Correlation between Biting Force and Dementia

Bull. Univ. Osaka Pref., Ser. B, Vol.48
大阪府立大学紀要, 農学・生命科学, 1996

Correlation between Biting Force and Dementia

Takaaki MIYAKE, Norinaga SHIMIZU, Yoshimasa MATSUURA,
Shigeru TSUNODA, Masaru NAKAGAMI, Shoji MAKORO and Go TANAKA

Dept. of Health Sciences, College of Integrated Arts and Sciences

(Received October 31, 1995)

Abstract

We determined the maximum biting force and Hasegawa's Dementia Scale-Revised (HDS-R) score of subjects aged 65 years or older. The correlation coefficient between them was 0.511 in males and 0.701 in females, showing a significant correlation at the 0.1% level. A comparison of the maximum biting force between dementia and non-dementia groups using the t-test showed that it was significantly stronger in the non-dementia group than in the dementia group regardless of sex (at the 5% level for males and the 1% level for females). These results suggest that a decrease in the biting force may induce dementia and that maintenance of the masticatory function and biting force is needed in the old.

Introduction

The average Japanese life span is now the longest in the world: 76.25 years for males and 82.51 for females. This causes an unprecedentedly rapid increase in the elderly population. Persons aged 65 years or older accounted for only 4.9% of the total population in 1946 and 12.1 % in 1990. It will presumably amount to 17.0% in 2000 and 25.8% in 2025. The number of elderly patients with dementia has also been increasing. The incidence was 6.7% of the elderly population in 1990. It will presumably increase to 7.1% in 2000 and 8.6% in 2020, when the elderly population will reach a peak. Thus, senile dementia is becoming a serious social problem requiring comprehensive measures for such patients .

As is generally known, dementia is classified in two types; multi-infarct and Alzheimer. In both types, cerebral disorder due to abnormal loss of neurons involves impairment of memory and thought as well as changes in personality. Multi-infarct dementia is caused by multiple cerebral infarctions due to cerebral arteriosclerosis. Removing risk factors for arteriosclerosis can prevent this type[1]. The etiology of the Alzheimer type is still unknown. At present, it appears to be related to a unique, fibrous, abnormal protein called amyloid. It is said that prevention of amyloid β protein deposition is effective in avoiding the Alzheimer type[2].

Dementia has been studied in various fields, but there is no complete prevention of the disease. Although biting force is a useful indicator in evaluating masticatory functions[3–5], there has been

no report about the biting force of the aged. Animal experiments using mice by Kubota *et al.*[6] strongly suggested that masticatory functions are closely associated with the vital function system. They also indicated a correlation between masticatory movements and cerebral functions.

We examined the maximum biting force and dementia of subjects aged 65 years or older to study a correlation between them.

Subjects and Methods

Subjects were 105 adults aged 65 years or older, consisting of 56 inpatients(26 males and 30 females) in a geriatric hospital and 49 persons (22 males and 27 females) attending a lecture on health held in a public gymnasium. Hasegawa's Dementia Scale-Revised (HDS-R)[7] was used to evaluate their dementia. A total score was calculated for each subject. Subjects with a total score over 20 points were judged as "non-dementia" and those with a score of 20 or less as "dementia".

Maximum biting force was examined using a measuring device (MPM-3000, Nihon Kohden Kogyo Co., Ltd.). The force was determined three times each for right and left. The maximum biting force was the greatest value among the six measurements.

From the results for the examinations of dementia and the maximum biting force, a correlation coefficient by sex was obtained using the Spearman rank correlation coefficient. Based on the HDS-R score, the subjects were divided into dementia and non-dementia groups by sex. The score and the maximum biting force were compared by t-test. Since variance was not judged homogeneous, Welch's t-test was used.

Results

Table 1 shows the results for the evaluation of dementia using the HDS-R. Based on criteria of dementia, 18 males (37.5%) and 23 females (40.4%) were judged dementia. The non-dementia group consisted of 30 males (62.5%) and 34 females (59.6%). As a whole, 41 subjects (39.0%) were judged as dementia and 64 (61.0%) as non-dementia. These results show that approximately 40% of the subjects were judged as dementia and approximately 60% as non-dementia in each comparison. Thus, there was no bias by sex for dementia and non-dementia.

Table 1 Results of HDS-R score

	Male (%)	Female (%)	Total (%)
Dementia group	18 (37.5)	23 (40.4)	41 (39.0)
Non-dementia group	30 (62.5)	34 (59.6)	64 (61.0)

Table 2 shows the mean value and standard deviation of the maximum biting force in the dementia and non-dementia groups. The mean value for males was 5.5 kg in the dementia group and 14.2 kg in the non-dementia group. Biting force for females was 1.8 kg in the dementia group and 12.0 kg in the non-dementia group. These results show that the mean maxi-

mum biting force was stronger in the non-dementia group than in the dementia group regardless of sex. In addition, males showed a higher value than females in both groups. The t-test showed the maximum biting force was significantly stronger in the non-dementia group than in the dementia group at the 5% level for males and at the 1% level for females.

Table 2 Comparison of biting force between in dementia group and in non-dementia group

	Male			Female			Total		
	N	Mean(kg)	S.D.	N	Mean(kg)	S.D.	N	Mean(kg)	S.D.
Dementia group	18	5.5	9.4	23	1.8	1.7	41	3.4	6.5
Non-dementia group	30	14.2	13.9	34	12.0	2.4	64	13.0	12.9

Figures 1 and 2 show a correlation distribution of the HDS-R score and the maximum biting force based on the Spearman rank correlation coefficient. The correlation coefficient was 0.511 in males and 0.701 in females. Both values were significant at the 0.1% level, showing a correlation.

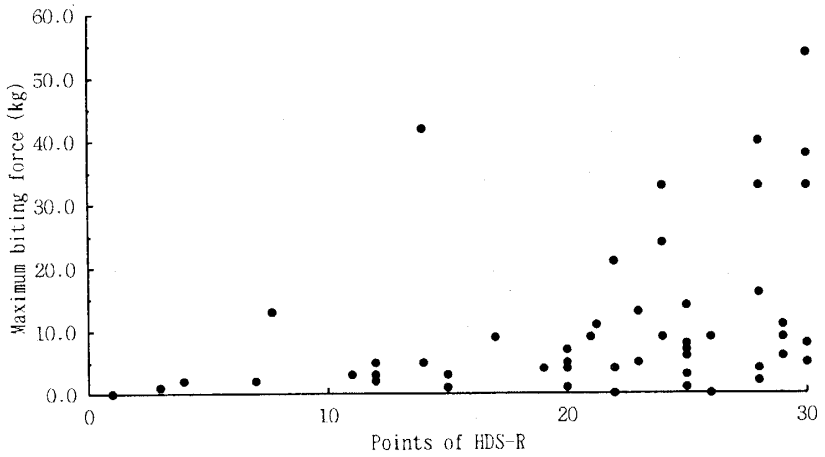

Fig. 1 Correlation between maximum biting forces and HDS-R scores in males.
Figure 1 shows a correlation distribution of the HDS-R score and the maximum biting force based on the Spearman rank correlation coefficient. The correlation coefficient was 0.511.

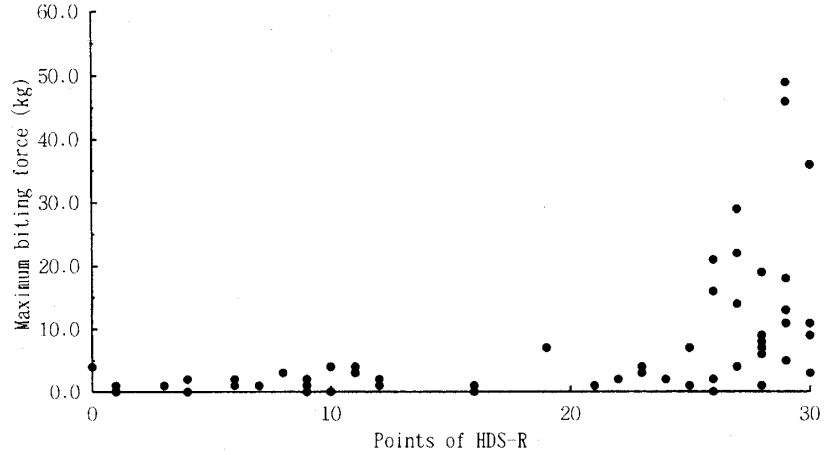

Fig. 2 Correlation between maximum biting forces and HDS-R scores in females.
Figure 2 shows a correlation distribution of the HDS-R score and the maximum biting force based on the Spearman rank correlation coefficient. The correlation coefficient was 0.701.

Discussion

In Japan, Hasegawa's Dementia Scale - Revised (HDS-R) has widely been used as a questionnaire to evaluate senile dementia because of its simplicity and reliability. It consists of nine questions about common sense, memory and so on. The educational level of a subject has no influence on this examination. It has high sensitivity and specificity in comparison with other methods. A close correlation exists between the HDS-R score and the Mini-Mental State Examination score which is most frequently used in other countries. Also, HDS-R is a highly reliable method[7]. Thus, we selected this scale for the present study.

In this study, we could not presume the severity of dementia because the number of subjects was as small as 105. However, we divided the subjects into dementia and non-dementia groups and succeeded in comparing the maximum biting force between them. Further study must be made to investigate a correlation between severity of dementia and biting force using a large number of subjects.

Kubota *et al.*[6] carried out a fundamental study on the masticatory system using the biting force as its indicator. They clarified that a decrease in the biting force reflects the health status and vital function system. In addition, their animal experiment using mice clearly demonstrated that blocking somatosensory input of the trigeminal nerve obviously decreases the vital functions. It suggests a correlation between the masticatory system and the vital functions. Based on studies of the relationship between biting force and development of intelligence in kindergarten children, Funakoshi *et al.*[4] indicated a correlation between the biting force and cerebral functions. Morimoto[8] reported that the mastication is a complex movement with controlled by a central program in the brain stem using many reflexes. It showed that the stimulation of masticatory movements is regulated in the brain stem. A decrease in stimulation to the brain has been studied as a cause of dementia. It appears that dementia is induced by the cerebral dysfunction resulting from a decrease in the stimulation to the nervous system in the aged. The brain is usually stimulated through the sensory system, but some input comes through the motor system. It is believed that masticatory movements provide a stimulus to the brain. From a point of view of both the cerebral development and prevention of dementia, mastication is an important stimulus to the cerebral function. Therefore, a decrease in the biting force is crucially related to dementia as one of the accelerating factors. In the present study, the results of the t-test showed that the maximum biting force was significantly stronger in non-dementia group than in the dementia group at the 5% level for males and at the 1% level for females. This supports the results obtained by Kubota *et al*[6]. A decrease in biting force is obviously a factor in accelerating dementia.

Bowen *et al.*[9] found that a decrease in acetylcholine synthetase in the cholinergic nerve is related to dementia. Subsequently, it has been clarified that various abnormalities of neurotransmitters have an effect on dementia. The role of the reticular formation, especially the noradrenergic neurons in the locus ceruleus of the brain stem, is now in the spotlight as the cerebral function for consciousness and concentration. The mastication stimulates the reticular formation, especially the locus ceruleus of the brain stem through the trigeminal nerve. Finally, concentration is focused resulting in improved learning ability. Therefore, it can easily be presumed that nervous dysfunction in this system may induce or worsen dementia symptoms. Since senile de-

mentia is characterized by a decrease in spontaneity, it can also be presumed that it lessens masticatory movements and thus the biting force, which induces dementia.

Conclusion

We determined the maximum biting force and HDS-R score of subjects aged 65 years or older. The correlation coefficient between them was 0.511 in males and 0.701 in females, showing a significant correlation at the 0.1% level. A comparison of the maximum biting force between dementia and non-dementia groups using the t-test showed that it was significantly stronger in the non-dementia group than in the dementia group regardless of sex (at the 5% level for males and the 1% level for females). These results suggest that a decrease in the biting force may induce dementia and that maintenance of the masticatory function and biting force is needed in the old.

References

1) TOHGI, H., CHIBA, K., and SASAKI, K. (1988). Pathophysiology of multi-infarct dementia. *Advances in Neurological Sciences*, **32**, 284-295.
2) HIRAI, S. (1994). Cerebral amyloidosis, Alzheimer's disease and amyloid degeneration. *Brain and Nerve*, **46**, 455-462.
3) HIROSE, N. (1988). Relationship between bite forces and EMG activities of masticatory muscles in children. *Japanese Journal of Pedodontics*, **26**, 97-111.
4) FUNAKOSHI, M., KAWAMURA, S., FUJIWARA, H., HAZAMA, T., and SAHASHI, K. (1988). Relationship between biting force and intelligent test. *J. Gif. Dent. Soc.*, **15**, 392-397.
5) IWASAKI, H., INABA, R., and IWATA, H. (1994). Biting force and physical fitness in athletes. *Jpn. J. Hyg.*, **49**, 654-659.
6) KUBOTA, K., LEE, M., CHANG, C., NARITA., N., HOSAKA, K., SONODA, Y., NAGAE, K., SHIBANAI, S., KAWAMOTO, T., and ODAGIRI, N. (1988). The role of sensory input and its significance in the masticatory system. *J. Stomatol. Soc. Jpn.*, **55**, 269-282.
7) HOMMA, A. (1993). Assessment of dementia symptoms. *Brain and Nerve*, **45**, 1119-1133.
8) MORIMOTO, T. (1993). Masticatory movements and jaw reflexes. *Advances in Neurological Sciences*, **37**, 834-844.
9) BOWEN, D.M., SMITH, C.B., WHITE, P., and DAVISON, A.N. (1976). Neurotransmitter-related enzymes and indices of hypoxia in senile dementia and other abiotrophies. *Brain*, **99**, 457-496.