"USE OF SIVA-P3 COUGH MONITOR TO DETECT RISK OF DYSFAGIA IN STABLE ALS PATIENTS"

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Introduction

Cough is a natural airway defence manoeuvre, a complex manoeuvre involving multiple muscles that can respond to a voluntary or reflex action(1). It is often associated with respiratory infections and the presence of external agents in the respiratory tract. Monitoring this sign has allowed progress in a technically complex diagnosis in entities such as chronic cough (2,3). However, in amyotrophic lateral sclerosis (ALS), since respiratory infections are an important cause of morbimortality, and silent bronchoaspirations in the context of dysphagia are common, cough assessment is part of the standard care. The control of bronchoaspiration episodes during eating measured by an intelligent cough detector could represent a paradigm for detecting dysphagia in very early stages of bulbar alteration.

Videofluoroscopic swallowing study (VFSS) is the gold standard test to determine the presence of dysphagia(4). This examination, requires an expensive technology, move the patients to the hospital and also emit radiation to the patients during the measurement. It has been studied other test less harmful for the patients but the results were not promising(5).

ALS patients are risk population to suffer dysphagia thus early detection is mandatory in these cases, so several bedside screening tests are employed in regular clinics. Several studies have demonstrated that a formalized dysphagia screening and assessment is capable to reduce the rate of pneumonia(6). To evaluate swallowing assessments at bedside there are some options like pulse oximetry, desaturation levels, as measured by pulse oximetry, are acknowledged as indicative of aspiration by certain screening tests(7). Another method used in the literature is to ask patients if they have a cough throughout the day or night and especially if the appearance of the cough is related to mealtime (8,9). In addition, the rest of test used are characterized by its subjectivity (questionnaire, EAT-10) (10) or the need to be supervised by a health professional (repeated saliva swallowing test or modified water swallowing test) to predict the risk of aspiration pneumonia in patients with Duchenne muscular dystrophy (DMD)(11).

For the first time, it is proposed to use an electronic device that does not require measurements in the hospital and can make a record in a real-life situation to detect reflex cough attacks due to episodes of bronchoaspiration even before they are detected by the gold standard(3). Using a portable digital device designed to complement the diagnosis of chronic

cough, SIVA monitor, a pilot study has been carried out on 4 patients with ALS. These patients agreed to participate in this pilot study (wearing the monitor as a necklace) for 14 days. SIVA-P3 device recorded continuous cough data detected in real life as used in its validation protocol(3).

This new tool allowed the detection of unexpected cough manoeuvres during the study period in ALS patients, even if these patients did not suffer any respiratory infection, frequent involuntary coughs were detected right after meals with solid and liquid textures.

The use of the SIVA-P3 cough detector for 24 hours for 14 consecutive days in the patient's home can record pre- or post-prandial cough spells that may be unnoticed by routine clinical laboratory evaluations in patients with ALS.

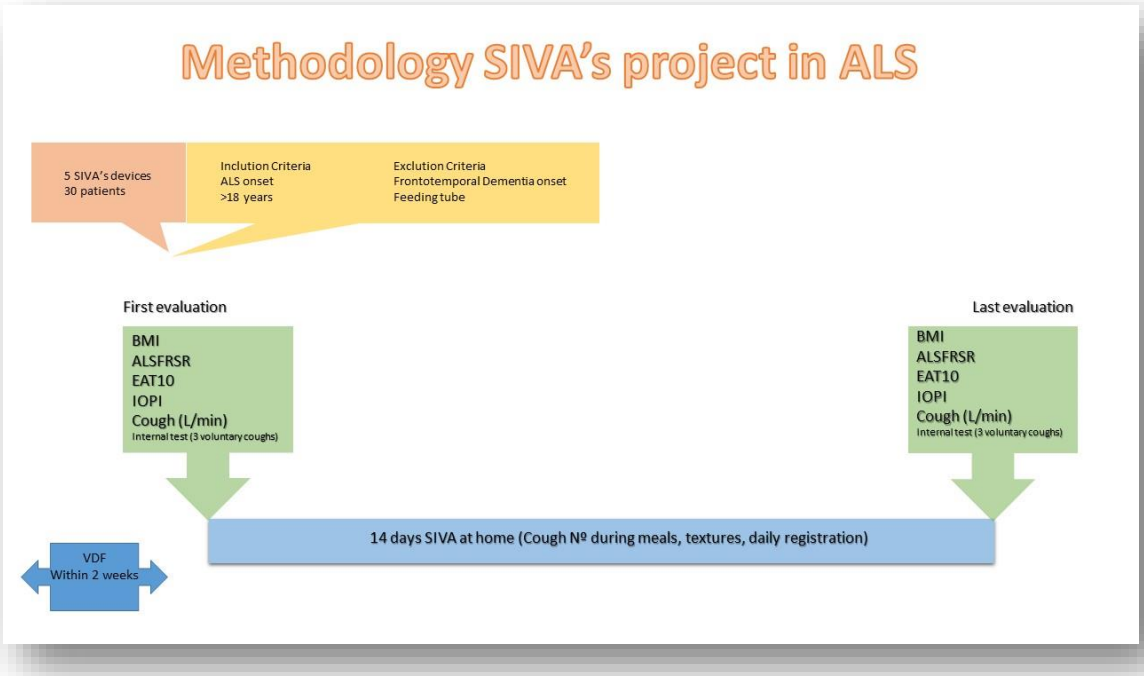
This study aims to describe the efficacy of SIVA-P3 cough detector, in recording cough spells to predict dysphagia in the early stages of the disease in a real-life setting. The results of SIVA-P3 will be compared with video fluoroscopy findings.

Design

A single center observational prospective study.

Methodology

Patients will be selected from the ALS clinic. Patients with a feeding tube, or the indication for its placement, will be excluded from the study.



As part of the standard care, functional tests will be performed to monitor signs and symptoms, overall functional impairment will be registered with the ALSFRSR scale, tongue strength and endurance (tongue dynamometry) as well as nutritional assessments. The included patients will have had a recent videofluoroscopy performed before the study period with SIVA-P3. During the consultation, patients and carers will be trained on the use of the SIVA-P3 device. SIVA-P3 device will start recording on the same consultation (Figure 1, 2). For two weeks patients have the device at home, they must complete a food/liquids intake diary, noting the time of intake throughout the day/night. At the end of the second week, they must complete a SIVA field test questionnaire. After the two weeks are completed the device will be returned to the hospital.

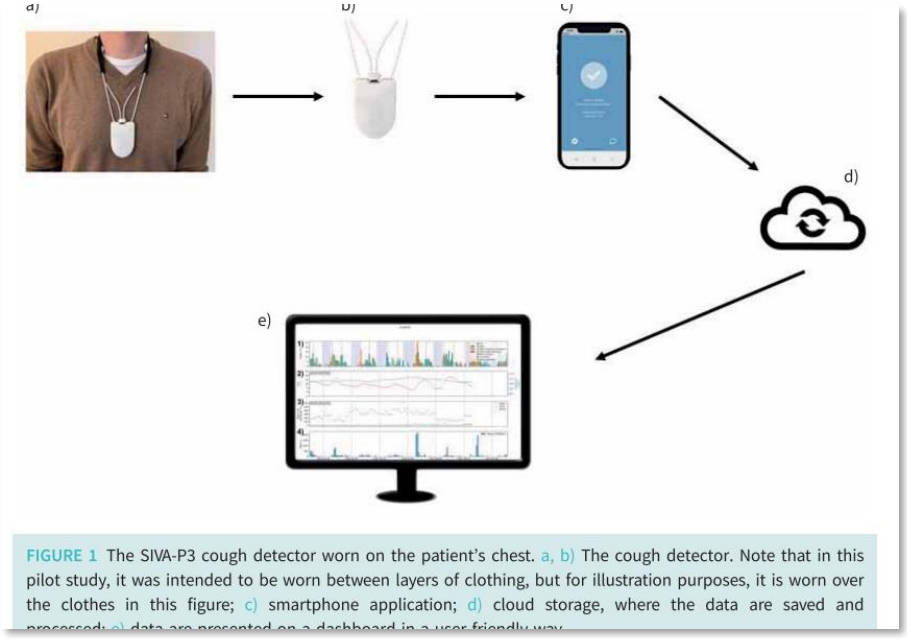
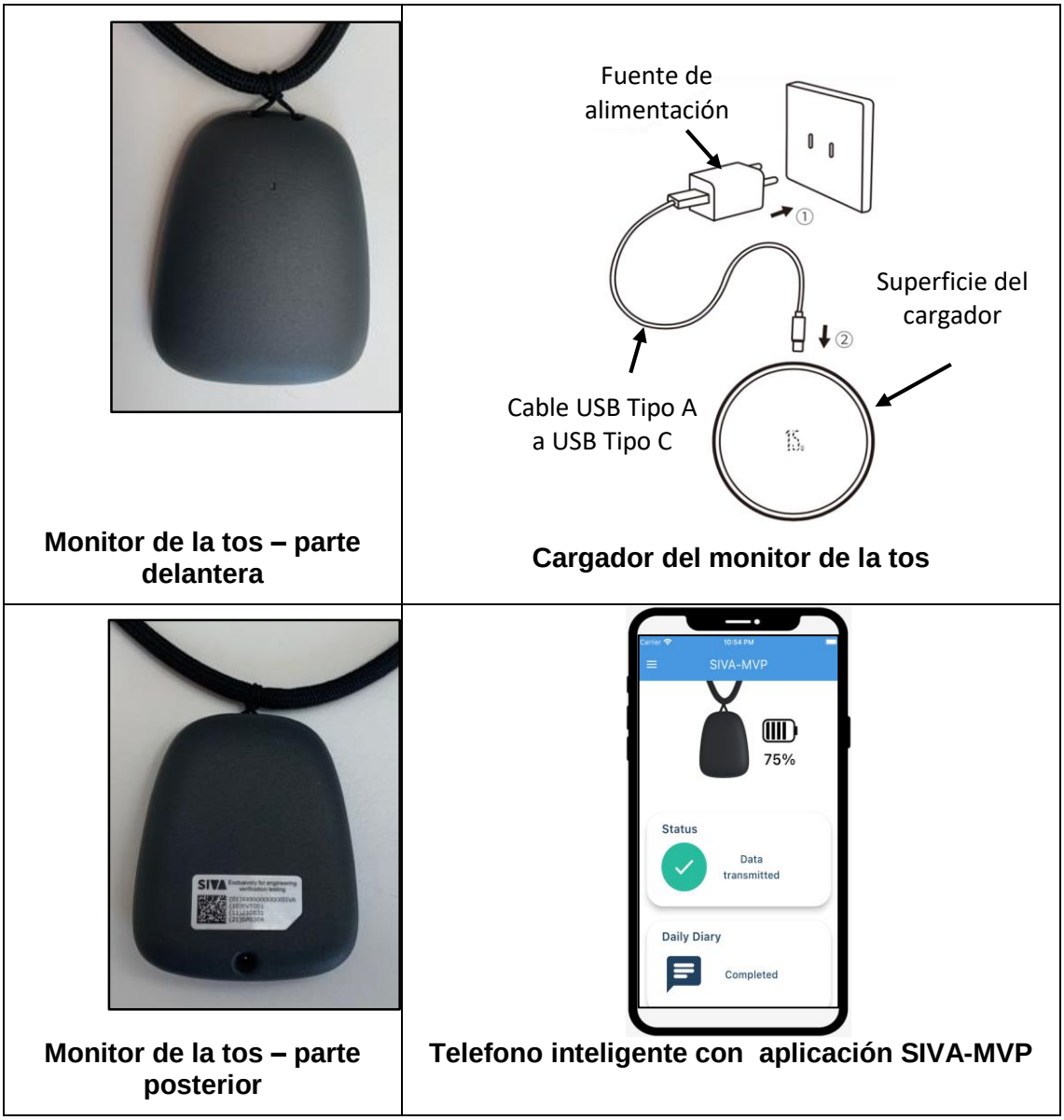


FIGURE 1 The SIVA-P3 cough detector worn on the patient's chest. a, b) The cough detector. Note that in this pilot study, it was intended to be worn between layers of clothing, but for illustration purposes, it is worn over the clothes in this figure; c) smartphone application; d) cloud storage, where the data are saved and processed; e) data are presented on a dashboard in a user-friendly way

Figure 1 Image from the fisrt model of SIVA-P3.



Monitor de la tos – parte delantera

Cargador del monitor de la tos

Monitor de la tos – parte posterior

Telefono inteligente con aplicación SIVA-MVP

Figure 2. SIVA-P3 new version, platform, and Smartphone app.

Analysis variables

Total coughs in a 14-day period, and coughs related to the intake of solids and/or liquids will be registered from the SIVA monitor.

A videofluoroscopy will be performed in a two-week window before the SIVA monitor recording. Videofluoroscopy is the gold standard for assessing and quantifying dysphagia.

Clinical bulbar involvement will also be registered on the first day of the recording in the clinic, by a certified neurologist, as part of the ALSFRS-R score. The functional impact of the dysphagia will be registered using the EAT-10 questionnaire, a well-known and validated tool to easily assess dysphagia in different settings. Tongue strength and endurance will be registered also on the first day of the recording in the clinic, using a tongue dynamometry device (IOPI).

Additionally, after the study, a questionnaire on satisfaction related to the use of SIVA-P3 device will be administered to all participants.

Study design

Patients who routinely attend for their usual follow-up in the ALS clinic will be invited to participate in the study. Patients with a feeding tube, or the indication for its placement, will be excluded from the study. A written consent will be signed to agree to test the SIVA-P3 device. The study is planned to start in September 2024 and conclude in August 2025. Based on previous studies, we must include a minimum of 27 subjects (3).

After signing the informed consent, all participants will perform a videofluoroscopy. In a two-week window period, patients will come to the clinic for clinical and functional assessments (see methods and variables) to place the SIVA device and start the recording. After 14 days of the recording, SIVA device will be returned. On the return, the same clinical and functional assessments will be repeated (ALSFRSR, EAT-10, tongue dynamometry) on the first day of the recording. This is to ensure that the recording reflects a stable situation in terms of dysphagia.

Participants who do not meet the exclusion criteria during follow-up will be re-invited to participate.

Budget for the study

For the conduct of this study, no budget is required as the necessary devices have been provided by the SIVA-P3 company for the project.

Statistical analysis

Clinical and functional data of the cohort will be described. The number of total coughs and coughs related to the intake of solids and/or liquids captured with the SIVA device will be correlated with videofluosocopy findings (primary outcomes), tongue dynamometry measurements, bulbar subscore, and the EAT-10 questionnaire (secondary outcomes).

ETHICAL ASPECTS

All participants will have signed the informed consent (attached) for the study, which will have authorization from the ethics committee that will ensure compliance with the General Data Protection Regulation according to applicable regulations. The rights of the patients will be protected at all times by national and international guidelines (code of ethics, Declaration of Helsinki) and legal regulations on data confidentiality (Organic Law 3/2018 of December 5 on the Protection of Personal Data [LOPD]). Additionally, the care received by the patients will not depend on whether or not they participate in the study. Ethical approval will be obtained from the relevant committee of each institution (multicenter) (in process).

STUDY PROCEDURES

The medical record numbers of each hospital center will be assigned a consecutive number, and these will be stored in a database that only the principal investigator of the center will have access to. Subsequently, the clinical variables will be obtained by reviewing the medical record numbers. This data will be stored in a different database where each patient will be

assigned the consecutive numerical identification previously given, in order to pseudo-anonymize the patients. This second pseudo-anonymized database from each center will be unified into a common database that will be stored indefinitely in the "departametals (disc R) of Hospital del Mar: HM-ELA," where the study's principal investigators, MA Rubio Pérez/Ana Balañá Corberó, have access.

The dissemination of the results obtained from this study will be carried out at Pulmonology congresses and possibly in the preparation of a scientific article.

WORK PLAN:

The following work plan details the development stages and task distribution to carry out the observational study:

Development stages (3 months: 1/12/2024-1/03/2025)

- Thorough literature review as well as translation of SIVA-P3 documentation and study design.
- Online meeting with the SIVA-P3 team to establish criteria and details for the loan of devices.
- In-person meeting at Hospital del Mar for education on the use and handling of the devices.

Device usability in pilot phase 1/03/2025-15/04/2025:

- Shipment of loaned devices from Switzerland to Spain (Hospital del Mar). Pilot test with a team researcher to familiarize with the software, platform, and devices.

Project start with patient inclusion: 15/04/2025-15/04/2026

- Data collection.
- Statistical analysis of the collected data to determine the efficacy of the device in detecting cough episodes in stable ALS patients to predict possible dysphagia by comparing clinical data with evaluations.

Final report writing June-September 2026:

- Analysis and interpretation of the obtained results.

• Writing of the final study report, including a detailed description of the methods used, the results obtained, and the study conclusions.

• Finally, the project will be adapted for publication in a first-quartile respiratory medicine journal according to the editorial group's instructions in Neurology/Endocrinology

TASK DISTRIBUTION

Principal Investigators MAR and ABC: General project coordination, literature review, study design, fieldwork, data analysis, and final report writing.

Collaborating Researchers ADG: Patient recruitment, fieldwork, and final report writing.

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