# Dental Informatics tool "SOFPRO" for the study of oral submucous fibrosis

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## Abstract

**Background:** Dental informatics is an evolving branch widely used in dental education and practice. Numerous applications that support clinical care, education and research have been developed. However, very few such applications are developed and utilized in the epidemiological studies of oral submucous fibrosis (OSF) which is affecting a significant population of Asian countries.

**Aims and Objectives:** To design and develop an user friendly software for the descriptive epidemiological study of OSF.

**Materials and Methods:** With the help of a software engineer a computer program SOFPRO was designed and developed by using, Ms-Visual Basic 6.0 (VB), Ms-Access 2000, Crystal Report 7.0 and Ms-Paint in operating system XP. For the analysis purpose the available OSF data from the departmental precancer registry was fed into the SOFPRO.

**Results:** Known data, not known and null data are successfully accepted in data entry and represented in data analysis of OSF. Smooth working of SOFPRO and its correct data flow was tested against real-time data of OSF.

**Conclusion:** SOFPRO was found to be a user friendly automated tool for easy data collection, retrieval, management and analysis of OSF patients.

**Key Words:** Dental informatics, descriptive epidemiology, oral submucous fibrosis, SOFPRO software

## INTRODUCTION

Dental informatics is a relatively new field that has significant potential for application of computer and information sciences to improve dental research, education and management. This new way to practice dentistry will require the second-generation dental records and decision support software which, while running in the background, will connect diagnostic findings and patients problems to a regularly updated knowledge base. Numerous applications that support clinical care, education and research have been developed. Dental informatics is beginning to exhibit the characteristics of a discipline: Core literature, trained specialists and educational programs.[1-3]

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Oral submucous fibrosis (OSF) is a multifactorial premalignant condition caused mainly by *Areca* nut, betel quid, tobacco chewing habits and nutritional deficiencies. Many *in vivo* and *in vitro* studies have confirmed the above implications. A worldwide estimate in 1996 indicated that 2.5 million people were affected by the disease.[4]

Our Dental College and Hospital since 1997 has got registry in oral cancer and precancer. Till date, a total of 2000 OSF cases have been registered by the Department of Oral Pathology and Microbiology.

This huge epidemiological data will definitely throw light on the complex nature of OSF and its association with various chewing habits. However, to study and handle such large-scale epidemiological data, the help of a computer is inevitable.

Data entry in the computer for its compilation would be a Herculean task. Prior to advent of graphical user interface (GUI) softwares, commonly employed methods for dental epidemiological data collection and data entry were use of punch card and scanning of special forms by the clinician.

Hence, it was thought to develop a user-friendly software program for a personal computer to study the descriptive epidemiology of OSF, which will be easy to handle, very economical and facilitate "online" data feeding, which will be faster and error free.

## MATERIALS AND METHODS

With the help of computer experts, we planned to design and develop an automated user-friendly tool "SOFPRO" (an acronym for a computer program for the study of OSF) for the study of OSF patients, with GUI support, for easy data collection, organization, retrieval, management and analysis. Designing a suitable "form" for data entry and "format" for storage of information (computer screens) was done with little modification in the structure of case record form which was previously developed by the expert Oral Pathologist.

We used a personal computer with the standard configuration of the hardware, consisting of Windows XP, Ms-Visual Basic 6.0 (VB), Ms-Access 2000, Crystal Report 7.0 and Ms-Paint.

Windows XP is an operating system which supports GUI and is a secure environment that provides support to VB 6.0. MS-Access was used so that it can also provide support for networking and other required features.

a. With the use of VB 6.0, utility "form" used to design the GUI screen for data entry purpose. A total of 27 screens were developed. Data flow was designed. The forms were segregated as per the concepts of relational database management design and its concepts to capture the accurate information from patients. The forms were also designed to be user-friendly by giving the functionality of "Add," "Edit," "Delete" and "Save," which will insert, modify, delete or commit data in database in backend

b. Database was designed to acquire minimum space in the hard disk of machine. Database plays a key role in the software and hence was designed with due considerations and importance. Different tables with unique data fields were designed so as to avoid redundancy of data. Ms-Access was used as database, and Structured Query Language (SQL) queries were designed to extract the required data based on parameters provided. The Ms-Access relational database concepts helped to reduce the memory size used by database to increase the response time and minimum memory consumption

c. Social feasibility that is applicability was used in designing the software so that the software should be accepted by the user, i.e. clinician, data entry operator as well as statistician

d. Statistician was interviewed time-to-time to make the necessary changes in the design so that it will suffice all requirements of descriptive epidemiological study. Great amount of time was dedicated to design phase of software, keeping in view the future need and extension of project

e. Minimum key hits were designed for ease of data entry. For example, response to a question about type of *Areca* habit, may be in four different forms such as fresh, boiled, fermented or roasted, so list of responses was developed so that data entry operator only needs to choose the correct response from the list

f. The different analysis to be performed was planned and designed accordingly, such as gender distribution, habit patterns, age-wise distribution and symptoms

g. Graphical representations were designed to represent the analysis in the form of charts, bar diagrams, pie and line diagrams

h. Reports were designed for summary fact sheets. Thus, reports extracted from database were presented using the templates of crystal report's reporting tool. Further, VB chart control was used to represent the graphical analysis of extracted data produced by SQL queries

i. The application also covers the imaginary representation of oral health of patient which describes the extent of oral fibrosis. Ms-Paint brush was used to record the color legend to show the extent of oral fibrosis. The file gets saved with unique patient Id. "Yellow" was used to show the "Blanching,""Green"used to show "Fibrous Bands,""Brown" for "Pigmentation" and "Red" for "Malignant Ulcer"

j. Development: Development process was carried out using VB forms for GUI screens. Coding was done using VB Script. Database was developed using MS-Access. Reports developed using data report utility of VB. Standard setup was developed for distribution of the package

k. Testing: Testing of software was carried out using the real-time data available in the department from year January 2000. The errors were identified and rectified at time of testing to judge the smooth working and correct data flow

l. Post implementation maintenance: Once the software is implemented, it needs to be observed. In case of system crash, the software may get lost or data may get lost. Hence, all precautions and measures were taken for security of data

m. The correct data files were now loaded in the computer through data evaluation module and were processed to get result in tabular forms. Correctness of the result was checked, compared and confirmed with tables prepared manually. All above steps confirmed the successful working

of the software "SOFPRO," which was designed and developed.

## RESULTS

The data were fed manually in the different forms such as patients' demographic details, habit patterns, clinical examination, clinical diagnosis, treatment given and follow-up. On each screen, "Save and Next" functionality is provided where data will be saved in respective tables behind the user-friendly screens due to data coding.

The case records of 1000 OSF patients were entered in "SOFPRO" and results with predetermined aims were obtained in graphical format. The software was successfully designed and an automated user-friendly tool "SOFPRO" was developed for the study of OSF patients, with GUI support, for easy data collection, organization, retrieval, management and analysis. Figures 1a-d and 2a-d show features of "SOFPRO." It allows effective retrieval and modification, deletion of the existing data of OSF patients [Figures 3a, b,
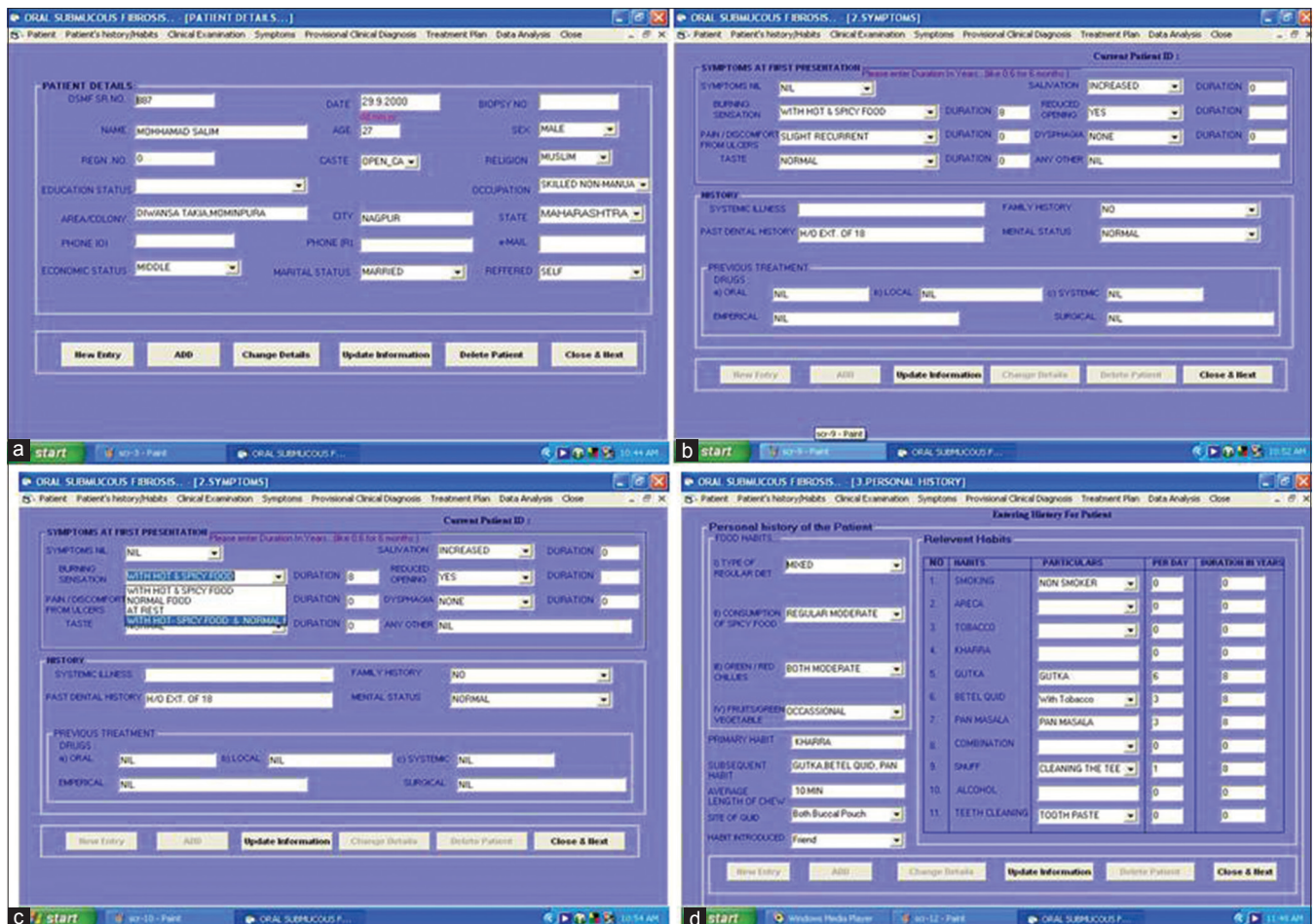


**Figure 1:** (a) The screen of demographic data collection, (b) the screen of patients' symptoms at first presentation, (c) screen representing symptoms and (d) screen representing patients personal history including habits
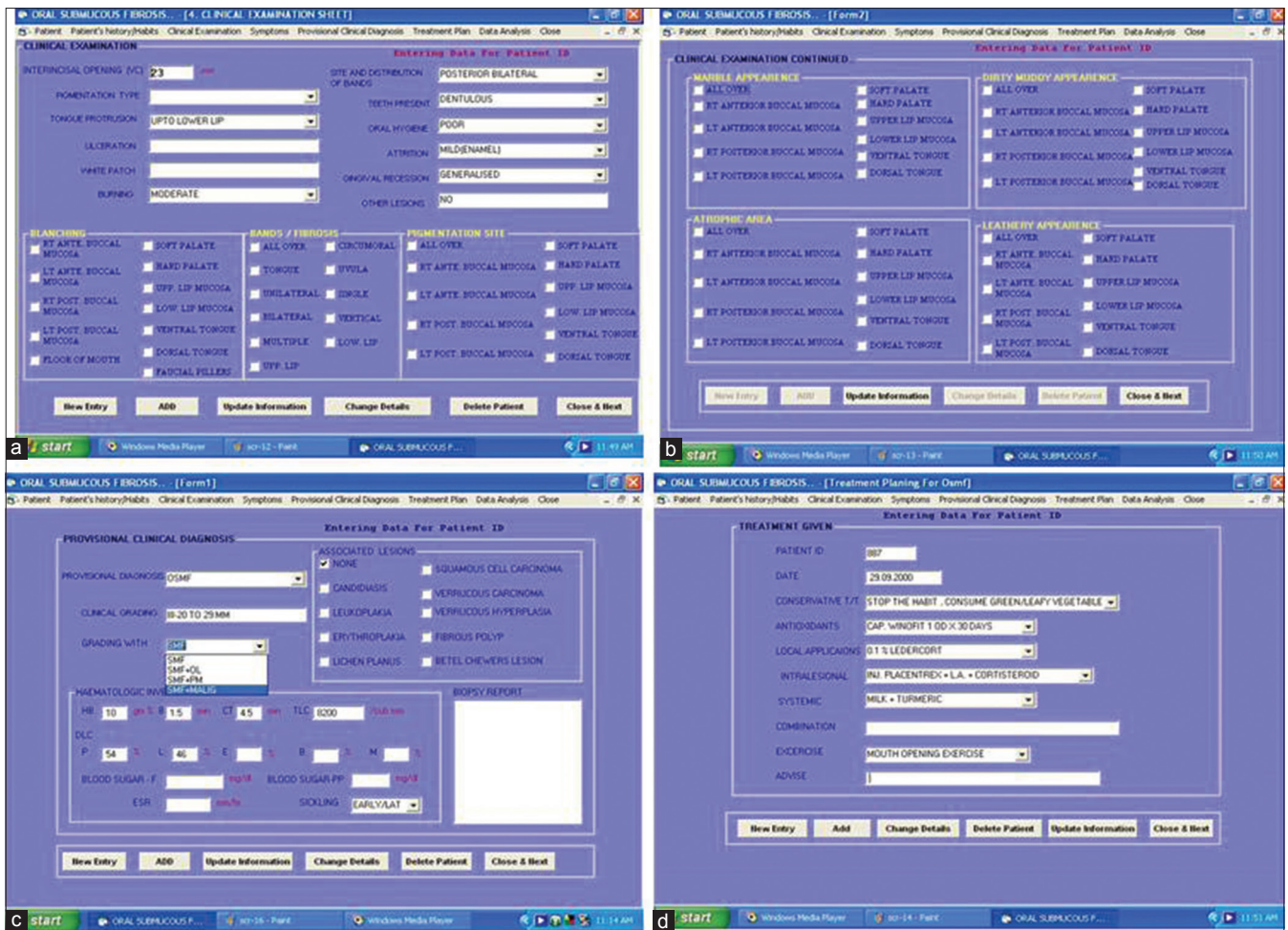
**Figure 2:** (a and b) Screen representing clinical examination of the patient, (c) screen showing provisional diagnosis with included investigation data, (d) representing screen for treatment planning
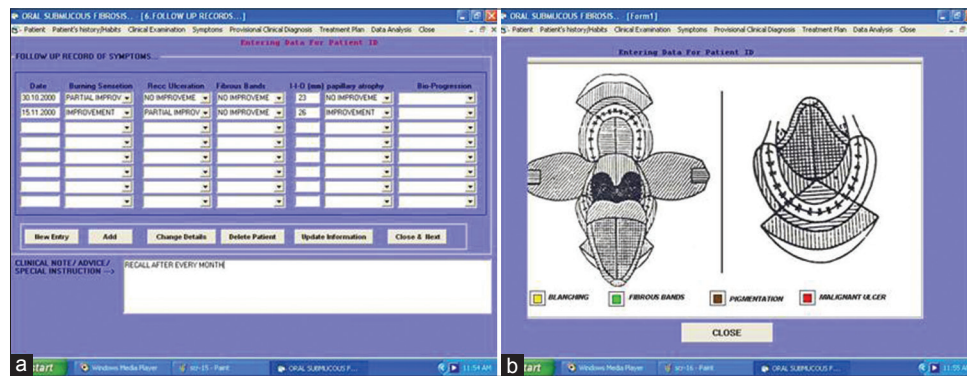


**Figure 3:** (a and b) Representing screen for follow-up

4a-d and 5a, b]. The database requires minimum space on the hard disk of the personal computer. Different tables with unique data fields were designed so as to avoid redundancy of data. It facilitates effective report generation of data in textual forms (in soft and hard form). As a result of GUI screens, user having introductory knowledge of computer can effectively handle "SOFPRO;" hence, it is socially feasible."SOFPRO"

is portable and distributable over local area network (LAN) for multiple users."SOFPRO" is economically feasible as it is compatible with minimum hardware configurations such as Pentium III/IV CPU, monitor, keyboard, mouse, printer and commonly available operating system such as Windows 9x/Millennium/XP. Single click information for less key press with number of drop-downlists makes"SOFPRO" more

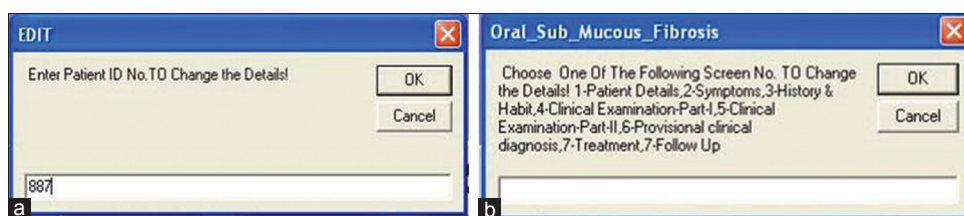**Figure 4:** (a-d) Representing screens for patient data retrieval



**Figure 5:** (a and b) Representing screens for allowing change in patients details

user-friendly. Minimum key hits were designed for data entry operator. We successfully converted the paper data to digital data and overcame the problem of manual maintenance of case files from environmental elements such as dust and moist, and it overcomes the problem of management of voluminous information, loss of information, searching a particular patient, maintaining follow-up, biopsy reports and identifying effective treatment modalities. This is effectively facilitated by ease in manipulation and updating of records as a unique case number to each case report.

Ms-Access (database) and SQL was used to analyze the data. When a button on software is pressed, it triggers the SQL query attached to the button. The query in turn finds out the logical information from different tables in database and collects the required information, which is ready to be presented either in report or in graphical chart format. Output on frontend, Ms-Graph control was used to represent these analyzed cases, and graph legends were configured for better scale representation. Multiple queries were run in the background to create the output on different screens.

Once the data of OSF patients are fed in SOFPRO, the epidemiological data can be easily analyzed with the click of a button. This software currently gives age and gender distribution of affected patients with OSF. In addition, it elaborates their religion and analysis of demography. The affected population can also be analyzed with a click of a

button in regards to the most prevalent habit patterns, duration of habit or no habit at all. Even this software has a facility to represent pie diagram of patients having exclusive *Areca* nut habit. Detail data analysis with graphical representations such as charts, bar and line diagrams of different parameters is generated in relation to various symptoms of diseases such as burning sensation, inability to open mouth and recurrent ulceration. The histopathological grading can also be correlated with severity of OSF. The bio-progression tab will give the feedback data and guides the user clinician about malignant transformation of disease in a consecutive follow-up. SOFPRO is unique in regards to mapping and analyzing the OSF patients who have other lesions such as lichen planus, leukoplakia, carcinoma *in situ* and candidiasis. This feature enables the clinician to point out the patients who require frequent clinical monitoring to prevent any lethal change in patient's oral cavity and thus, increase the longevity and alley the progression of OSF [Figure 6].

For the smooth working and correct data flow, "SOFPRO" was tested against real-time data of OSF available as department records. Known data, not known and null data are successfully accepted in data entry and represented in data analysis.

## DISCUSSION

OSF is a chronic oral mucosal disease characterized by inflammation and progressive fibrosis of lamina propria and the
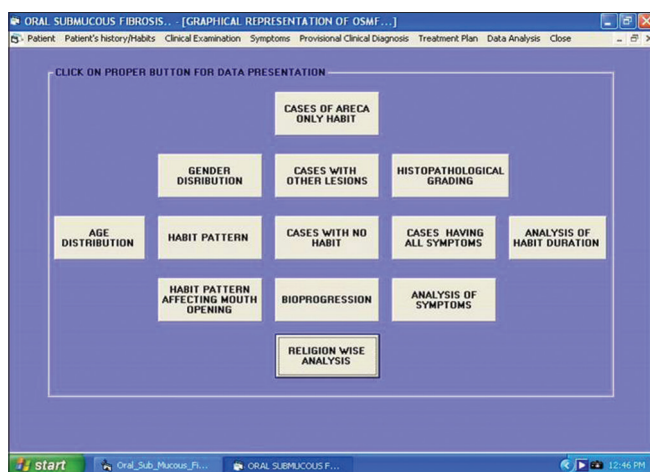
**Figure 6:** Data analysis in graphical form for oral submucous fibrosis

underlying submucosal layer of the oral cavity. The pathogenesis of the disease is believed to be multifactorial.

Many epidemiological studies from India[5-9] and abroad,[10-14] have shown that chewing *Areca* nut (*Areca catechu*) is the major etiological factor for OSF. Many patients with OSF have other habits concurrently, which may also play a role in the initiation and the progress of this premalignant condition. The disease affects around 2.5 million people worldwide. The statistics of OSF in Indian subcontinent alone in 2002 was about 5 million people (0.5% of the population of India).[15] This indicates that the worldwide estimates will be much higher in the future. Hence, OSF is considered as a public health issue in many parts of the world, including the UK, South Africa and many Asian countries such as India.

It is thus necessary to probe the complexity of OSF and role of high-risk factors and various chewing habits. A large-scale epidemiological survey and data analysis through modern equipment such as computers would probably throw light on this issue. The thought of computer software program for collection of huge epidemiological data, which will also perform large-scale descriptive analysis, was the silver line in the design and development of dedicated software tool, "SOFPRO".

Dental informatics is an emerging branch of bioinformatics that deals with application of computer and information technology to improve dental research, education and management. Clinical pathology was first to accept mechanical data processing, because information expressed was in numericals and is ideal for data processing. In oral pathology, Fischman *et al.*[16] were the first to use electronic data processing.

In the development of "SOFPRO," Microsoft VB tool was selected as the main application development environment. VB Script is the most leading and preferred language for application development because it handles the most difficult and complicated steps involved with ease of writing the code.

By dragging the various active X controls on "form" window of VB tool, data entry screens were developed. VB is an advanced high-level language, which facilitates static checking of syntax, which in turn corrects the syntactic errors while code writing. It also helps to debug the program in runtime environment, which is helpful for testing the code for validation at design time.

Good database design is the keystone to software performance. Data files for "SOFPRO" were designed using Microsoft-Access as it is portable with other application tools such as Intercooled Stata and Excel.

Tables, forms, reports and database element were defined and created separately in a tabulated manner, for example, ID, name, age, sex, address, religion, etc., for the collection of patients' demographic details. Likewise, the database design was done for all data entry heads.

Once the exacting task of defining the data heads was complete, the writing of computer program was taken up. Visual Basic language has flexible grammar that helps in a way that any statement having syntactic error will not be accepted and executed. This helped in smooth running of the program and resulted in correct data entries.

Since the last three decades, so many workers have tried to develop different computer systems for pathology in general and oral pathology in particular. Myers in 1975[17] developed computer-retrievable systems for pathology, Robboy *et al.*[18] developed a computer-assisted pathology encoding and reporting system, "CAPER."

Pieper *et al.*[19] developed a microcomputer-based portable system for recording dental epidemiologic data. Priddy *et al.*[20] developed an oral pathology data management system for an oral tissue diagnostic program and Quivey *et al.*[21] developed a computer program for the analysis of data from rat caries.

The computer program "SOFPRO" developed in the present study was found to be much more advanced and user-friendly than the above computer programs because in the past computer languages were very primitive and computers had less data storing capacity.

Abramson[22] developed the four PEPI-for-Windows (WINPEPI) computer programs for epidemiologist namely DESCRIBES, COMPARE2, PAIRSect and WHATIS. The DESCRIBE programs are developed for use in descriptive epidemiology in practice and research in the health field. They aim to complement other statistical packages.

The present computer program"SOFPRO"was found to as advanced as WINPEPI's DESCRIBE program for use in descriptive epidemiology.

The facility to analyze large quantities of data is an important feature of the "SOFPRO"system. The different heading options allow the users quick analysis at a finger touch. "SOFPRO" allows effective retrieval and modification or deletion on the existing data of OSF patients.

The database requires minimum space on the hard disk of personal computers. Different tables with unique data fields were designed so as to avoid redundancy of data. It facilitates effective report generation of data in textual forms. As a result of GUI screens, users having introductory knowledge of computer can effectively handle "SOFPRO." Hence, it is socially feasible, found to be portable and distributable over LAN for multiple users.

The first head was demographic analysis of age, sex, education, religion and socioeconomic status. In the second head, data analysis of different habit patterns such as exclusive habits with their duration and mouth opening and detail analysis of multiple habit patterns is possible. Third, in clinical analysis part, various symptoms, gender-wise clinical grading, other associated lesions and bioprogression of OSF patients are made possible.

"SOFPRO" successfully generated the above results. At present, "SOFPRO" does not provide analytical data management facilities.

Hence, statistical package "Intercooled STATA version 8.0' (STATA corporation, Lakeway, TX, USA) was used for the remaining statistical analysis.

In the development of "SOFPRO," we required minimum cost, equipment, training and time. Thus, our system proves to be economical and useful for clinical research.

The development of "SOFPRO"is a baseline study on which newer technologies such as "Cloud Computing,""Simulation" and "Artificial Intelligence" or we can simply develop "Android App" which can be incorporated to improve the understanding of this crippling Indian disease. At present, the work is under progress for such an ambitious project.

## CONCLUSION

We designed and developed "SOFPRO" an automated tool for easy data collection, organization, retrieval, management and analysis of OSF patients. " It can be a valuable aid in teaching or in the rapid testing of new ideas that are being considered for more detailed clinical research on OSF. By making this program available on the internet, large international epidemiological studies on OSF can be made possible. We propose to introduce in near future "SOFPRO" as a mobile friendly application for the clinicians and researchers more handy and user friendly.

### Conflicts of interest
There are no conflicts of interest.

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