action	Ball and socket action	Protrusive-retrusive (anterior-posterior) jaw motion activates ball & socket, which extends shaft portion
Prehensile function	Pincer	Bite closes pincer arms Tongue protrusion closes pincer arms Protrusive-retrusive jaw motion activates ball & socket
Prehensile function	Suction	Sipping action creates vacuum to hold lightweight objects

al., 1985; Olsen et al., 1986; Stow, 1966). These components have resulted in a variety of commercially available products.

Questionnaire Results

To learn more about current practice in occupational therapy, a questionnaire was sent to the 40 occupational therapy departments located at Veterans' Administration Spinal Cord Injury Programs and Regional Spinal Cord Injury Centers. Twenty-four questionnaires (60%) were returned. Respondents' work experience ranged from 1½ to 35 years, with a mean of 9.48 years. The number of clients with high-level quadriplegia treated in the previous 2 years varied from 0 to 48 per institution.

This questionnaire provided descriptive information. The multiple unweighted responses and the lack of hard data (only 8% of responses were based on data; others were based partially on data and partially on estimates) did not permit statistical analysis.

Responses showed variations in the provision and the design of temporary and permanent mouth sticks. To determine the frequency of mouth-stick training, the respondents were asked to rate the frequency with which they introduced mouth sticks to clients with lesions at different neurological levels. Responses indicated a higher frequency of mouth-stick training in the centers that treated greater numbers of clients with high-level quadriplegia. Of the 14 centers treating 11 or more clients with high-level quadriplegia during the previous 2-year period, 13 reported that they always introduce mouth sticks to clients with lesions at specific neurological levels (generally C₃ and C₄). Of the remaining 10 centers,

which treated 10 or fewer clients with high-level quadriplegia during the same period, 6 stated that they always introduce mouth sticks to clients with lesions at certain levels, and the other 4 indicated that they frequently or rarely introduce mouth sticks.

Fourteen of the 24 centers always or frequently provide temporary mouth sticks before providing permanent mouth sticks. Of 28 responses regarding who fabricates the temporary mouth sticks, 21 indicated occupational therapy personnel, 3 indicated a dentist or dental assistant, and 4 others indicated an orthotist, a rehabilitation engineer, a technician, or a volunteer. Two other respondents stated that they purchased commercial products for temporary use.

The design of the temporary mouth sticks varied greatly. The most common design, used at 14 of the 24 centers, consisted of a molded, low-temperature thermoplastic mouthpiece with a rod. Other designs included dowel sticks, molded Plexiglas rods, pens or pencils, metal rods coated with plastisol or a similar product, and respirator mouthpieces attached to rods or metal tubing.

Nineteen of the 24 centers indicated that they either always or frequently provide a permanent mouth stick. This was generally provided during the client's first admission.

Some therapists included numerous responses to the question regarding the design of permanent mouth sticks. A total of 42 responses described mouthpieces; of these, 26 reported the use of a custom-molded design. Eight of these were indexed to upper teeth, 8 to upper and lower teeth, 4 to lower teeth, and 6 to the palate. Of these 26 custom-molded designs, 17 were made of dental acrylic: 15 by dentists and 2 by the occupational therapist and orthotist. Two were fabricated of polypropylene by orthotists and 7 were fabricated of thermoplastic splinting material by occupational therapists. Five other mouth sticks, also described as custom-made, were not molded to teeth; they consisted of rubber or plastic tubing and plastisol coating on metal. Thirteen of the mouth sticks used were purchased from commercial suppliers. These designs were not custom-molded.

Eight of the 26 custom-molded designs referred to in the 42 responses, adhered to the basic dental mouthpiece standard. These data alone fail to define the scope of the problem, but they do highlight the need for follow-up studies. It appears that client use of a mouth stick for limited tasks, such as signing a check, or for short periods of time is less likely to cause oral problems, in which case a custom-molded mouth stick may be contraindicated due to cost.

To determine the incidence of patients' complaints about prescribed permanent mouth sticks, survey respondents were asked to use a frequency scale of *never*, *rarely*, *frequently*, or *always* to rate

clients' complaints from the following list: choking, gum problems, headaches, neck pain, palate problems, saliva problems, temporomandibular joint problems, tooth movement, tooth pain, and other. Only saliva problems and neck pain were rated as occurring more often than *rarely*. Other complaints were rated between *rarely* and *never*. This suggests that those who treat spinal cord-injured clients during the rehabilitation phase receive limited negative feedback regarding the mouth sticks provided. Six of the 24 centers, however, acknowledged that problems in fit do cause either limitations in or discontinuation of use. The low frequency of reported problems reflects opinions based on inpatient care rather than on follow-up care and may reflect too short a period of use for oral motor problems to have developed.

Five of the 24 centers provide routine dental examinations for mouth-stick users, and 15 provide medical or dental examinations in response to patient complaints. The remaining centers refer clients to their own dentists due to a lack of on-site dental personnel. This lack of dental personnel further limits any communication and sharing of knowledge between dentists and therapists.

Numerous comments by questionnaire respondents indicated a lack of follow-up data. This suggests that therapists lack information about the extent of mouth-stick use and the long-term effects of that use in terms of intraoral problems and functional productivity. This information is necessary to improve clinical decision making related to the safety of mouth sticks.

Conclusion

The results of this survey and the literature review suggest limited adherence to the dental standards for mouth-stick design. Collaboration among dentists, occupational therapists, orthotists, and rehabilitation engineers exists in some treatment settings, as is seen in the literature (Buckley & Slominski, 1958; Frankel et al., 1975; Kozole et al., 1985; Sniderman & Hollis, 1954). Collaboration between dentists and therapists is especially important in mouth-stick provision and training, but it does not occur in many treatment settings. Therapists and dentists do not traditionally work as a team, and each has limited awareness of the other's skills. Occupational therapists, the primary providers of mouth sticks for clients with spinal cord injuries, often lack sufficient knowledge of key oral safety factors. Moreover, although dentists are knowledgeable about the dental standards for intraoral safety, they lack the ability or inclination to train clients in the functional use of mouth sticks and to determine extraoral design requirements. In addition to the effects of this limited collaboration, the client

may experience difficulty obtaining dental care due to limited staffing, inaccessibility, lack of transportation, and lack of reimbursement. Given the increased survival rate among persons with spinal cord injuries and their need for mouth sticks, follow-up studies to determine the outcomes of mouth-stick use are needed.

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References

- Bastable, A. D. (1956). Typewriter frame and mouthstick for the quadriplegic with neck involvement. *American Journal of Occupational Therapy*, 10, 7-8, 12.
- Blaine, H. L., & Nelson, E. P. (1973). A mouthstick for quadriplegic patients. *Journal of Prosthetic Dentistry*, 29, 317-322.
- Buckley, R. R. (1957). Mouthpieces for the handicapped. *Journal of Dentistry for Children*, 24, 174-178.
- Buckley, R. R. (1959). The acrylic mouthpiece for poliomyelitis and cerebral palsied patients. *Journal of Dentistry for Children*, 26, 248-251.
- Buckley, R. R., & Slominski, A. H. (1958). The acrylic mouthpiece. *American Journal of Occupational Therapy*, 12, 23-25.
- Cloran, A. J. (1974). Telescopic mouth instruments for severely handicapped patients. *Journal of Prosthetic Dentistry*, 32, 435-438.
- Evans, B. A., & Cooley, A. M. (1956). Writing, typing and painting aids for the respirator patient. *American Journal of Occupational Therapy*, 10, 85.
- Ey, M. C. (1956). Ejectable mouth stick. *American Journal of Occupational Therapy*, 10, 121, 133.
- Frankel, M. A., Hawkesford, J., & Simonson, J. (1975). A new mouthstick. *Paraplegia*, 13, 66-69.
- Garcia, S., & Greenfield, J. (1981). Dynamic protractible mouthstick. *American Journal of Occupational Therapy*, 35, 529-530.
- Georgia Warm Springs Foundation. (1957). The pincer mouthstick. *American Journal of Occupational Therapy*, 11, 288-289.
- Hemley, S. (1938). Bite plates, their application and action. *American Journal of Orthodontics*, 24, 721-736.
- Kozole, K. P., Gordon, R. E., & Hurst, P. S. (1985). Modular mouthstick system. *Journal of Prosthetic Dentistry*, 53, 831-835.
- Lutwak, E. (1979). A new mouthstick prosthesis for handicapped patients. *Journal of Prosthetic Dentistry*, 37, 61-66.
- Materson, R. S., & Lotz, J. W. (1975). Cloran telescoping oral orthosis. *Archives of Physical Medicine and Rehabilitation*, 56, 409-413.
- Moore, J. C. (1956). Reading aids for a quadriplegic patient. *American Journal of Occupational Therapy*, 10, 119-120, 133.
- Mulligan, R. (1983). A physiologic bitestick appliance for quadriplegics. *Special Care in Dentistry*, 3, 24-29.

Nawoczenski, D. A., Rinehart, M. E., Duncanson, P., & Brown, B. (1987). Physical management. In L. E. Buchanon & D. A. Nawoczenski (Eds.), *Spinal cord injury, concepts and management approach* (pp. 123-184). Baltimore: Williams & Wilkins.

O'Donnel, D., Yen, P. K. J., & Robinson, W. (1985). A mouth controlled appliance for severely physically handicapped patients. *British Dental Journal*, *159*, 186-188.

Olsen, R. A., Prentke, E. M., & Olsen, D. B. (1986). A versatile and easily fabricated mouthstick. *Journal of Prosthetic Dentistry*, *55*, 247-249.

Pedretti, L. W. (1985). Spinal cord injury. In L. W. Pedretti (Ed.), *Occupational therapy: Practice skills for physical dysfunction* (2nd ed.) (pp. 403-418). St. Louis: Mosby.

Smokler, J., & Rappaport, S. C. (1979). Mouthstick prosthesis for a patient with arthrogryposis multiplex congenita. *Journal of Prosthetic Dentistry*, *42*, 316-321.

Sniderman, M., & Hollis, L. T. (1954). The use of self-curing acrylic in the making of a mouthpiece. *American Journal of Occupational Therapy*, *8*, 115-116.

Spencer, E. A. (1983). Functional restoration—Specific diagnosis. In H. L. Hopkins & H. D. Smith (Eds.), *Occupational therapy* (6th ed.) (pp. 381-445). Philadelphia: J. B. Lippincott Co.

Stow, R. (1966). Grasping mouthstick. *Archives of Physical Medicine and Rehabilitation*, *47*, 31-33.

Trombly, C. (1983). Spinal cord injury. In C. A. Trombly & A. D. Scott (Eds.), *Occupational therapy for physical dysfunction* (2nd ed.) (pp. 385-398). Baltimore: Williams & Wilkins.

Wilson, D. J., McKenzie, M. W., Barber, L. M., & Watson, K. L. (1984). *Spinal cord injury: A treatment guide for occupational therapists* (rev. ed.). Thorofare, NJ: Slack.