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LITERATURE REVIEW

Biomechanical assessment of human posture: A literature review

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Summary *Introduction:* Postural deviations have been linked to a series of different kinds of pain and dysfunction. However, posture is not an easy subject to study, mainly because postural assessments are still scientifically inaccurate, such as photography, or expensive, such as MRI, whereas others, such as X-ray, involve radiation problems. The aim of this literature review was to search for new scientific methods for assessing posture and to discuss which among both new and old methods are best for scientific and clinical objectives.
Materials and methods: The Medline and Lilacs databases were searched for the period 2003 to 2013 with the use of the following keywords: "posture" and "postural."
Results: A total of 452 articles that assessed posture in some way were found. Twenty-two articles were selected, and 11 relevant types of technologies were described.
Discussion: The relevant technologies discussed were force plate; pictures; goniometers, inclinometers, tape, and other devices; 3D analysis; 3D X-ray; sensors; electromyography; Kinect; magnetic resonance imaging; 4D computed tomography; and infrared.
Conclusion: There is enough technology to make a very good quantitative evaluation possible. For example, the 3D MRI or the 4D CT can register static and dynamic posture. Other cheaper solutions may use combined and synchronized equipments. However, these synchronizations still require validation.

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Introduction

Postural deviations have been linked to a series of different kinds of pain and dysfunction. However, posture is not an easy subject to study, mainly because postural assessments are still scientifically inaccurate, such as photography, or expensive, such as MRI, whereas others, such as X-ray, involve radiation problems (Rosário et al., 2012; Suzuki et al., 2010; Berthonnaud et al., 2009; Steffen et al., 2010).

There is some scientific evidence establishing connections of posture and equilibrium problems with orthopedic and rheumatologic diseases, such as knee osteoarthritis, ankle instability, neck tension, and back pain (Missaoui et al., 2008).

Among the most common methods to evaluate posture in literature reviews are force platform for balance (Missaoui et al., 2008) and the use of a goniometer, an inclinometer, flexible curves, tape measurements, and photography of the posture itself (Fortin et al., 2011).

Myers (2006) affirmed that posture, meaning standing or sitting still, does not exist because humans are never placed in stillness. In other words, people are always moving, shifting, balancing, and adapting. Consequently, in the present article, the word posture has a wide range of meanings in order to increase the possibilities of assessment. Stillness, balance, and repeated patterns of stabilization movement are all considered as posture.

Therefore, the aim of this literature review was to search for efficient scientific methods for assessing posture and to discuss which among both new and old methods are best for scientific and clinical objectives.

Materials and Methods

Search methods

The keywords "posture" and "postural" were used in searching the Medline and Lilacs databases for relevant articles from 2003 to 2013. The articles needed to be in English, Portuguese, French, Italian, or Spanish.

Criteria for inclusion and exclusion

All articles that assessed posture in some way were considered. This criterion was kept as broad as possible to identify all possible ways of postural evaluation. Reviews of postural assessment and articles that discussed posture in some manner that could help the discussion were also included.

Empirical research, letters to the editor, and conference proceedings were excluded.

Study selection

The titles, keywords, and abstracts of all research articles identified during the search were read to confirm whether they satisfied the inclusion criteria. Full text copies of all articles that met the inclusion criteria were obtained for analysis and data extraction. Preference was given to recent reviews on postural assessment and researches on new or unusual forms of evaluation. Older articles that show the same information contained in newer ones were also excluded.

Results

The twenty-two most relevant articles were selected (Table 1), and 11 relevant types of technologies were described, namely, force plate; pictures; goniometers, inclinometers and tape; 3D analysis; 3D X-ray; sensors; electromyography; Kinect; magnetic resonance imaging; 4D computed tomography; and infrared.

Discussion

The general idea of the article was to show the common and uncommon options used to evaluate posture. Thus, to facilitate understanding, the assessment procedures were divided into categories describing related technologies.

Force plate

Duarte and Freitas (2010) reviewed the use of the force plate. According to them, balance and postural control are usually assessed through the center of pressure (CP). The CP is the resultant point from the action of the vertical force on a surface. The equipment most often used to

Table 1 List of relevant articles found by author in alphabetical order, technologies discussed in each paper and year of publishing.

Authors	Technologies discussed	Year
1 — Allum and Carpenter	Sensors	2005
2 — Alta et al.	4D computed tomography	2012
3 — Berthonnaud et al.	X-ray	2009
4 — Cargill et al.	Magnetic resonance imaging	2007
5 — Clark et al.	Kinect	2012
6 — Duarte and Freitas	Force plate	2010
7 — Dutta	Kinect	2012
8 — Engsberg et al.	Pictures and x-ray	2008
9 — Fortin et al.	Goniometers, inclinometers and tape; pictures	2011
10 — Fuschillo et al.	Sensors	2012
11 — Godfrey et al.	Sensors	2008
12 — Gorton et al.	3D analysis	2012
13 — Kingma et al.	Force plate	2011
14 — Missaoui et al.	Force plate	2008
15 — Pazos et al.	3D analysis	2005
16 — Rosário et al.	Pictures	2012
17 — Saffer et al.	Electromyography	2008
18 — Sawacha et al.	3D analysis	2012
19 — Steffen et al.	X-ray	2010
20 — Suzuki et al.	X-ray	2010
21 — Tao et al.	Sensors	2012
22 — Wong et al.	Sensors	2007