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Posture and balance control in patients with acromegaly: Results of a cross-sectional study

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ABSTRACT

Acromegaly is a chronic debilitating disease that presents with multiple systemic manifestations, including changes in body composition, joint abnormalities, muscular impairment and visual disturbances. This study aimed to assess posture and body balance in acromegalic patients and to establish the correlation between these measures. Twenty-eight acromegalic patients and a similar number of control subjects matched for sex, age, weight, height and body mass index underwent postural evaluation using the photogrammetry and measurement of balance using the stabilometry in two tasks: feet apart, eyes open and feet together, eyes closed. In comparison with the control group, the acromegalic group presented postural deviations in lateral views in the vertical alignment of the trunk ($P = 0.001$ for the right side and $P = 0.021$ for the left), the hip angle ($P = 0001$ for the right side and $P = 0.016$ for the left side) and horizontal alignment of the pelvis ($P = 0.017$ for the right and $P < 0.001$ for the left side). Compared with healthy subjects, the acromegalic patients presented displacement of the centre of pressure in both the anterior–posterior direction and the medial–lateral direction in both evaluated tasks. We observed significant correlations between balance measures and the following posture evaluation variables: distance between the lower limbs, horizontal alignment of the head and vertical alignment of the head. Our results suggest that posture and balance need to be evaluated for acromegalic patients in clinical practice, as there are significant postural imbalances and deviations in these patients.

1. Introduction

Acromegaly is a chronic debilitating disease resulting from systemic consequences of excess growth hormone (GH) and insulin-like growth factor I (IGF-I) [1]. The estimated annual incidence of acromegaly is 3.3 cases per million population, with an overall prevalence of 58–130 cases/million people [2]. The diagnosis of acromegaly is hampered by several factors, including the slow and insidious onset of the disease. The average time between onset of symptoms and diagnosis of the disease is 3–7 years [2].

Because of the delay in diagnosis, the disease can be quite evident in many patients, with somatic disfigurement, enlarged extremities, joint involvement, carpal tunnel syndrome, visual abnormalities, hypertension, glucose intolerance, and diabetes mellitus [3,4]. GH hypersecretion is also associated with expansion of the volume of total body water and modulates the deposition and accumulation of fat [5]. Acromegalic arthropathy is the most important cause of morbidity and disability in these patients [4]. At diagnosis, the large peripheral joints of approximately 60–70% of individuals are compromised, and up to 50% present axial arthropathy, especially of the lumbar spine [6]. Muscle involvement is also quite common in acromegaly, and the presence of muscle hypertrophy associated with weakness is typical [7].

Posture is the arrangement of the positions of body joints at a given moment and a neuromechanical response that is related to maintaining balance [8]. A good posture is one in which the weight-bearing joints are in alignment and minimal muscle action is required to maintain an upright posture. Moreover, posture is an

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important indicator of health: postural changes are associated with a large number of disorders that can cause pain and regional or generalised musculoskeletal injury. Posture may be evaluated by rigorous interpretation of photographic images that can also be used to monitor treatment effects [9].

Balance is the capacity of the nervous system to detect instability both in advance and at the time and generate coordinated responses that bring the centre of mass (COM) back to the support base. The maintenance of postural balance is a complex control mechanism that depends on the integrity of the vestibular, visual, somatosensory and musculoskeletal systems, the latter being the effector portion related to postural control motor responses [10]. This information is processed by the central nervous system and is returned via the efferent pathways to maintain body balance control by contraction of the antigravity muscles. It is possible to use a force platform to evaluate balance, which is a method of analysing postural balance by quantifying body oscillation. Its application is related to the clinical, rehabilitation and sports training areas [11].

Patients with acromegaly may have changes in posture and balance due to changes in body composition, joint abnormalities and muscle and visual impairments. Research on postural control in acromegaly is important because it may increase the appropriateness of physical therapy interventions. We think that a better knowledge on posture and balance control in acromegaly can serve as a starting point to evaluate the impact of rehabilitation strategies for these patients. Thus, posture and body balance in acromegalic patients, along with the correlation of these measures, were assessed in this study.

2. Methods

2.1. Subjects

This cross-sectional study was conducted between June 2012 and March 2013. The study involved 40 subjects >18 years of age with acromegaly who were followed up at the Clementino Fraga Filho University Hospital of the Federal University of Rio de Janeiro. Diagnoses were based on clinical features and were confirmed by high levels of GH that did not fall below 0.4 ng/ml after an oral glucose tolerance test or IGF-I levels above the upper boundary of the age-specific normal range [12].

Patients were considered to have controlled acromegaly when their IGF-I levels were within the reference range adjusted for age and when their baseline GH levels were less than 1.0 ng/ml [12]. Individuals who were using psychotropic medications, had a diagnosis or history of neurological or vestibular disorders or had any type of physical disability impairing locomotion were excluded from this study. Untreated hypothyroidism and hypocortisolism were also considered as exclusion criteria. A control group of 28 healthy volunteers from both genders was recruited from the Augusto Motta University Center (UNISUAM). All participants signed an informed consent form, and the protocol was approved by the Research Ethics Committee of the UNISUAM under number 005/2012.

2.2. Measurements

Functional balance was measured using the Berg Balance Scale (BBS), which was previously validated for the Brazilian population [13]. The BBS examines balance using different standardised positions and actions related to 14 daily life items. The items are scored according to the amount of time that the body position can be maintained and the distance at which the arm is capable of reaching forward. Each item has an ordinal scale of five alternatives, ranging from 0 to 4 points. The maximal score that can be achieved is 56 [14].

Body posture analysis was performed at the Human Movement Analysis Laboratory (UNISUAM) by means of photogrammetry using the postural assessment software (PAS, FAPESP Incubator, SP, Brazil) [9]. For the acquisition of photographs, the coordinates of anatomical points marked with passive markers (Styrofoam balls held with double-sided tape) were used. Four photographs were acquired for all participants in the anterior, posterior and lateral (right and left) views after the location of anatomical points. The anatomical points were chosen based on previous studies using the same method [15,16]. The patients were placed in an orthostatic position on a sheet of paper upon which their feet had been previously outlined and were instructed to assume a comfortable position. Next to the patients, a plumb line with two Styrofoam balls placed 1.20 m apart served to calibrate the photographs in the software prior to analysis. The camera was placed 163 cm above the floor and 3.0 m from the patients. After each photograph, the sheet of paper was rotated 90°, and the patients were repositioned. The photographs were transferred to a compatible microcomputer and analysed. Before analysis, the photographs were calibrated based on the two plumb line Styrofoam balls. The anatomical points marked on the patients were also marked on the photographs using the mouse according to the software protocol. Fig. 1 shows the angles and distances that were evaluated by the protocol of the PAS.

Body balance was quantified using a force platform system (AccuSway Plus, AMTI, Watertown, Massachusetts, USA) and digitised by a 16-bit converter (NI-USB 6210, National Instruments, TX, USA). All participants performed the following two tasks: feet apart, eyes open (FAEO); and feet together, eyes closed (FTEC) (feet parallel and <1 cm apart). The patients were asked to maintain a static position with their eyes focused on a target on the wall located 1.5 m away for 30 s. The representative value for each postural balance variable was computed as the average of three tasks [17]. Regarding the centre of pressure (COP), the following stabilometric variables were calculated: medial–lateral standard derivation (X SD); anterior–posterior standard derivation (Y SD); medial–lateral range (X range); anterior–posterior range (Y range); length; rectangle area; elliptical area; average velocity (V avg); maximal medial–lateral velocity (V_x); and maximal anterior–posterior velocity (V_y) [18,19].

2.3. Statistical analyses

Data distribution was tested using the Shapiro–Wilks test. Comparisons were made using Student's t-test. Pearson correlation tests were used to assess the associations between variables. The results are expressed as means and standard deviations or frequencies (percentages). The analyses were performed using the software SigmaStat 3.5 (Systat Software, San Jose, CA, USA). Statistical significance was considered when $P < 0.05$.

3. Results

Of the 40 patients with acromegaly initially recruited, 12 were excluded for the following reasons: refusal to participate in the study (8), physical disability impairing locomotion (3) and vestibular disease (1). Therefore, the acromegalic group included 19 women and 9 men with a mean age of 52 ± 9.10 years. Four patients (14.3%) had hypopituitarism, but they were in hormone replacement therapy and had normal hormone levels. The disease was active in 12 patients and controlled in 16 patients. Twenty-two patients (79%) underwent surgery, and 7 patients (25%) underwent radiotherapy. No patient had a previously diagnosed visual disturbance. The general characteristics of acromegalic patients are outlined in Table 1.

The control group (17 women and 11 men) had the following anthropometric variables: age = 48.6 ± 12.5 years, weight = 79.2 ± 15 kg, height = 165 cm ± 0.11, body mass index (BMI) = 28.8 ± 3.37 kg/m^2. No significant differences were observed between healthy volunteers and patients with acromegaly for age, weight, height and