Influence of prosthodontic treatment during the convalescent phase for care prevention of elderly patients with bone fractures resulting from falls

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We investigated the influence of prosthodontic treatment during the convalescent phase for care prevention of elderly patients with bone fractures resulting from falls. Eighteen non-dementia elderly patients (mean age 78 years) with bone fractures resulting from falls who were hospitalized at a convalescent rehabilitation hospital were selected as the subjects. Based on an intraoral examination upon admission, we categorized the subjects by assigning nine to a group with need of prosthodontic treatment (Prosthodontic Treated group ; PT) who received the treatment, and nine to a group who needed prosthodontic treatment but had refused it (non Prosthodontic Treated group ; non-PT). Regarding the effect of care prevention, we selected four categories. Motor function, nutritional status, oral function and mental function were compared for the two groups on admission and at discharge. In motor function, oral function and mental function, significant changes were observed only in the PT group. Nutritional status was not significantly different for the PT group. The results showed that for the elderly patients with bone fractures resulting from falls, prosthodontic treatment during the convalescent phase, resulted in improvements in oral function as well as in care prevention. (J Osaka Dent Univ 2013 ; 47 : 57–65)

Key words : Prosthodontic treatment ; Care prevention ; Convalescent phase

INTRODUCTION

According to the Comprehensive Survey of Living Conditions, reported by the Ministry of Health, Labour and Welfare (MHLW) of Japan, the percentage of individuals requiring assistance in daily life because of fall-related fractures is about 10% of all individuals requiring daily living care.¹ The activities of daily living (ADL) for elderly who have experienced a fall tend to be restricted because of their fear of falling again. This can lead to a deterioration in physical ability caused by disease. For these elderly individuals, it is difficult to maintain or improve the effectiveness of rehabilitation. This can result in a vicious cycle of fall recurrence resulting in the need for assistance in daily life.² In Japan, which is now facing a trend towards a super-aging society where 1 in 3 individuals is aged 65 or over, it is an important social issue to prevent fractures due to falls among the elderly, and to provide prophylactic care for them so that they will not require assistance in daily life even after experiencing a fracture.

Care prevention is defined as “care aimed at preventing (or delaying) as best possible the onset of a condition requiring assistance in daily life, prevention of aggravation of a condition requiring such assistance, and reduction in the need for assistance in daily life.”³ This type of care is not simply aimed at improving individual issues for elderly people such as motor function and nutritional status, but is also aimed at improving their quality of life (QOL) through helping them feel the value of their life and achieve self-realization. With these taken into account, the MHLW care prevention manual⁴ states that the following measures are useful as means of care prevention: (1) improvement in motor function, (2) improvement in nutritional status, (3) improvement in oral function, (4) prevention of withdrawal and support for individuals in a se-
cluded state, (5) prevention of cognitive function deterioration and support to individuals with impaired cognitive function, and (6) prevention of depression and support to depressed individuals.

In the field of dentistry, several studies dealing with fall and prostodontic treatment have been published. It has been reported that restoration and preservation of occlusal support by prostodontic treatment contribute greatly not only to improvement in oral function, but also to improvement in motor function. \(^5\)\(^-\)\(^7\) At present, however, only 14% of all hospitals in Japan have a department of dentistry. Thus, elderly patients may not be receiving appropriate dental treatment during recovery from fall-related fractures. The present study was undertaken to evaluate the influence of prostodontic treatment during the convalescent phase for care prevention of elderly patients with bone fractures resulting from falls.

**MATERIALS AND METHODS**

**Subjects**

Elderly patients satisfying all of the following requirements were eligible: (1) patients admitted to and discharged from a convalescent rehabilitation hospital because of bone fractures resulting from falls during the approximate one-year period from June 2011 to May 2012, (2) non-dementia patients, recording 21 or higher scores on the revised version of Hasegawa's Dementia Scale (HDS-R) \(^6\) upon admission, (3) patients who had led an unassisted daily living at home before the fracture, (4) patients who had no history of cerebrovascular disease and were free of hepatic and renal disease, and (5) patients rated by the intraoral examination upon admission as requiring prostodontic treatment for tooth defects or prosthesis failure. There were 18 elderly patients (5 males and 13 females with a mean age of 78 years) satisfying all of these requirements.

The subjects were divided into a group of patients receiving prostodontic treatment (PT group, \(n = 9\)) and a group of patients refusing prostodontic treatment (non-PT group, \(n = 9\)). Table 1 shows the mean age, male-to-female ratio, and fracture site in each group. The PT group treatment aimed at restoration of occlusal support of the molars by means of crown restoration/fixed partial denture (2 cases), denture adjustment/denture relining (3 cases) and fabrication of new dentures (4 cases).

Rehabilitation for each subject was planned and implemented by the attending physician, occupational therapist and physiotherapist. Rehabilitation included muscle use training, muscular reinforcement, parallel bar training, and gait training. The rehabilitation program was designed so that individual subjects could adapt themselves to their living environments after being discharged from the hospital.

Upon admission, the motor function, nutritional status, oral function and social cognition of individual patients of the two groups were compared by the Mann-Whitney U test. This comparison revealed no significant difference between the two groups in terms of any parameter.

**Evaluation**

The following evaluations were made, referring to the care prevention manual.

**Oral function**

Oral function was evaluated through analysis of the number of occlusal-support areas, the masticatory performance and oral health-related QOL of each patient upon admission and discharge. Occlusal support was evaluated through measuring the number of occlusal-support areas at the time of placing the prosthesis according to the Eichner classification. In cases rated at Eichner class B4, the number of occlusal-support areas was regarded as 0, because this class lacks occlusal support in the molars.

Color-Changeable Chewing Gum (XYLITOL) \(^8\) for

<table>
<thead>
<tr>
<th>Table 1 Subjects</th>
<th>PT((n = 9))</th>
<th>non-PT((n = 9))</th>
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<tbody>
<tr>
<td>Average age (yrs)</td>
<td>77</td>
<td>78</td>
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<tr>
<td>Males</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Females</td>
<td>7</td>
<td>6</td>
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<tr>
<td>Fracture site</td>
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<td>Femur</td>
<td>4</td>
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<tr>
<td>Lumbar</td>
<td>1</td>
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<tr>
<td>Thoracic vertebral</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Thoracicolumbar vertebrae</td>
<td>2</td>
<td>2</td>
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<tr>
<td>Knee</td>
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Masticatory Performance Assessment, Lotte, Saitama, Japan) was employed as the test food for evaluation of masticatory performance. Each subject was instructed to chew the gum for 3 minutes in a manner resembling mastication during meals in daily life. After mastication, the gum was immediately collected and compressed through a polyethylene film onto a glass plate to form a 1.5 mm thick gum layer. The color of the gum layer was then assessed with a colorimeter (Shade Eye NCC, Shofu, Kyoto, Japan) from above the polyethylene film. Colorimetry was conducted at 5 points, with the average adopted for analysis. Of the elements of the L*a*b+ color expression system, we analyzed the indicator of red (the a+ value).9 Evaluation of oral health-related QOL was made in accordance with the Japanese version of the oral health impact profile (OHIP-J). Each item of the profile was read aloud by the subject and scored on a five-grade scale from 0 to 4. Three parameters of oral function were evaluated by a dentist.

**Nutritional status**

The nutritional status was evaluated with serum albumin level and body mass index (BMI) serving as indicators. Data on serum albumin level were derived from the biochemical test data of blood sampled within 7 days after admission and 7 days before discharge from the hospital. In this study, a serum albumin level below 3.5 g/dL was rated as “malnutrition”.10 BMI was measured by a nurse. For calculation of BMI, height and body weight were measured upon admission and only body weight was measured at the time of discharge. In accordance with the criteria of the Japan Society for the Study of Obesity,11 a BMI less than 18.5 kg/m² was rated as “underweight”.

**Motor function**

Motor function was evaluated on the basis of the total score for 13 motor items of the functional independence measure (FIM) (6 self-care items, 2 sphincter items, 3 transfer items and 2 locomotion items).12 In addition, the score of the items related to “walking” and “stairs” (listed as activities needed for improvement of ADL according to the care prevention manual) were used from the locomotion items. Scoring of the FIM items was carried out by the occupational therapist in charge of each patient upon admission and at the time of discharge.

**Communication and social cognition**

Communication and social cognition related to withdrawal, dementia and depression were evaluated on the basis of the total score for FIM cognition items. FIM includes 5 cognition items (2 items related to communication and 3 related to social cognition). FIM scoring was conducted by the occupational therapist in charge of each patient, in a manner similar to evaluation of motor function.

**Statistical analysis**

The scores obtained for the 9 items upon admission and at the time of discharge were compared between the PT group and non-PT group. Statistical analysis employed the Wilcoxon test. Data were entered and analyzed using SPSS (Windows version 19.0, SPSS, Chicago, IL, USA). Statistical significance was set at 5%.

This study was carried out after approval by the Osaka Dental University Medical Ethics Committee (Approval No.110504).

**RESULTS**

The results of each evaluation upon admission and at the time of discharge are shown below.

**Oral function**

The number of occlusal-support areas at the time of placing the prosthesis increased significantly only in the PT group and remained unchanged in the non-PT group (Fig. 1). Although masticatory performance showed significant improvement in the PT group, there was no significant change in the non-PT group (Fig. 2). While all subjects in the PT group showed improvement in masticatory performance, the results among individual subjects in the non-PT group varied greatly. Although the OHIP-J score changed significantly in the PT group, it showed no significant change in the non-PT group (Fig. 3). No subject in the PT group showed an increase in the total OHIP-J score. Although the total OHIP-J score decreased or
increased in many subjects in the non-PT group, oral function did not change.
showed an increase in the total score at the time of discharge from the score recorded upon admission. The score for "walking" and the score for "stairs" improved significantly only in the PT group. The number of subjects with the score for "walking" below 5 (indicating the need for daily life assistance) at the time of discharge was 2 in the PT group and 4 in the non-PT group (Fig. 7). Also in terms of the score for "stairs," the number of subjects scoring below 5 (indicating the need for assistance) at the time of discharge was 6 out of 9 in the PT group and 7 out of 8 in the non-PT group (Fig. 8).

**Communication and social cognition**

The total score of FIM cognition items showed significant improvement only in the PT group (Fig. 9). Although the total score did not decrease in any subjects in the PT group, it decreased in one subject in the non-PT group.

**DISCUSSION**

**Subjects**

The convalescent rehabilitation hospital participating in this study provides intensive rehabilitation so that patients can recover not only motor function, but also return to ADL. Treatment is accompanied by support for prevention of bed-ridden status and facilitation of return to home. During the early stages of illness, primary emphasis is laid on treating systemic illnesses and stabilization of symptoms. Prosthodontic intervention is difficult at this time even in cases having

**Motor function**

The total score of the motor items of FIM improved significantly in both groups (Fig. 6). All subjects
normal oral function. It has been reported that starting rehabilitation soon after stabilization of symptoms facilitates functional recovery. Thus, we selected elderly patients during the convalescent phase as subjects of this study to evaluate the influence on parameters related to care prevention because prostodontic intervention done during convalescence may facilitate functional recovery. The period of stay at a convalescent rehabilitation hospital by patients covered under the national health insurance system in Japan depends on the nature of the illness. For patients with a fracture, the upper limit of the hospital stay is 90 days. In the present study, patients discharged from the hospital within 30 days after admission were excluded, because prostodontic treatment requires a relatively long period of time.

In demented elderly people, the extent of functional recovery in response to rehabilitation can vary depending on the severity of dementia because comprehension of the instructions during rehabilitation may be affected by the dementia. In addition, objective evaluation with OHIP-J is not possible in demented elderly. For these reasons, the absence of dementia was adopted as one criteria for inclusion in this study.

In elderly individuals having a history of cerebrovascular disease, paralysis sometimes remains. Functional recovery may vary greatly among such patients as compared to elderly patients having orthopedic disorders alone. Albumin is usually formed in the liver and excreted via the kidneys. Thus, serum albumin levels can vary greatly among patients with hepatic or renal disease. For these reasons, elderly patients having a history of cerebrovascular disease or having hepatic or renal disease were excluded from this study.

Patients with a fracture caused by a fall resulting from illness, such as cerebrovascular disease or accidents, were excluded from this study. The cause of falls among elderly can be roughly divided into exogenous and endogenous factors. The living environment factor does not directly cause a fall. Instead, a fall associated with the living environment is considered attributable to the inability of the individual to adapt himself to his surroundings in the presence of impaired physical function. For that reason, the cause of a fall was not included for the subjects of this study.

**Oral function**

Parameters related to facilitation of improvement in oral function were selected. The number of occlusal-support areas was measured using the Eichner classification of the residual state of 4 occlusal-support areas (right and left premolar and molar groups of the upper and lower dentitions). This classification is related to the stability of the intercuspal position and the degree of occlusal-support. As a result of prostodontic treatment aimed at improving oral function and restoring occlusal support, the number of occlusal-support areas at the time of denture placement increased significantly in the PT group, while no such increase was seen in the non-PT group.

It has been reported that the a* value, which corresponds to the “red color” element of the L*a*b* color expression system serves as an indicator of masticatory performance. During the course of gum chewing the color changes from yellow green to red. The L*a*b* color expression system is a representative color expression system making use of the L*a*b* space, adopted in 1976 by the International Commission on Illumination (CIE). With chewing, the gum becomes more red and has a higher a* value.

In all subjects from the PT group, an increased number of occlusal-support areas resulted in improved masticatory performance. In the non-PT group, some subjects showed increases or decreases in masticatory performance. To date, there has been no report on assessment of masticatory performance with the use of Color-Changeable Chewing Gum XYLITOL in subjects with a small number of residual teeth (fewer than 7). This reflects the difficulty in assessing masticatory performance with this kind of gum in subjects having only a small number of residual teeth. The variance in the masticatory performance data in the non-PT group may be attributable to this factor. The masticatory performance in the non-PT group seemed to also be unstable during daily living.

The OHIP-J used for evaluation of oral health-related QOL is a Japanese version of the OHIP used worldwide. OHIP-J is designed to make appropriate
assessments of parameters related to tooth defects before prosthodontic treatment and to evaluate the extent of post-treatment recovery or alleviation from the morphological/functional disorders associated with tooth defects. This scale is composed of 54 items in 7 categories, with each item being scored. In view of a report that reliable and valid evaluation of oral health-related QOL is possible even with 14 items selected from among these 54, we used these 14 items to reduce the test-related stress on the subjects.18,19

The total OHIP-J score improved in the PT group. This result seemed to reflect improvement in oral health-related QOL, considering the improvements in masticatory performance and improvements also seen in many items related to esthetics. However, improvement in the total OHIP-J score was noted also in some subjects from the non-PT group despite an absence in changes in the oral cavity. In this connection, there is a report that patients staying in hospitals tend to have an illusionary feeling that they can masticate well (although they actually cannot) because the hospital’s arrangement of the diet tailored to individual patients makes them unaware of masticatory dysfunction.20 Furthermore, as the patients become accustomed to their hospital stay, they tend to lose the feeling of shame from “loss of teeth.” Thus, the improved total OHIP-J score in some subjects from the non-PT group seems to reflect a decrease of discomfort with the oral cavity following loss of the awareness of oral dysfunction.

Prosthodontic treatment is therapeutic intervention aimed at restoration of the morphology and function of teeth, oral cavity, jaws and related tissues.21 The oral function findings in this study indicated that the PT group showed restoration of oral function by the time of discharge as a result of prosthodontic treatment provided for the purpose of restoring occlusal support. This result agrees with one of the goals of the care prevention manual which is aimed at “facilitation of a good-tasting, enjoyable and safe diet”.

Nutritional status
Serum albumin levels reflect the amount of protein ingested at meals. This parameter has been used for evaluation of malnutrition among elderly.22 BMI is a simple and easily understood indicator of obesity used worldwide.19 The present study adopted the serum albumin level and BMI as indicators of nutritional improvement. Nutritional deterioration, decrease in muscle mass, reduction in muscular strength, and reduced physical balance can lead to a feeble constitution, falls, and dysbasia, resulting in a reduction in ADL.2

Our findings on serum albumin indicate that in the PT group, the subjects who had had a serum albumin level below 3.5 g/dL (“malnutrition”) upon admission had an increased level at the time of discharge. In the non-PT group, however, the serum albumin level of such subjects had further decreased by the time of discharge. In this connection, it has been reported that the increase in the masticatory activity level and sensory stimuli stimulated gastric motility and secretion,23 and that changes in dietary style can reduce nutrient ingestion, making nutritional management difficult.24 These reports suggest that nutritional management is easier in the PT group, who show improved masticatory performance, than in the non-PT group, who have unstable masticatory performance. Of the subjects in whom the serum albumin level was over 3.5 g/dL upon admission, many from both groups showed a reduction in the serum albumin level by the time of discharge. This finding may reflect the influence of the stress of rehabilitation, which increases prior to discharge from the hospital.

It has been reported that evaluation of the serum albumin level and BMI is important for accurate nutritional assessment.25 We found no significant difference in BMI between the two groups we studied. This suggests that nutritional management by dieticians was sufficient in both groups.

According to previous reports, the volume of meals ingested may decrease and the diet may become biased after discharge from hospital because of the stress related to preparation and cooking of meals, resulting in an elevated risk for malnutrition.2 Masticatory performance is closely associated with nutritional status after discharge.26 These reports suggest that prosthodontic intervention during the hospital stay period can further reduce nutritional deterioration after discharge.
Motor function
Rehabilitation was planned for each subject and implemented by the attending physician, occupational therapist and physiotherapist with goals set as recovery of not only function, but also ADL, prevention of the patient becoming bedridden, and facilitation of return home. FIM evaluates the extent of care needed as an indicator of improvement in ADL and has been used extensively in the field of rehabilitation.\textsuperscript{12, 27} Rather than having the evaluator record something on the fly, FIM is scored as a situation where the subject's behavior is objectively evaluated. Evaluation is made on a 7-grade scale, and a judgment "independent" or "requiring assistance" is made on the basis of the presence or absence of the need for care givers. Individuals requiring care givers are scored at 5 or less (5 levels between 1 and 5, depending on the intensity of need). Each level corresponds to 1.6 minutes of need for care.

Evaluation of motor function in this study was based on the total score for FIM motor items. In both groups, the total score for FIM motor items at discharge from the hospital were significantly higher than the score upon admission. This reflects the effects of rehabilitation during the hospital stay period by the occupational therapists and physiotherapists in charge of the individual patients. If the time needed for care is calculated from the FIM score, 20 corresponds to 32 minutes or more of care (care necessity level 1). At the time of discharge, 2 subjects in the PT group and 6 subjects in the non-PT group had FIM motor scores below 71. Thus, the number of subjects showing care necessity level 1 at the time of discharge was greater in the non-PT group than in the PT group.

The scores for items related to "walking" and "stairs" increased significantly only in the PT group. In this connection, there is a report that individuals having occlusal support are more likely to respond to physiotherapy.\textsuperscript{7} Thus, restoration of occlusal support by prosthodontic treatment may favorably affect the response to physiotherapy. The number of subjects requiring assistance at the time of discharge was greater in the non-PT group than in the PT group. The improvement at the time of discharge in the PT group was more frequent for the subjects who had a score of 1 for the items related to "walking" or "stairs." This indicates that the influence of prosthodontic treatment during the recovery period is greater in subjects having lower motor function upon admission.

Communication and social cognition
Because the subjects of this study were nondementia elderly patients, their total FIM cognitive scores upon admission were greater than that for demented patients. This score, however, was significantly increased at the time of discharge only in the PT group, while it remained unchanged in most subjects in the non-PT group. These findings together with those of previous reports that found improvement in oral function makes meals more enjoyable and stimulates esthetic demands, resulting in elevation of QOL.\textsuperscript{28, 29} suggest that the improvement in oral function and esthetics following prosthodontic treatment during a hospital stay increases the QOL of patients, resulting in stimulation of mental activity and improvement in scores related to FIM cognition. These changes may be helpful in preventing or alleviating withdrawal and cognitive dysfunction after discharge from the hospital.

CONCLUSIONS
We found that the PT group, who received prosthodontic treatment during the convalescent phase after the fracture, showed improvement in oral health-related QOL and masticatory performance, as well as good nutritional status. In addition, motor function, communication and social cognition improved in this group. Prosthodontic treatment exerted a favorable influence in an integral manner, rather than affecting only one item. These findings, support the statement of the care prevention manual that integral commitment is important for care prevention. It has also been reported that beginning rehabilitation soon after stabilization of symptoms is effective in facilitating functional recovery.\textsuperscript{13} For this reason, providing dental treatment at the earliest possible stage is considered important in enhancing rehabilitation and reducing the need for care during daily living.

The results of this study indicate that prosthodontic treatment during the convalescent phase is expected
not only to improve oral function but also to exert a favorable influence on care prevention in elderly patients with bone fractures resulting from falls.

We would like to thank Dr. Nobuyuki Tanaka, Dr. Masataka Itoda, Dr. Masako Kishima and other staff members of the Wakakukai Health Care Corporation, Wakakusa-Tatsuma Rehabilitation Hospital, and Emeritus professor Takayoshi Kawazoe of the Department of Fixed Prosthodontics and Occlusion, Osaka Dental University, for their kind advice and assistance. This study was supported in part by Osaka Dental University Research Funds (12–07). It was presented at the 535th meeting of the Osaka Odontological Society, October 13, 2012, Hirakata, Japan.

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