Screening Method of Dementia Using Odor

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Abstract
The medical inspection which detects the dementia in early stage is difficult because elderly persons have a negative impression to the inspection. For this reason, the purpose of this study is to propose a screening method which can detect the dementia by using the simple olfactory identification test. Authors focused on the deterioration of the olfactory function. Before the investigation, authors selected the seven odors which can be easily identified and which has not uncomfortable impression. These seven odors were selected among twelve odors that are included in OSIT-J. OSIT-J is an identification test of odor to evaluate the olfactory function. Experimental participants were eight healthy elderly people and fifty-five elderly people with dementia living at the nursing home. As a result, we clarified that olfactory function of elderly people with dementia is significantly deteriorated (p<0.01) than healthy elderly people. In the results of receiver operating characteristic (ROC) analysis, we clarified that the investigation using seven odors has high accuracy to screen dementia (Area Under the Curve : AUC=0.93). Through these investigations results, we devised a method which can screen 85% of dementia patients accurately. The devised method may detect the dementia more accurately by increasing the experimental participants.

Keywords: Dementia, Screening method, Odor, Olfactory function

1. Introduction
Dementia is desired to be detect and diagnose in early stage, but conventional inspections are difficult to detect the dementia in early stage. Conventional inspections of dementia consists of interview-type method and diagnostic imaging type method, and so on. However, interview-type hurts the self-esteem of patients by asking extremely easy questions. In addition, these inspections have a possibility which provides different results by examiner because the method is a subjective assessment. Inspections of imaging diagnostic-type are used to identify dementia type usually. Therefore, this inspection is not used to detect the dementia. Conventional inspections need expert knowledge and technique. In this reason, patients have to visit to specialized medical facilities to receive the inspections of dementia. However, they will not receive the inspections voluntarily because they have psychological resistance to the dementia.

Some types of dementia are reported that the olfactory function is deteriorated in early stage. Screening methods focusing on this deterioration are reported already. However, these methods have a possibility which gives fear and discomfort to the patients because this detection uses or more odors and the stink.

Therefore, we aimed to establish screening method of dementia that focused on deterioration of olfactory function. In this study, we will devise a screening method of dementia which gives little mental and physical burdens for patients.

This study investigates how to detect a dementia in the elderly. The investigation is undesirable to give mental and physical burdens to them. Therefore, we conducted the preliminary investigation to young people before we investigated elderly people. And we will consider investigation conditions which give little physical and mental burdens to the patients.

We will analyze the relationship between presence of dementia and olfactory function by comparing healthy elderly people and elderly people with dementia.

2. Investigation conditions which targeted elderly
2.1 Summary of preliminary investigation
The investigation needs to avoid giving psychological resistance and disgust against investigation. Therefore, it is undesirable to use odors which are not identified easily and which does not give uncomfortable impression to the patients. The purpose of the preliminary investigation is to select some odors which can be easily identified and which do not have uncomfortable impression, if olfactory function and cognitive function are normal. This investigation used OSIT-J (Daiichi Yakuhin Sangyo Co. Ltd., Tokyo, Japan) which is a test kit of olfactory function. In this study, the task which used the OSIT-J is called "olfactory task". From this score, we selected the candidates of odors to be used in the investigation for elderly people. In addition to this, we investigated the impression of each odors by questionnaires when participants sniffed them. This investigation was conducted among young people.

This investigation contents were checked in detail by experimental ethics committee of Kagawa University, Faculty of Engineering.
2.2 Evaluation indexes

2.2.1 Olfactory task score
Preliminary investigation used OSIT-J which is an identification test of odors to evaluate the olfactory function. This kit is composed of twelve odors which are familiar to Japanese people (Timber, Menthol, Indian ink, Rose, Cooking gas, Orange, Roasted garlic, Condensed milk, Perfume, Sweaty smelling clothes, Japanese cypress, Curry).

The score obtained by olfactory task quantifies the failure of olfactory function and the deterioration level. From the olfactory task score, we evaluated odors that healthy people can identify easily and which do not have uncomfortable impression to them.

2.2.2 Questionnaire
In order to investigate the physical and mental burden, the questionnaire was conducted after participants sniffed the odors. This questionnaire includes the discomfort level and familiarity of each odor. Discomfort level is evaluated by six step evaluation (-3, -2, -1, 1, 2, 3). The positive value shows “comfort”, and the negative value shows “discomfort”.

2.3 Procedure of preliminary investigation
The procedure of preliminary investigation is shown in Fig.1. Participants sniffed the paper which applied odor stick. Next, they selected the odor which is presented from six choices, and they answered to the questionnaire regarding discomfort level and familiarity. They conducted these procedure repeatedly in twelve odors.

![Procedure of preliminary investigation](image1)

Fig. 1 Procedure of preliminary investigation

2.4 Preliminary investigation participants
In order to select odors which can be identified correctly if the olfactory function is normal, the investigation was conducted among young people who did not show deterioration of olfactory function with age.

Participants were fourteen male students (Average age : 22 years old, Standard deviation (SD) ± 0.97) who got an informed consent before the investigation. They were confirmed to be not having olfactory disorder in advance.

2.5 Preliminary investigation results
The percentage of correct answers of the twelve odors is shown in Fig.2, and the discomfort level of the twelve odors is shown in Fig.3. From these results, it is shown that the odors which showed high percentage of correct answers were often classified into “comfortable”. In addition, many participants felt the familiarity to these odors. From the results of Fig.2 and Fig.3, there are seven odors that the percentage of correct answers are higher than the average value (73.2 percent) among twelve odors and did not give uncomfortable impression. (Menthol, Indian ink, Rose, Orange, Condensed milk, Perfume, Curry)

However, we confirmed the change of physical condition such as headaches and dizziness when participants sniffed the odor of "perfume". In addition, the odor of "Japanese cypress" showed the percentage of correct answer which is close to the average value of twelve odors (73.2 percent), and it gave comfortable impression to the participants than other odors when participants sniffed this odor.

![The percentage of correct answers of the twelve odors](image2)

Fig. 2 The percentage of correct answers of the twelve odors

![The discomfort level of the twelve odors](image3)

Fig. 3 The discomfort level of the twelve odors

2.6 Selected odors for clinical investigation
In the results of preliminary investigation, we evaluated seven odors which can be easily identified and which does not uncomfortable impression, if the olfactory function is normal (Menthol, Indian ink, Rose, Orange, Condensed milk, Perfume, Curry). However, the odor of "perfume" was estimated unsuitable to use in clinical investigation because the participants were confirmed negative change of physical condition when they sniffed this odor.

Regarding the odor of "Japanese cypress", it is considered that is possible to use in clinical investigation because it showed the percentage of correct answer close...
to the average value of twelve odors (73.2 percent) and it gave comfortable impression than other odors. Therefore, clinical investigation used the following seven odors (Menthol, Indian ink, Rose, Orange, Condensed milk, Japanese cypress, Curry).

3. Difference of olfactory function by the presence of dementia

3.1 Purpose of clinical investigation

We investigated the difference of olfactory function to clarify the presence of dementia using the seven odors which were selected from the results of the preliminary investigation. The clinical investigation aimed to clarify the olfactory task score which is possible to screen the dementia.

3.2 Conditions of clinical investigation

3.2.1 Used odors in clinical investigation

The clinical investigation used seven odors which can be easily identified and which does not give uncomfortable impression, if the olfactory function is normal (Menthol, Indian ink, Rose, Orange, Condensed milk, Japanese cypress, Curry).

3.2.2 Procedure of investigation

This investigation used seven odors which were selected in twelve odors. The procedure of investigation is shown in Fig.4. Participants sniffed the paper which applied odor stick. Next, they selected the odor which was presented among six choices. After that, they got a break over thirty seconds to prevent the fatigue of olfactory function. They conducted these procedure repeatedly in seven odors.

Fig.4  Procedure of investigation

This investigation contents were checked by experimental ethics committee of Kagawa University Faculty of Engineering and the nursing care insurance facilities in advance.

3.3 The constitution of investigation participants

The participants were sixty-three elderly people (Average age : 84 years old, SD ± 7.20) who got the informed consent enough before the investigation. We confirmed that they did not have olfactory failure in advance. The following is the constitution of participants.

1) Healthy elderly people : 8 people (Average age : 75.3 years old, SD ± 3.46)
2) Rank I of elderly people with dementia (mild) : 17 people (Average age : 84.2 years old, SD ± 5.85)
3) Rank II of elderly people with dementia (moderate) : 22 people (Average age : 87.2 years old, SD ± 7.37)
4) Rank III of elderly people with dementia (severe) : 17 people (Average age : 87.1 years old, SD ± 5.88)

These rank were evaluated by independence degree of daily living for the elderly with dementia[4] (independence degree of daily living). The increase of ranks of this index means the severity of dementia. Severity in parentheses was determined on the basis of the method for predicting the HDS-R scores from independence degree of daily living[5].

3.4 Relation of olfactory function and the presence of dementia

The olfactory task scores obtained by healthy elderly people and elderly people with dementia was compared. Average number of correct answer of olfactory task between healthy elderly people and elderly people with dementia is shown in Fig.5.

Fig.5  Average number of correct answers in olfactory task between healthy elderly people and elderly people with dementia (** : P<0.01)

We conducted statistical t-test to clarify the difference of olfactory task average score between each participants. As a result, we clarified that the olfactory function of elderly people with dementia is significantly deteriorated (p<0.01) than healthy elderly people. This result shows that dementia patients deteriorate the identification capability of odors because all participants could detect odors. These results are consistent with previous researches[1,2]. Therefore, the screening method using seven odors have a possibility which screens the dementia.

4. Optimal threshold for screening dementia

We conducted Receiver Operating Characteristic (ROC) analysis to set the optimal threshold for screening of dementia. In addition, sensitivity and false positive rate of the olfactory task score were calculated. The ROC
Curve is shown in Fig.6. From the results of Fig.6, we calculated Area Under the Curve (AUC). The value of AUC mean which have high accuracy for screening when it approaches to 1.0. This result (AUC=0.93) showed that the investigation using seven odors has high accuracy for screening dementia. According to the ROC analysis, the optimal threshold is the corresponding score located closest to the coordinates (0, 1). Therefore, three points of olfactory task score is suggested the optimal threshold. This case showed that the threshold has a sensitivity of seventy-five percent and a false positive rate of zero percent.

![ROC Curve Image]

**5. Screening method of dementia using odors**

This study devised screening method using the following seven odors (Menthol, Indian ink, Rose, Orange, Condensed milk, Japanese cypress, Curry). According to the results of ROC analysis, the threshold for screening dementia is suitable to set three points of olfactory task score. However, if the threshold was set at three points or less, the result showed that 25.5 percent of olfactory task score. This method defined as "olfactory task" because we hope to recommend people to prevent the the risk of dementia. If the screening dementia was overlooked, there is the possibility that symptoms of dementia deteriorate further. Therefore, if the threshold was set at four points or less, we think it is possible to minimize the overlook of dementia. In this case, twenty-five percent of healthy people are classified into dementia incorrectly. However, it is able to recommend them a measure to prevent the risk of dementia by using olfactory task.

![Flowchart Image]

**6. Conclusion**

We think that devised screening method using odors is possible to minimize the physical burden against inspection of dementia, because it does not give the image of medical inspection almost. Furthermore, it is possible to minimize the physical burden because the investigation participants in the future. From the results of clinical investigation, the dementia patients suggested the deterioration of identification capability of odor than health people. However, we couldn't confirm the difference of olfactory task scores between each rank of independence degree of daily living. As this reason, we thought that difference among individuals affected on olfactory task scores widely. Therefore, the devised method is able to screen the dementia severity by increasing the investigation participants in the future.

**7. References**


