Data Article

Postural data from Stargardt's syndrome patients

Agnese Sbrollini [a], Valentina Agostini [b], Chanda Cavallini [c], Laura Burattini [a,*], Marco Knaflitz [b]

[a] *Cardiovascular Bioengineering Lab, Department of Information Engineering, Università Politecnica delle Marche, Via Brecce Bianche 12, 60131 Ancona, Italy*
[b] *Dipartimento di Elettronica e Telecomunicazioni, Politecnico di Torino, Corso Duca degli Abruzzi 24, 10129 Torino, Italy*
[c] *Presidio Sperino, Ospedale Oftalmico di Torino, Via Juvarra 19, 10122 Torino, Italy*

A R T I C L E   I N F O

A B S T R A C T

The database is a collection of postural data acquired from 10 patients affected by the rare Stargardt's syndrome, all having the ABCA4 gene mutation, and from 10 control healthy subjects. Specifically, the database includes a file (.xlxs) called SubjectsData and 20 datasets (MATLAB structures) containing postural signals. Each subject performed a total of 15 postural tests, 5 postural tests for 3 different conditions ('C': eyes-closed; 'O': eyes-open, still target fixation; 'M': eyes-open, moving target tracking). For each postural test, 11 postural derived signals (the anterior-posterior force, the mediolateral force, the vertical force, the plate moment about x axis, the plate moment about y axis, the plate moment about z axis, the plate moment about top plate surface about x axis, the plate moment about top plat surface about y axis, the x-coordinate of the center of pressure, the y-coordinate of the center of pressure, and the free moment about z axis) were computed from 8 raw signals, acquired at the Ophthalmic Hospital of Turin, Italy, through an 8-channel Kistler 9286A force platform connected to a Step32 system. Thus, a total of 285 postural signals (120 raw and 165 derived) are available for each subject. The database may be useful to: (1) investigate postural adaptations of patients affected by Star-

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* Corresponding author.
   E-mail address: l.burattini@univpm.it (L. Burattini).

gardt's syndrome; (2) support definition of rehabilitative procedures to reduce postural instability of patients affected by Stargardt's syndrome; and (3) support investigation on visual control of balance in the general population.

Specifications table

Subject	Biomedical Engineering
Specific subject area	Postural data
Type of data	Matlab structures Excel file (.xlsx)
How data were acquired	Kistler 9286A force platform connected to a Step32 system (Medical Technology, Italy); retinal microperimetry (with MP-1 NIDEK, Italy) and survey.
Data format	Raw and analyzed
Parameters for data collection	The database includes a file called SubjectsData.xlxs and 20 datasets (MATLAB structures) containing postural signals acquired from 10 Stargardt's syndrome patients and 10 control subjects. Each subject randomly performed 15 postural tests (5 postural tests for 3 different conditions: eyes-closed; eyes-open, still target fixation; eyes-open, moving target tracking). SubjectsData.xlxs includes demographic data (birth date, sex, age, weight, height, toes' distance and toe-heel distance), ophthalmic data (visual acuity, fixation stability and age at the first diagnosis) and tests data (date and order of postural tests). A postural signal dataset includes 8 postural raw signals and 11 postural derived signals (the anterior-posterior force, the medio-lateral force, the vertical force, the plate moment about x axis, the plate moment about y axis, the plate moment about z axis, the plate moment about top plate surface about x axis, the plate moment about top plat surface about y axis, the x-coordinate of the center of pressure, the y-coordinate of the center of pressure, and the free moment about z axis) for a total of 285 postural signals (120 raw and 165 derived)for each subject.
Description of data collection	Demographic data were collected by survey. Ophthalmic data were collected by clinical investigation (MP-1 NIDEK). Tests data were annotated by technicians supporting the acquisitions. Postural derived signals were derived from postural raw signals, acquired at the Ophthalmic Hospital of Turin, Italy, through an 8-channel Kistler 9286A force platform connected to a Step32 system.
Data source location	Acquisitions were performed at the Clinica C. Sperino (Ophthalmic Hospital of Turin, Italy); data were successively stored in the Department of Electronics and Telecommunication (data owner), Politecnico di Torino, Turin, Italy.
Data accessibility	Raw and derived data are publicly available at Mendeley data public repository. Link: https://data.mendeley.com/datasets/5rz9j8t6p4/draft?a=6f16b7b2-a786-4628-9b9c-066017b7fd8d
Related research article	V. Agostini, A. Sbrollini, C. Cavallini, A. Busso, G. Pignata, M. Knaflitz, The role of central vision in posture: Postural sway adaptations in Stargardt patients, Gait and Posture (2016). doi:10.1016/j.gaitpost.2015.10.003. [1]

Value of the data

- The database is a unique collection of postural data related to patients affected by a rare syndrome, the Stargardt's syndrome, all showing the ABCA4 gene mutation.
- The database may be useful to: (1) investigate postural adaptations of patients affected by Stargardt's syndrome; (2) support definition of rehabilitative procedures to reduce postural instability of patients affected by Stargardt's syndrome; and (3) support investigation on visual control of balance in the general population.

- Clinicians may investigate about the relationship between visual diseases and balance in order to define new procedures to reduce postural instability of patients affected by Stargardt's syndrome.
- Biomedical engineers may create new models related to the visual control of balance.
- Further acquisitions could involve other visual diseases, other biosignals (such as electromyograms) and/or parameters, and other acquisition devices.

1. Data

The database contains raw and derived data publicly available at Mendeley (https://data.mendeley.com/datasets/5rz9j8t6p4/draft?a=6f16b7b2-a786-4628-9b9c-066017b7fd8d).
It includes a file (.xlxs) called SubjectsData and 20 datasets (MATLAB structures) containing postural signals acquired from 10 patients affected by Stargardt's syndrome (STn, with $n = 1$, 2, …,10) and 10 control subjects (CTm, with $m = 1$, 2, …,10). Each subject performed a total of 15 postural tests, 5 postural tests for 3 different conditions ('C': eyes-closed; 'O': eyes-open, still target fixation; 'M': eyes-open, moving target tracking).

SubjectsData.xlxs is an Excel file that includes demographic data, ophthalmic data and tests data of all subjects. The demographic data are sex (male or female), age (years), weight (kg), height (cm), toes' distance (cm) and toe-heel distance (cm). The ophthalmic data are clinical parameters of visual acuity and of fixation stability and age at first diagnosis. For visual acuity, decimal scale (adi), minimum angle of resolution (min of arc), and logarithm of minimum angle of resolution (adi) were reported for both right and left eyes. For fixation stability, percentage of fixation points inside circles with diameters equal to 2° and 4° that have the centroid of all fixation points as center were reported for both right and left eyes. Age at first diagnosis and clinical parameters of fixation stability were available only for the Stargardt's disease patients. The tests data are date of the acquisition and the temporal order with which the 15 postural tests were performed.

Each postural dataset is organized as a MATLAB structure (Sig) composed of 15 substructures (PostTest_p, with $p = 1$, 2, …,15), one for each postural test. Each substructure is organized in thirteen fields, containing the condition of the postural test (Type), the matrix containing the 8 postural raw signals (RAW) and the 11 postural derived signals. The 8 postural raw signals are collected in a $L \times 8$ matrix (where $L = 120,000$ is the length in samples; Table 1). The 11 postural derived signals are the anterior-posterior force (Fx, N), the medio-lateral force (Fy, N), the vertical force (Fz, N), the plate moment about x axis (Mx, N mm), the plate moment about y axis (My, N mm), the plate moment about z axis (Mz, N mm), the plate moment about top plate surface about x axis ($Mx1$, N mm), the plate moment about top plat surface about y axis ($My1$, N mm), the x-coordinate of the center of pressure ($COPx$, mm), the y-coordinate of the center of pressure ($COPy$, mm), and the free moment about z axis (Tz, N mm). Overall, a total of 285 postural signals (120 raw and 165 derived) are available for each subject.

Table 1
Description of the 8 postural raw signals (contained in the MATLAB Sig structure) by the four sensors located on the force platform.

| Channel	Signal name	Signal Description
1	f_{x12}	x-axis force measured between the sensor 1 and the sensor 2
2	f_{x34}	x-axis force measured between the sensor 3 and the sensor 4
3	f_{y14}	y-axis force measured between the sensor 1 and the sensor 4
4	f_{y23}	y-axis force measured between the sensor 2 and the sensor 3
5	f_{z1}	z-axis force measured by the sensor 1
6	f_{z2}	z-axis force measured by the sensor 2
7	f_{z3}	z-axis force measured by the sensor 3
8	f_{z4}	z-axis force measured by the sensor 4
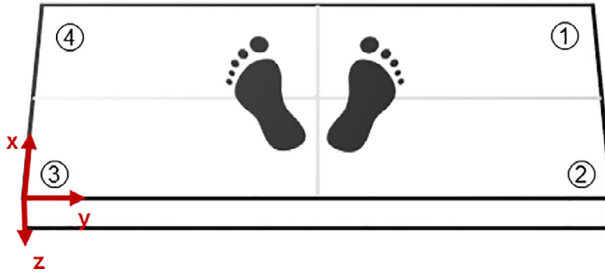
Fig. 1. Representation of the Kistler 9286A force platform and of the four sensors placed on it used to obtain the raw data. Footprints were depicted to standardize foot position. The reference system for the measurements is located on the lower left corner of the platform.

2. Experimental design, materials, and methods

2.1. Data collection

Ten out of the 20 subjects recruited at the Clinica C. Sperino (Ophthalmic Hospital of Turin, Italy) had a genetically confirmed diagnosis of Stargardt's syndrome based on the most frequent ABCA4 gene mutation [2]; the remaining 10 subjects were healthy individuals recruited as controls. For all subjects, absence of osteoarticular, sensorimotor or vestibular impairments was confirmed. Moreover, no ocular diseases (except for Stargardt's syndrome for Stargartd's syndrome patients) were diagnosed after a complete orthoptic and neuro-ophthalmologic examination. Only for Stargardt's syndrome patients, an additional fixation stability test [3] was performed by retinal microperimetry (with MP-1 NIDEK, Italy). All subjects gave their informed consent prior to data collection and acquisitions, which were undertaken in compliance with the ethical principles of Helsinki Declaration and approved by a local expert committee.

Demographic data, ophthalmic data, tests data and postural raw signals were collected during the same acquisition. Demographic data were collected by survey. Ophthalmic data were collected by clinical investigation. Tests data were annotated by technicians supporting the acquisitions. Eventually, 8 postural raw signals were obtained through an 8-channel, 60-second acquisition performed by four sensors placed on the four corners of a Kistler 9286A force platform (Fig. 1) connected to a Step32 system (Medical Technology, Italy). Footprints were depicted on the platform to standardize foot position of subjects (frontside towards sensors 1 and 4; backside towards sensors 2 and 3); inter-malleolar distance was 4 cm, feet opening angle 30° [4–6] (Fig. 1). The reference system for the measurements was located on the lower left corner of the platform. Description of the acquired postural raw signals is reported in Table 1. Sampling frequency was 2 kHz and amplitude range was ±2.5 V for 1–4 channels and ±5 V for 5–8 channels.

Successively to acquisitions, the 11 postural derived signals were obtained from the 8 postural raw signals as follows:

$$Fx = f_{x12} + f_{x34} \tag{1}$$

$$Fy = f_{y14} + f_{y23} \tag{2}$$

$$Fz = f_{z1} + f_{z2} + f_{z3} + f_{z4} \tag{3}$$

$$Mx = b \cdot (f_{z1} + f_{z2} - f_{z3} - f_{z4}) \tag{4}$$

$$My = a \cdot (-f_{z1} + f_{z2} + f_{z3} - f_{z4}) \tag{5}$$

$$Mz = b \cdot (-f_{x12} + f_{x34}) + a \cdot (f_{y14} - f_{y23}) \tag{6}$$

$$Mx1 = Mx + c \cdot Fy \tag{7}$$

$$My1 = My - c \cdot Fx \tag{8}$$

$$COPx = \frac{c \cdot Fx - My}{Fz} \tag{9}$$

$$COPy = \frac{c \cdot Fy + Mx}{Fz} \tag{10}$$

$$Tz = Mz - Fy \cdot COPx + Fx \cdot COPy \tag{11}$$

with *a*, *b*, and *c* being structural parameters of the force platform equal to 175 mm and 275 mm, 22 mm, respectively. By construction, all signals were 60 s long. Originally sampled at 2 kHz, the postural derived signals were resampled at 20 Hz.

2.2. Acquisition protocol

Each subject performed 5 postural tests in 3 different conditions ('C', 'O' or 'M'), for a total of 15 postural tests. A postural test consisted in a balance measurement though a force platform located in a normally enlightened room at 2.2 m from a frontal wall. During each test, subjects were standing still on the force platform, in upright position, with their arms along their sides. Each test was 60 s long and, between two tests, subjects rested for 60 s moving away from the force platform. The 3 different conditions were selected in order to simulate the visual control in posture [7,8]. During the eyes-open conditions ('O' and 'M'), subjects were looking at a target (10-cm diameter luminous spot, subtending a visual angle of 30°) projected on the frontal wall. During 'O' tests, the target was still at the subjects' eye level and subjects were staring at it without moving their head. During 'M' tests, the target moved along different directions (up/down, left/right and oblique) with a velocity of 0.2 m/s. Subjects were tracking the target only with the eyes, without moving their head. The order of postural test conditions was randomly selected to avoid habituation effects [9].

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships which have, or could be perceived to have, influenced the work reported in this article.

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