Review Article

Spinal Cord Injury and Oral Health Status: A Systematic Review

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Abstract

Aim: To assess the oral health status in patients with various levels of spinal cord injury. **Data Sources:** Relevant studies were included from the period of January 2007 to October 2017 via MEDLINE, EMBASE and GOOGLE SCHOLAR, TRIP DATABASE. The search identified no randomized control trials for the proposed research question. The first set of terms included 'oral health status of spinal cord injury patient. The second set included the term 'oral health', 'dental health' separated by Boolean operator "OR" 'and the third set included the term 'spinal cord injury patient, 'upper limb paralysed patients 'separated by Boolean operator "OR. **Conclusion:** Based on inclusion criteria 5 articles were included. The methodological quality of the selected articles were assessed using the Effective Public Health Practice Project (EPHPP) 1998. The study results implied that the oral health among SCI patients was fair which is due to poor oral hygiene practices, greater levels of plaque, gingival bleeding and increase levels of caries experience. Oral hygiene instructions should be given in these patients and the caregivers should be trained adequately to maintain the oral hygiene of these physically compromised patients.

Keywords: Hemiplegia, oral health status, quadriplegia, spinal cord injury

INTRODUCTION

Spinal cord injury (SCI) is damage to the spinal cord that causes changes in its function, either temporary or permanent. These changes translate into loss of muscle function, sensation, or autonomic function in parts of the body served by the spine below the level of the lesion. It is a life-threatening condition that gives rise to high risk of mortality and morbidity.[1] The global annual incidence of SCI is 40–80 cases per million population. In India, incidence of SCI is 15 new patients per million population (according to conference of spinal injury management in 1995).[2]

In India, the major reason for SCI is accidental fall which accounts for 53% of SCI, whereas road traffic accidents and other injuries leading to SCI are 28% and 19%, respectively.[3] Spinal injuries most frequently occur in the neck (cervical) and lower back (thoracic and lumbar) areas. A cervical injury may affect breathing as well as movements of the upper limbs and lower limbs (tetraplegia and paraplegia).[4]

SCI is a serious medical condition that causes functional, psychological, and socioeconomic impairment. The long-term secondary complications after SCI include respiratory complications, cardiovascular complications, urinary and bowel complications, spasticity, pain syndromes, pressure ulcers, osteoporosis, and bone fractures.[5]

Patients affected with SCI often taken medications such as anticholinergic drugs, drugs used for muscle spasm, and neurogenic bladder problems resulting in xerostomia which is strongly associated with formation of dental plaque hence leading to the formation of dental caries.[6]

In some patients, smoking aggravates xerostomia by reducing the salivary flow.[7] Tobacco use, specifically the smoking form, is common in people with SCI. Smoking impedes the ability to heal soft tissue and bone, which in combination with an increased number of periodontal pathogens found among smokers, can be contributing to periodontal disease. Smokeless tobacco use results in recession of the gums and root exposure causing periodontal breakdown and risk for dental caries.[8]

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Hemiplegia and quadriplegia leave individuals with severe physical handicaps. Disabled individuals have usually revealed gingival and dental health problems with significantly poorer oral hygiene compared to the nonhandicapped. Adults who reported mouth dryness were more likely to have self-reported signs of loose teeth, bleeding gums, cavities, or broken teeth and symptoms of toothache, sensitive teeth, chewing problems, bad breath, or unpleasant taste in mouth.[6]

Some SCI patients use mouthstick for driving and controlling devices which may cause occlusal and oral tissue trauma. Altered mood and depressive symptoms prevalent in patients with SCI may lead to further periodontal complications.[9] Adults with SCI often face numerous obstacles in obtaining regular dental care services, including high cost, dental fear and anxiety, physical barriers (wheelchair-inaccessible dental offices), limited transportation, lack of dentists specializing in oral health needs of this population, and limited knowledge of oral health issues. In SCI patients, dental anxiety is due to inaccessibility to dental office environment and asphyxiation is due to impaired respiratory musculature while undergoing dental treatment.

People with SCI accompanied with socioeconomic disadvantage are more likely to experience none unmet oral needs. Oral health problems have considerable negative effects on quality of life.[10] Hence, it is essential to study the existing oral health status of the participants with SCI and to provide interventions at the earliest to improve the oral health invariably improving their general health. Patient education by dental and medical providers should emphasize on awareness of the side effects of xerostomia-causing medications, management of dry mouth, and smoking cessation as well as proper oral hygiene.

The main aim of this systematic review is to assess the oral health status of patients with various level of SCI.

MATERIALS AND METHODS

This review was conducted in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Research topic
The research topic used to assess the oral health status of SCI patients.
- Population – Patients with various levels of SCI
- Outcome – Assessment of various variables of oral health status such as oral hygiene status, dentition status, periodontal status, and prosthetic needs in various levels of SCI.

Inclusion criteria
1. Studies which included patients with SCI
2. Case–control studies and cross-sectional studies only included
3. Studies which included patients with SCI who had undergone treatment for minimum period of 1 year
4. Studies done within the past 10 years were included

5. Studies which was written in English language were only included.

Exclusion criteria
1. Studies on patients with systemic illness
2. Reviews, expert opinion, and case studies were excluded.

Search strategy
Relevant studies were included from the period of January 2007 to October 2017 through Medline, Embase, Google Scholar, and Trip database. The search identified no randomized control trials for the proposed research question. A detailed search strategy was developed for Medline through the use of MeSH terms and was revised for Google Scholar and Trip database also. The first set of terms included "oral health status of SCI patient." The second set included the term "oral health" and "dental health" separated by Boolean operator "OR," and the third set included the term "SCI patient" and "upper limb paralyzed patients" separated by Boolean operator "OR."

Data extraction
The data extraction from the final five articles was done using a data extraction form. It included the first author name, year of publication of the article, study population, type of spinal injury, objectives of the study, study design, method of obtaining relevant information (assessment tool), results and primary outcome, and author's conclusion.

Quality Assessment of the Studies
The final analysis included four cross-sectional studies and one case–control study [Flowchart 1]. The methodological quality of the selected articles was assessed using the effective public health practice project 1998,[11] quality assessment tool for quantitative studies which has six components of selection bias, study design, confounders, blinding, data collection methods, and withdrawal/dropouts. Each component was classified as strong, moderate and weak.
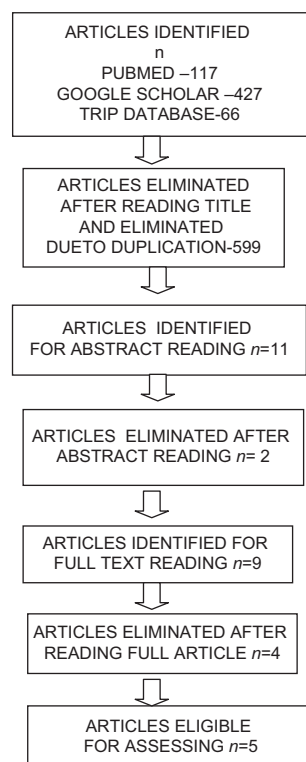
1. Strong
2. Moderate
3. Weak.

RESULTS

The search generated a total of 610 articles from different electronic bases, i.e. PubMed (117), Google Scholar (427), and Trip database (66), respectively. PRISMA (2009) guidelines regarding the paper selection are represented as flowchart. The full texts of nine articles were obtained for further review. On the basis of inclusion and exclusion criteria, five articles were included in the final analysis for the systematic review.

The included studies assessed the oral health status of SCI patients and factors limiting the access to dental care among those patients. All the studies reported were descriptive cross-sectional studies except study done by Pakpour *et al*. (2016) which was a case-control study.) Quality assessment (selection bias, study design, confounders,

Table 1: Quality assessment of included studies'

Studies	Selection bias	Study design	Confounders	Blinding	Data collection and methods	Withdrawal/dropouts
Dr. Vasudha khattar *et al*., 2009	2	3	3	2	1	3
AL Sullivan *et al*., 2013	2	3	3	2	1	3
Hon K Yuen, 2009	2	3	3	2	1	3
Hon K Yuen, 2010	2	3	3	2	1	3
Amir H Pakpour, 2016	2	2	2	1	1	3

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ARTICLES IDENTIFIED
n
PUBMED –117
GOOGLE SCHOLAR –427
TRIP DATABASE-66
        ↓
ARTICLES ELIMINATED
AFTER READING TITLE
AND ELIMINATED
DUETO DUPLICATION-599
        ↓
ARTICLES  IDENTIFIED
FOR ABSTRACT READING n=11
        ↓
ARTICLES  ELIMINATED AFTER
ABSTRACT READING n= 2
        ↓
ARTICLES IDENTIFIED FOR
FULL TEXT READING n=9
        ↓
ARTICLES ELIMINATED AFTER
READING FULL ARTICLE n=4
        ↓
ARTICLES ELIGIBLE
FOR ASSESSING n=5
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Flowchart 1: Flow diagram for studies included in the review. *n* = number of article

blinding, data collection methods, and withdrawal/dropouts) of included studies were tabulated as seen in Table 1. The population assessed in all the studies were adult patients with SCI [Flowchart 1].

A study by Sullivan *et al*. (2013) assessed that the various predictors for oral health which included socioeconomic, injury-related, and oral habit variables were used for predicting oral health score (OHS); decayed, missing, and filled teeth (DMFT) score; and periodontal screening and recording (PSR) index in SCI patients. In that study, regarding daily oral habits, 84% reported brushing teeth, 48% rinsing mouth, 14% flossing, 33% tobacco use, and 13% mouthstick use. Only 32% had teeth cleaned within the past year. On oral examination revealed three decayed and eight missing teeth on average, with prominent periodontal disease (64%).

Further only one study by Pakpour *et al*. (2016) assessed the oral health-related quality of life (OHRQoL) by using the oral health impact profile (OHIP-14) which consisted of 14 questions in 7 domains (2 items per domain) which comprised functional limitation, psychological discomfort, physical disability, psychological disability, mental disability, social disability, and handicap while assessing the perceived impact of oral health on SCI patients. In that study, SCI patients exhibited significantly higher DMFT scores than the healthy individuals (mean $\pm$ SD = 17.2 $\pm$ 8.7). Except for the decayed teeth, SCI patients had a greater number of missing and filled teeth when compared to the healthy individuals. With respect to periodontal status, community periodontal index (CPI)-3 and CPI-4 denoting pocket formation were predominantly found in the SCI patients. Furthermore, periodontal health as assessed by gingival index was poorer in SCI patients compared to the healthy controls. In addition, the mean score of dental plaque of SCI patients was significantly higher than the healthy controls.

Vasudha Khattar (2009) assessed various oral health needs that include D assessment of oral health status (oral hygiene, tooth mobility, denture status and denture need, lesions of the oral mucosa, and oral health needs assessment). In that study results, the level of oral health of SCI patients was fair. The overall level of edentulousness was 1.7%, the need of restorative treatment and extractions was 8.2%, and the assessment of treatment needs revealed that 81% of the study population required dental care.

A study done by Yuen *et al*. (2010) assessed barriers for dental care in SCI, which included wheelchair-inaccessible dental offices, limited transportation, lack of dentists specializing in oral health needs of this population, and limited knowledge of oral health issues faced by persons with SCI. In that study results, approximately 47% of participants reported having oral problems at the time of the survey, and 42% reported experiencing oral pain within 12 months before the survey date. Oral problems and oral pain were positively associated with dry mouth symptoms, financial barriers to dental care access, smoking, and paraplegia.

Study population, study design, objectives, assessment tool, outcome, and summary of these included studies were tabulated as seen in Table 2.

DISCUSSION

In the present review, search based on PRISMA guidelines narrowed down on a set of four descriptive cross-sectional studies and one case–control study that suggested an outcome

Table 2: Summary of included studies

Author	Population	Assessment tools	Primary outcomes	Study summary
Amir H Pakpour, 2016	A total of 203 SCI patients and 203 healthy controls	There is a significant difference between the two groups in terms of oral health expressed in DMFT, oral hygiene, and periodontal status, controlled for age, gender, family income, and occupational status. Oral health-related quality of life was assessed by the OHIP-14. All the participants were examined for caries which was quantified using the DMFT index, GI, plaque index, and periodontal status by CPI	There is a significant difference between the two groups in terms of oral health expressed in DMFT, oral hygiene, and periodontal status, controlled for age, gender, family income, and occupational status.	SCI patients had poor oral hygiene practices, greater levels of plaque, gingival bleeding, and caries experience than the healthy controls. In addition, more number of SCI patients had periodontal pockets and dry mouth than the comparative group
Dr. Vasudha khattar, 2009	Total of 58 adults with SCI	WHO assessment form, plaque index, calculus index/completed questionnaire	The overall level of edentulousness was 1.7%; the need for restorative treatment and extractions was 8.2%. People need for periodontal care was 88%. The normative assessment of treatment needs revealed that 81% patients required dental care	The level of oral health of the SCI patients was fair. A high percent of spinal injury patients were found to be in need of dental care. Nursing and care staff had positive attitudes toward oral health care
AL Sullivan, 2013	Total of 92 SCI patients	Completed questionnaires, OHS, DMFT index, PSR index	Most people with SCI were able to bring at least one hand to the mouth (82%) and brush teeth independently (65%). Regarding daily oral habits, 84% reported brushing teeth, 48% rinsing mouth, 14% flossing, 33% tobacco use, and 13% mouthstick use. Only 32% had teeth cleaned within the past year	Oral health appears compromised in people with SCI. Identification of modifiable risk factors warrants examination whether intervention with focus on behavioral changes may improve oral health in this population
Hon K Yuen, 2010	Total of 192 SCI patients	The BRFSS is a standardized population-based survey developed by the CDC to collect information on health practices and risk behaviors	There was no significant difference in the proportion of participants with SCI who visited the dentist for any reason in the past year compared to the general population	Physical barriers preventing access to dental facilities and dental fear are prevalent and significantly impede the delivery of dental health care to adults with SCI. Dentists should undertake necessary physical remodeling of their facilities to accommodate wheelchair users and implement appropriate strategies for the management of dental fear among patients with SCI
Hon K Yuen, 2009	Total of 192 SCI patients	Online oral health survey-questionnaire methods	Approximately 47% of respondents reported having oral problems at the time of the survey, and 42% reported experiencing oral pain in the 12 months before the survey date. Multiple predictor analyses (controlling for age, gender, income, and dental insurance) indicated that current oral problems were positively associated with dry mouth symptoms, financial barriers to dental care access, smoking, and paraplegia. Oral pain experienced in the past 12 months was positively associated with dry mouth symptoms, financial barriers to dental care access, minority race, and paraplegia	Adults with SCI reported a high prevalence of oral problems and oral pain. Those with paraplegia were more likely to report problems than those with tetraplegia. Because dry mouth and smoking were significantly associated with these problems, patient education from both dental and medical providers should emphasize awareness of the side effects of xerostomia-causing medications, dry mouth management, and smoking cessation

OHIP-14: 14-item oral health impact profile, SCI: Spinal cord injury, DMFT: Decayed, missing, and filled Teeth, BRFSS: Behavioral Risk Factor Surveillance System, GI: Gingival bleeding index, OHS: Oral health score, CDC: Centers for disease control, CPI: Community periodontal index, PSR: Periodontal Screening and Recording Index

on oral health status of SCI patients. In SCI patients, injury to the corticospinal projection system provokes a deficit of manual dexterity. The decreased dexterity due to poor muscle coordination, complicated medical condition, makes their tooth brushing and oral hygiene maintenance difficulty. Loss of hand function is a particularly devastating aspect of SCI that patients associate with a reduction in quality of their life. SCI leave individuals with severe physical handicaps. Disabled individuals have usually revealed gingival and dental health problems with significantly poorer oral hygiene. Spinal Injuries are classified in general terms of beingneurologically"complete" or "incomplete" based upon the sacral sparing definition.[12] In SCI patients, Xerostomia which occurs due to various medications is strongly associated with formation of dental plaque and further formation of dental caries.

In this review, all the studies included were SCI patients in both complete and incomplete level of injury. Pakpour *et al*. (2016) stated that SCI patients had poor oral hygiene practices, greater levels of plaque, gingival bleeding, and caries experience than the healthy controls. Khattar *et al*. (2009) also stated that the level of oral health in SCI patients was fair. A large number of SCI patients needed periodontal care and dental treatment. In addition, more number of SCI patients had periodontal pockets and dry mouth than the comparative group. The reason for poor oral hygiene could be the medications usually prescribed in these patients to treat muscle spasms, and neurogenic bladder disorders might lead to dry mouth which, in turn, leads to increased accumulation of dental plaque and also dental caries. Second, these patients restrain themselves from performing regular oral hygiene as this needs extra efforts and specialized equipment such as arm supports, universal cuffs, or splints. Pakpour *et al*. (2016) stated that SCI patients had poorer OHRQoL than the comparative group. All the oral findings had a significant negative effect on OHRQoL; participants with dry mouth, greater caries levels, and periodontal pockets reported greater OHIP-14 scores (poor OHRQoL). It is evident that the clinical oral health status is significantly related to OHRQoL. However, plaque and gingival bleeding were not related to OHRQoL. The reason for poorer oral hygiene in SCI patients are due to secondary health problems, dependence on others for their needs, and limitation in regular movement. Limited movement and dependence on caregivers hinder the performance of regular general hygiene and also oral hygiene in SCI patients.

Sullivan *et al*. (2013) stated that oral health appears to be compromised in people with SCI, which suggests the need to focus more attention to the provision of adequate dental and periodontal care to this population. The reason for compromised oral health after SCI was employment before injury and behaviors that heighten the risk for compromised oral health (not flossing, not rinsing, tobacco use, and mouthstick use). These factors predicted both the participants' self-assessment of OHS and the formal examination of periodontal disease (PSR). Older age was the only predictor of DMFT, in agreement with the

findings in the general population. Yuen *et al*. (2009) stated that there was no significant difference in the proportion of participants with SCI who visited the dentist for any reason in the past year compared to the general population. The most common barrier to accessing dental care was high cost followed by physical barriers and dental fear. Other barriers included wheelchair inaccessibility to dental office, examination room, or dental chair, and lack of transportation prevented them from receiving dental care. Respondents with dental insurance had slightly better odds of going for an annual dental visit (including professional cleaning) than those with no insurance. Those who reported brushing teeth less often than twice a day were twice as likely not to visit the dentist in the past year compared to those who reported brushing at least twice a day. Of the three major barriers that limited dental access among persons with SCI, physical barriers may be the factor most under the control of dental health professionals. Caregiving services in SCI patients were predominantly provided by informal caregivers. Quality of care by informal caregivers matches with formal caregivers. The role of caregivers in SCI patients is to improve oral health by brushing their teeth and flossing their teeth every day, make them to visit a dentist regularly, rinse the dentures after every meal, and brush them daily with dental cleaner. If the SCI person had dry mouth, providing alcohol-free mouth rinse can help them keep hydrated.

Limitations

The quality of the evidence included in this systematic review was affected by a number of methodological issues. First, there was marked heterogeneity of the studies selected and included. The sample size of some studies was small, while some studies did not report the statistical procedure of sample size calculation or justified the sample size used in their studies. This review may not be comprehensive because those studies published in Japanese, Chinese, Spanish, or Portuguese were not included and only English articles were considered in this review. For some studies, blinding of outcome measurement was either not achieved or not mentioned by the researchers. Longer observation periods are required to measure periodontal changes.

CONCLUSION

In SCI patients, poor oral hygiene practices, greater levels of plaque, gingival bleeding, and caries experience were noticed. Since the resources are limited, it becomes even more essential that oral hygiene instructions should be given to these patients and the caregivers should be trained adequately to maintain the oral hygiene of these physically compromised patients. Henceforth, for further evaluation of the oral health status and OHRQoL, barriers faced by dental care studies of better standards/designs are recommended.

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Conflicts of interest
There are no conflicts of interest.

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