Toothbrush Design for Tetraplegia Handicapped (C5-C7) throughout UCD Method

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ABSTRACT:
The objectives of this study are to design a manual toothbrush for cervical spinal cord handicapped (tetraplegia C5-C7) that it is in compliance with the movement restrictions of this group. In this case study, data were collected by field study. The method of user center design (UCD) was also used to gain information and pertinent feedback of users. In this study, 27 volunteers participated. In the final stage of UCD in which the aim was to provide the comfort parameters of tetraplegia handicapped C5-C7’s manual tool, the satisfaction questionnaire of manual tool was used to determine the convenience. To emphasize the independence of the user, which is the most important item in designing a product for this group, the muscle atrophy and consequently, the mismatch of the health people’s anthropometric dimensions with this group are important. Therefore, the handle of toothbrush must have proper dimensions with the hands of this group in addition to the grasp to balance between the form, function and the dimensions of hand tool and the restrictions of the user’s hand.

Keywords: Toothbrush, Convenience, Tetraplegia, User-centered design.

Relevance to Design Practice:
The motion restrictions of the disabled with the tetraplegia of C5-C7 were studies to design a product to facilitate the daily activities and reduce the help of the caregivers. It has been tried to solve needs in the process of designing properly by investigating the needs of the target group.

INTRODUCTION:
The term “disability” refers to any limiting disturbance or restrictions on certain types of daily activities (Liu et al., 2009). Spinal cord is a communicated canal that exchange sensory and motion information between brain and body (Harvey, Graves, 2011). Spinal cord injury (SCI) can be classified into two groups: paraplegia, tetraplegia (Harvey, Graves, 2011). Given the international standard classification of spinal cord injury, each of them can include full injury or partial injury (Backus, 2010). The levels of cervical spine injury are different and in three-quarters of cases, it is about the sixth cervical segment (Lamb, 1984). All cervical spine injuries in conformity with upper body function have different degrees in accordance with the level and extent of spinal cord injury (Backus, 2010; Keith et al., 1996). People with an injury at the level of C2-C4 may never have arm or hand function, while those with injury at the level of C5, which is more common level, their functions are limited by the shoulder and elbow (Backus, 2010). People with an injury at the level of C6 may have stretching of the wrist, while they have a better function in any capacity, but still have no movement of the triceps which is maintained in C7. This situation restricts the access and maneuver of the body (Figure 1) (Backus, 2010). At the higher levels of damage, C5 and C6, the ability
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of muscles controlled by will be low and alternative methods are required (Keith et al., 1996). In patients with incomplete tetraplegia, most of sensory input and motion output are changed and inappropriate and sensory and motion functions disappear like complete tetraplegia people (Backus, 2010). Tetraplegia people know that the loss of upper body function is a significant obstacle to independence and even a small increase of performance in upper body can be very useful (Curtin et al., 2005). The level and extent of the lesion influences of independence of the patient (Snoek et al., 2004). This serious shortcoming is functional that in a recent survey, the tetraplegia youths identified the loss of the upper body function, as the first priority of their disability (Lamb, 1984). It is a lost physical function which has psychological, social and economic losses (Anderson et al., 2008).

![Figure1. The involved range of each nerve roots in the organs (Harvey, Graves, 2011)](image)

Damaging the spinal cord results in reducing the ability of people for self-care and he is obliged to rely on caregivers to do his daily activities (Anderson et al., 2008). Brushing is the most basic method to maintain a good oral hygiene. However, even for adults, brushing inconclusive or insufficient can cause cavities and gum inflammation that ultimately lead to tooth decay or lose it (Kim et al., 2009; Nakano et al., 2008). The results show that the decay in permanent teeth is associated with primary teeth in adolescents (Nakano et al., 2008). Tooth loss is associated with impairment of life quality; and the location and distribution of the missing tooth in the mouth has an impact on the severity of the disorder. So keeping teeth at any time may be important (Liu et al., 2014). One of the factors affecting the quality of life is oral health that not only has impacts on physical health, but can effect on the effective functioning, interpersonal relationship, social relationship, self-esteem and mental health (Masood et al., 2014; Gallagher, Scambler, 2012). The oral health of the disabled is worse than healthy people because of the lack of their required dental care (Liu et al., 2009). Studies performed in the Netherlands and Japan showed that the oral health of disabled children can be improved.
to a same or better condition that normal same age children have despite their flaws in intelligence, body, physiology, coordination and relations. One of the main reasons for the improvement of this status is brushing by themselves or their caregivers in daily life (Liu et al., 2009). In this research, to design a toothbrush was studied in order for the disabled to achieve the oral health in a similar situation of healthy people. The effect of brushing is largely dependent on three factors: the method of brushing, brushing frequency and duration and toothbrush design. The first two factors shows the brushing behavior of person which is learned by experience (Ren et al., 2007), while the third factor shows the improvement of technology by influencing the physical and mechanical properties of the bristles of brush, shape, size and form of the head of toothbrush and its handle (Ren et al., 2007).

As mentioned before, the aim of this study was to design a hand toothbrush handicapped cervical spinal cord injury (tetraplegia of C5-C7) in compliance with the movement restrictions of this group and also to evaluate the convenience of the tool by user-centered approach.

Hand tools
In designing hand tools, designing the handle of tool is important in terms of the safe, convenient and easy use (Lewis, Narayan, 1993). In research conducted by L.F.M. Kuijt-Evers et al. (2004) entitled as Identifying predictors of comfort and discomfort in using hand tools, the result showed that the function has the most relationship with the convenient use and the physical interaction and appearance are placed after it, while the discomfort is predicted only by describing the side effects of body (Kuijt-Evers et al., 2005). L.F.M. Kuijt-Evers et al. (2007) concluded in their research that underlying same factors in the convenience of the different types of hand tools, specifically, are functional, physical interaction and the negative effects on the skin and the side effect on soft tissue (Kuijt-Evers et al., 2007).

User-centered design is a broad term to describe the design processes in which the final users influence on how the design forms (Abram et al., 2004). User-centered design is based on the structural analysis of the tasks of users (Kesseler, 2006). User becomes a key part of the development process. The intervention of users creates the more effective, more efficient and safer products and also helps to the acceptance and success of products (Abram et al., 2004). User-centered design (UCD) was begun by Donald Norman's research lab at the University of California in 1980 that was emphasized on the necessity to explore the needs and demands of users in using a product (Perlman et al., 2008). Designing for human or human-centered design must improve the safety, increase comfort and user acceptance and reduce fatigue and stress (Kuo et al., 2012). Patel Harshada et al. (2006), in their research to control virtual environments to develop the new 3-D interaction devices by user-centered method, concluded that the best way to ensure the fulfillment of technical and user requirements is to adopt a frequent user-centered approach to design and evaluate before actual implementation. Where human factors are used to ensure the design of simple product for a life of each individual, the interaction between the user and product have been improved to enhance the usability and ensure the benefit of a product for people of all ages and all abilities (Wong et al., 2012). Often, the 13407 ISO standards is used to describe human-centered design as an interdisciplinary activity. Conditions include human factors and ergonomics knowledge and techniques to increase efficiency and productivity, while it improves the working condition of people (Kesseler, 2006).

In this research, the user-centered method was used to achieve an appropriate form and correct function. Given the 13407 ISO standard, there are 5 essential processes in user-centered design that must be used to incorporate the requirements of usability in the software development process (Maguire, 2001) and they are to plan user-centered design process, to
understand and specify the context of use, to specify the user and organizational requirements, to produce design solutions and to evaluate by user (Chart1). The process is done in an iterative model that the objectives are achieved for the specific usability (Maguire, 2001) (Kesseler, 2006).

Chart1. The framework of user-centered method based on 13407 ISO standard

METHODOLOGY

In this case study, the user centered method was used as a primary method of data collection and required feedback of users. The components and process of this method were based on a proposed table of Martin Maguire (2001) in which 4 groups of use, assessment, needs and design are evaluated. In this evaluation, each group has subgroups which include several items such as expert and heuristic evaluation, supplementary assessment, satisfaction questionnaire, interview, analysis of competitors, mental map and design standards. Due to the lack of designing toothbrush for people with tetraplegia, one of the toothbrushes on the market that are accessible to the majority of the population was prepared to continue this research. This toothbrush is handy and was produced by Thermoset materials and it has a packing at its head. Selected toothbrush is made in Oman. Due to the constraints of the research, the user with cervical injury (C6) was selected from available and voluntary sampling. In order to obtain good function for the target group, at first, the user was asked to indicate brushing. Then, the guidance of oral health office (the rubber handle of bike) was used to brush properly (www.dshs.wa.gov) and the contact points of the user’s hand with toothbrush were investigated. For this purpose, placing the toothbrush handle on the user's hand were studied by dipping the handle of the toothbrush in paint. For complete information, in addition to review the anatomy and physiology, what if? Method (Barratt, Moeed, 2005; Sivapirakasam et al., 2009) was used that made the process of giving idea desirable.

In investigating the competitors’ products, their strengths and weakness were identified and used in making ideas. The comfort during use, sticking instead of grip, versatility of the handle, low cost, using different forms of toothbrush with different are their strengths and ignoring the correct brushing, neglecting the appropriate independence, non-overlapping several groups of cervical injury and the lack of domestic productions are their weaknesses.

About the needs of the target group, in order to the independence of the user, the workload of each process should be reduced. For this reason, by conducting observations, in order of importance, three classified groups of efficiency (the grip of the toothbrush handle, the brush of the toothbrush, the movement of toothbrush in hand, the sequence of brushing process, washing mouth), considering ancillary facilities (the versatility of the handle, removable head, washing mouth) and appearance beauty were needed. Accurate use of tools, proper cleaning of the teeth is proportional to the movement restrictions of the users.
The ergonomics of hand tools, standards of toothbrush and the guidance of correct brushing conclude another part of this research. The mental map technique was used for the initial ideas and then better ideas were selected. To gain the best ideas, the comment of experts and people with cervical spinal cord were used. 9 schemes were considered for the poll. In this step, the population concludes a specialist doctor, an occupational therapist and 4 people with cervical spinal cord injury. To prioritize the items of design, 13 experts and people with spinal cord injury was polled. They were asked to prioritize the items. These items are: function and comfort, appearance beauty, considering ancillary facilities. An occupational therapist, an ergonomics specialist and a dentist were interviewed to design a toothbrush for people with tetraplegia. The dentist was interviewed by phone. The models of 2 best ideas were prepared and offered to 10 people with spinal cord injury. The users expressed their views by testing the models. The users’ comments were recorded at each session each sessions and then analyzed. In this step, the color test was performed again. To get a comfort level in using the toothbrush and also to select the final idea, the hand tool questionnaire (Table 1) (Kuijt-Evers et al., 2007; Kuijt-Evers et al., 2005) was used. This tool consists of 28 items, some items were omitted in testing the toothbrush due to the inefficiency. The number of questioning items was 16. Some independent variables such as the kind of injury, the duration of injury, age and gender, which were appropriate in analyzing the data, were added to the questionnaire. The questionnaire was set by 7-option Likert scale from Kuijt-Evers L.F.M (Kuijt-Evers et al., 2007). The number of asked people was 13 that 3 of them were eliminated due to the large hand tool or the full ability of one hand. In the next step, the interview was performed by the prototype test. The population of this step was targeted, including 10 tetraplegia disabled (C5-C7). The users were sampled randomly.

**RESULTS**

In telephone interview was conducted by the dentist to design the brush of toothbrush, it was concluded that the brush of toothbrush in dealing with the internal tissues of the oral frequently causes damage it. Short of the brush on one side of the toothbrush was rejected due to the lack of correct brushing. Based on the observations, maximum shared movement among the people with tetraplegia C5-C7 is the limited movement between the thumb and hand side. In conducted study on the brush of the toothbrush, a rough brush represents a focused surface in toothbrush design and can greatly improve the effectiveness of brushing. Thickness, order and hardness of brush have been corrected by the advent of new materials and development in technological processes. For this reason, it has agreed that the smooth surface of the teeth can be cleaned, with any type of toothbrushes and any way of brushing, but the space between the teeth and gum edges are less accessible and need a toothbrush with rough brush which is useful for cleaning (Ren et al., 2007).

The studies and initial ideas were evaluated by the software sample technique. Two ideas (Figure2) were gained maximum points and identified as the best ideas.

**Figure2.** Two types of toothbrushes designed by PC: fixed head of toothbrush and variable-angle head of the toothbrush (authors)
Then the changes were made after evaluating by the users and the models of the two best ideas were made. For testing, they were offered to the users with satisfaction questionnaire. This questionnaire was designed to evaluate the convenience of the users with tools.

To evaluate the significance of independent variables of the injury extent and type, the linear regression was used on the items of 1, 2, 3, 4, 5, 8, 10 and 11. The error rate was considered %1 (P (0.01). With the exception of one of the mentioned questions, the relationship between two independent variables was significant in both tools. The variables of gender and age have an effect on the dimension of the handle. The models were made to fit adults (www.isiri.org).

The color test results were obtained from two models: the model 1 (Figure 3) is not usable for all people who have dropped wrist or spasms or have no abilities to hold the tool between their thumbs and forefinger. There are pressure points only at the edge of tool (Figure 4). The model 2 (Figure 3), the clip part of the handle is not usable only for people who have closed spasm or who cannot open their palms (Figure 5). There are pressure points on the U-shaped and clip parts on the back of the hand and which edges are in contact with the palm of the hand (Figure 6). By comparing the answers of the question about the convenience of the tool, the model 2 has a higher level of satisfaction. In model 2, one of the rings was removed due to the lack of efficiency.

The prototype of final product was obtained by making final changes (Figure 7) and then it was offered to the users for retesting.

Figure 4. Testing the first mock up. The pressure points on the palm after product usage.

Figure 5. Testing the second make up. The pressure points on the palm of the hand.
Recommendations

The materials of the grip must be not too soft (Mital, Kilbom, 1992). The highly polished gloss coating on the handle should be avoided (www.ccohs.ca). The materials of the handle should not absorb oils or fluids and also shouldn’t be a conductor of heat or electricity. Wood and plastic materials are suitable for handle. The foam rubber handles are preferred by the users, because they decrease the tiredness of hand and sensitivity to pain (Mital, Kilbom, 1992). To ensure a good grip in handle, there is enough friction between the hand and handle (www.ccohs.ca). To prevent the handle from slipping, the materials with low friction coefficient such as rubber or foam plastic must be used (Charles, 1999). Sweating increases the friction coefficient, while the oil and fat reduce it (Mital, Kilbom, 1992). The sharp edges and lines can be covered by relatively soft strips to minimize the injury (www.ccohs.ca). The power of grip increases of the diameter of the grip, but beyond a certain point, the power of grip decreases with the diameter of the grip. The maximum power of grip was recorded by a diameter of 4 cm (Johnson, 1990). In order to optimal grip, the handle of tool must have the appropriate length which is slightly longer than the width of the palm of the hand (Charles, 1999). Lyndestern (1973) recommended the length of 110mm for men and 100mm for women. In general, the length must be such that it does not limit the function of the tool and avoid the excessive force or the pressure concentrating on the sensitive part of the palm (Mital, Kilbom, 1992). If part of a hand pass through the ring at the time of holding the handle, there should be enough space to pass the relevant organs: for one finger or thumb, a circle with the diameter of 35mm permits the entrance, rotation and existence of the organ (pheasant, 2001). To eliminate the dangers at the edges of the handle, rounding the edges and corners off by creating a large radius was recommended (Lewis, Narayan, 1993). When a non-circular handle such as a rectangular or triangle handle is used, the probability of slipping will be decreased. The edges in such handles are resistant against slipping. The angle of grip must be 78 degrees from the horizontal (Mital, Kilbom, 1992). A single handle form must be appropriate to the palmar arch curve in the transverse direction to allow the use of force (Meagher, 1987; Johnson, 1990).

The minimum length of the toothbrush which is made of the brush and handle is 100mm for adults, 120 mm for adolescents and 140mm for children. The maximum foundation of brush is 13.5mm for adults, 12 mm for adolescents and 9.5 mm for children (www.isiri.org). The lateral image of brush may be flat or convex.
that the maximum changes in the length of filaments can be 2.1 mm, 5.1 mm, respectively. The end of the coils’ arrangement must be smooth or serrated or jagged arc, these forms must be regular. The length of brush which is measured on the surface of the head of toothbrush must be 27-34 mm for adults, 22-30 mm for adolescents and 15-25 mm for children. The width of brush which is measured on the surface of the head of toothbrush must be 11.5 mm for adults, 10 mm for adolescents and 7.5 mm for children. The length of filaments which is measured on the surface of the head of toothbrush must be 9-13 mm for adults, 9-11 mm for adolescents and 8-10 mm for children (www.isiri.org).

The location of the toothbrush bristles on the gums is a 45-degree angle to the gums. In roll method, the wrist twists slightly and the bristles bends along the tooth. In circular method with closed mouth, placing the brush inside of the cheek is done fast and with low pressure. Every time that toothbrush is placing on the teeth, must overlap with the previous area (Perlman et al., 2008; www.dshs.wa.gov; www.nidcr.nih.gov; www.ada.org).

**DISCUSSION**

Inability to rotate the brush, inability to hold a toothbrush properly, the intolerance of the heavy weight of a toothbrush, using both hands to brush the teeth are the behavioral findings which were obtained from the initial observations. Based on the study done on a user, the final knuckle, the upper knuckle, sesamoid bone, the muscle of the circular part of the fibrous sheath, Adductor pollicis muscle are most responsible in the process of brushing (Johannes, Chichiro, 1993).

The suggestions outlined in the oral health guidance for the disabled with the cervical spinal cord injury are: use a Velcro strap to hold cutlery. Hold a toothbrush by closing a wide rubber or plastic band around the hand and toothbrush (Figure 8). Make a small incision on the side of a tennis ball and put it on the toothbrush handle. Put the rubber handle of bike on the handle of toothbrush. Apart from the available devices, an electrical toothbrush is sometimes used for its convenience (Perlman et al., 2008; www.nidcr.nih.gov).

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**Figure 8. The competitors’ sample products:** (1) the tools to hold the toothbrush without hand, (2) the use of ductile material for forming the toothbrush handle in accordance with the hand, (3) the toothbrush for the spinal cord injury disabled, (4) an example of the international guidance of the care of oral health and (5) auxiliary tools to use the toothbrush (www.nidcr.nih.gov; www.spinalistips.se; www.wihd.org; www.pinterest.com).
The function of toothbrush is placing among the finger and brushing the teeth and tongue. Brushing is done by rotating the hand in two axis and with a circular motion. To keep it, its head should be avoided from being contaminated. It should be washed with water after using. The main use of a toothbrush is cleaning the teeth, tongue and palate by brushing. Its handle is used to hold it. A toothbrush consists of a brush and body. Inability to rotate the toothbrush, inability to hold it properly, the intolerance of its heavy weight, using both hands to brushing the teeth is the behavioral finding which was obtained from the initial observations.

To analyze the data from the questionnaires for both tools, the satisfaction percentage of both tools were used for each item (Table1).

In model 2 (Figure2), there were no abilities to detect correctly whether the transmission of force is doing well, because it was new and also non-applicability for testing by the users. In some cases, pressuring to stabilize in hand caused the spasms partially that it was not mentioned in interviewing by the users. In testing model1 (Figure2), the users who have wrist drop were not able to use the product properly. For this reason, the function of it became suitable for these people by changing the end of the handle and decreasing its width.

In conducted poll about the whereabouts of the disabled’s toothbrushes, it was pointed that displacing the disabled person from his bed is difficult and the disabled prefer to displace in urgent cases to reduce the amount of work imposed on caregivers and for this reason, they do their daily activities in their beds. The environment surrounds a disabled personis not a good place to hold a toothbrush due to observe hygiene; and also the disabled are dissatisfied to do it. So a toothbrush is kept by caregiver and it is offered to a disabled person in a case of the need. If the disabled are not able to wash their mouth, the caregivers help them to do it.

**Table1.** The statistical data obtained from the satisfaction questionnaire and comparing the satisfaction of two final model by the authors.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Model1</th>
<th>Model2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Fits the Hand</td>
<td>80%</td>
<td>81.81%</td>
</tr>
<tr>
<td>2 Is functional</td>
<td>80%</td>
<td>81.79%</td>
</tr>
<tr>
<td>3 Is very reliable</td>
<td>90%</td>
<td>90.91%</td>
</tr>
<tr>
<td>4 Is easy to use</td>
<td>70%</td>
<td>63.63%</td>
</tr>
<tr>
<td>5 Has good force transmission</td>
<td>70%</td>
<td>63.63%</td>
</tr>
<tr>
<td>6 Is a high quality tool</td>
<td>80%</td>
<td>81.82%</td>
</tr>
<tr>
<td>7 Has a nice-feeling handle</td>
<td>70%</td>
<td>72.72%</td>
</tr>
<tr>
<td>8 No muscle cramp</td>
<td>88.89%</td>
<td>63.64%</td>
</tr>
<tr>
<td>9 Feels calmly</td>
<td>80%</td>
<td>81.82%</td>
</tr>
<tr>
<td>10 Needs low hand grip force supply</td>
<td>80%</td>
<td>80%</td>
</tr>
<tr>
<td>11 Causes peak pressure on the hand</td>
<td>88.89%</td>
<td>66.66%</td>
</tr>
<tr>
<td>12 No pain</td>
<td>66.67%</td>
<td>80%</td>
</tr>
<tr>
<td>13 Handle size</td>
<td>80%</td>
<td>45.45%</td>
</tr>
<tr>
<td>14 Has a good friction between handle and hand</td>
<td>60%</td>
<td>81.81%</td>
</tr>
<tr>
<td>15 Styling</td>
<td>90%</td>
<td>63.63%</td>
</tr>
<tr>
<td>16 I think this hand tool is (overall comfort)</td>
<td>80%</td>
<td>90.91%</td>
</tr>
</tbody>
</table>
**CONCLUSIONS**

The results of this study which was performed by the user-centered method to design a toothbrush for people with tetraplegia of C5-C7 and to evaluate its convenience are as follows (Figure9):

The main function of a product is greatly related to the product form. The correct design of the handle can cause safety and comfort and increase the performance (Harith, Dolšak, 2013). In designing tools, eliminating all potentials of the injury is impossible, but many changes can be relatively simple design of a tool, in this case, the unsafe tool becomes a relatively safe tool (Lewis, Narayan, 1993). Considering proper weight, safe and effective grip, the accuracy of applying force and also the texture of the handle are important (Harith, Dolšak, 2013; Lewis, Narayan, 1993; Mital, Kilborn, 1992; Meagher, 1987).

![Figure9. 3d image and side view of the computer model obtained by the authors](image)

To study the motion activities of the users, the electric toothbrush was not considered. Electric toothbrushes are not considered to be active users. Due to prolonged use of a toothbrush handle and interchangeable brush, toothbrush handles should be washable and disinfected. In order to help the user to use the product, the graphic signs were used on the body of the product. These signs were used temporarily.

In order to test the product before buying, it must be packed in such a way that makes it possible; the toothbrush handle should be placed outside of the package.

Due to the muscle atrophy of the target group, the compatibility of the healthy individuals' anthropometric dimensions with this group is impossible.

To support the movement restriction of the users, the handle of toothbrush should be set in such a way that it is set in the user's hand.

To move the toothbrush between the two hands of user, in order to be independent in brushing all surfaces of the teeth and maintain the correct sequence of work, the user can be provided with a ring for the thumb to move the toothbrush between the two hands.

To avoid sharp edges, the overall thickness of the handle was considered 3 mm with the curved corners. Thumb ring is located along the handle and its diameter is at least 2.5 mm. The length of the handle was considered at least 7.5 cm. The height of the handle’s back is at least 6 cm. Interior width of the handle is at least 3.5 cm in both parts. The distance between the end of the handle and the main body is considered at least 1.5 cm in order to stabilize it in hand. The height of the set of brush to the handle is at least 6.5 cm.

Toothbrush head angles up to 30 degrees forward and also the brush of toothbrush fixed in 4 directions so that people who do not have the ability to turn their hands, this rotation is done by teeth and also the head of the toothbrush is fixed on two sides at the degree of 90. With this method, the users who have wrist drop are able to brush their teeth alone. The handle becomes thin from the end of the handle with the cross-section of 5 mm to the height of 2 cm along the handle. The design of the existing toothbrushes' brush on the market was suitable. In order to reduce the cost, the brush is interchangeable.

The handle of toothbrush should pressure on the hand to be set in it. The extent of this pressure must be investigated.
In this research, due to the time constraints, studying all needs of these people in brushing is impossible, two needs of washing mouth and the versatility of the handle were not studied. Because of the problems of this group to participate in society, this group of society has been neglected by the designers.

**Suggestions**

Because of the problems of this group to participate in society, this group of society has been neglected by the designers. To detect whether the angle of the toothbrush head is proper to brush the teeth, it is needed to build several prototypes and provided them to volunteer users to test. The pressure of the handles on the hand must be evaluated that it is impossible in this study. It is necessary to explain about the versatility of the handle that this function can be considered for the designed product. According to experts, the designed product has more adaptability with other routine devices than the competitors’ products, but due to the time constraints, it was not studied in this study and also washing mouth by the disabled was not studied too.

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