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Review

Electromyography variables during the golf swing: A literature review

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ABSTRACT

The aim of the study was to review systematically the literature available on electromyographic (EMG) variables of the golf swing. From the 19 studies found, a high variety of EMG methodologies were reported. With respect to EMG intensity, the right erector spinae seems to be highly activated, especially during the acceleration phase, whereas the oblique abdominal muscles showed moderate to low levels of activation. The pectoralis major, subscapularis and latissimus dorsi muscles of both sides showed their peak activity during the acceleration phase. High muscle activity was found in the forearm muscles, especially in the wrist flexor muscles demonstrating activity levels above the maximal voluntary contraction. In the lower limb higher muscle activity of the trail side was found. There is no consensus on the influence of the golf club used on the neuromuscular patterns described. Furthermore, there is a lack of studies on average golf players, since most studies were executed on professional or low handicap golfers.

Further EMG studies are needed, especially on lower limb muscles, to describe golf swing muscle activation patterns and to evaluate timing parameters to characterize neuromuscular patterns responsible for an efficient movement with lowest risk for injury.

Contents

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1. Introduction

Golf is a sport accessible to all ages and levels of physical condition. It offers an healthy alternative physical activity and has become increasingly popular all over the world. Nowadays, the "older" population has more leisure time available and since golf is considered a low impact sport with a general aerobic component, the "average" player tend to be older in age. Although golf players' characteristics are poorly studied, the sport is assumed to present some injury risks (McHardy et al., 2006), either through badly structured (or lack of) exercise programs and practice, specific morphological and functional properties of the participants, or through the nature of the mechanical demands of the activity. Due to increased participation, golf-related injuries are increasing, also. Cabri et al. (2009) indicated that golf players experienced injuries, resulting from overuse or from traumatic cause. However, health benefits and golf practice-related risks have not been fully explored. Furthermore, controversy still exists in the literature (Cabri et al., 2009).

The golf swing is an essential movement in the game and is considered to be responsible for the majority of golf-related injuries (Gosheger et al., 2003). In order to elucidate injury mechanisms in "average" golfers with different practice levels and to improve the quality and specificity of the golfers' physical conditioning, neuromuscular information about the golf swing is needed to provide a correct interpretation of the available epidemiological record (McHardy and Pollard, 2005a).

Therefore, we aimed in this paper to review the available literature concerning its behavior during the golf swing through electromyography (EMG). EMG is the measurement of the electrical activity generated in the muscle and is a useful tool to get information about the intensity and time structure of neuromuscular impulses received in the muscle from the central nervous system (Basmajian and De Luca, 1985). We were particularly interested in (1) the characteristics of the subjects and swings studied, (2) to critically analyse the EMG methods used, and (3) to give an overview on muscle recruitment during the golf swing based on the recent literature available.

2. Methods

A systematic search of the existing literature was conducted using the combined keywords "golf" and "swing" on studies published between 1965 and 2011, in the electronic databases B-On, PubMed, Scopus, Google Scholar and ISI Web of Science. Then a refined search was made adding the keyword "electromyography" (EMG) on the first retrieved data. The inclusion criteria were: (1) containing EMG data on golf swing phases; (2) amateurs and/or professional golfers of all ages, all handicaps and/or a population with or without injuries; and (3) the articles written in English, French and Portuguese. The exclusion criteria were: (1) papers with no EMG data; (2) no swing phases description, and (3) publications in languages other than those used in the inclusion criteria.

3. Results

3.1. Literature search results

The electronic databases retrieved 5219 articles that fitted the criteria words: "golf" and "swing". A refined search was then made to fit the criteria on EMG, retrieving 154 articles. Using reference manager software (Reference Manager V12, Thompson Reuters, USA) all duplicates were eliminated, which revealed 73 references for screening. Fifty-four articles were rejected because of lack of relevance to the criteria, and 19 articles went through further analysis (Fig. 1).

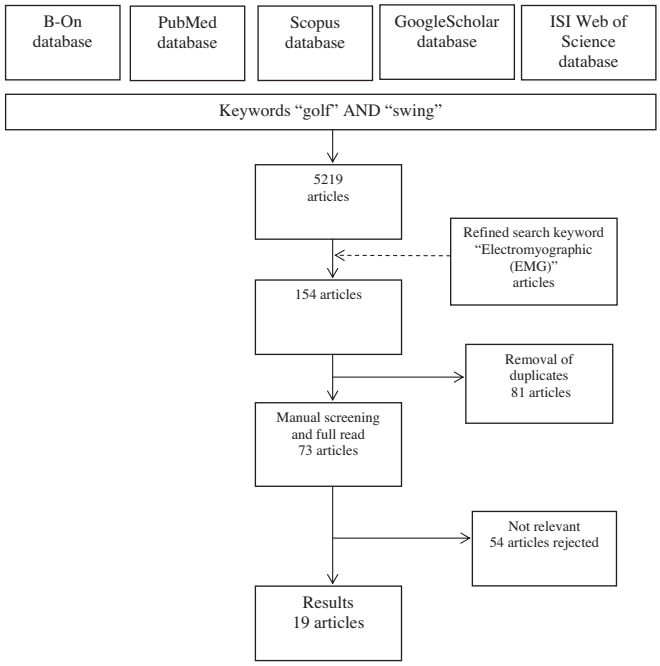

Fig. 1. Flow chart of methodology used for the article search.

3.2. The golf swing: movement phases

Most of the studies (Jobe et al., 1989; Pink et al., 1990, 1993; Kao et al., 1995; Bechler et al., 1995; Watkins et al., 1996; Farber et al., 2009) generally divided the golf swing into five phases using video analysis: (1) the backswing – from address to top of swing; (2) the forward swing – from top of swing to horizontal positioning of the golf club (early part of downswing); (3) the acceleration phase – from horizontal club position to ball impact (late part of downswing); (4) the early follow-through – from impact to a horizontal club positioning and; (5) the late follow-through – from horizontal club position to completion of the swing. Glazebrook et al. (1994) divided the golf swing into four phases: (1) address phase – preparation to swing (duration of 0.1 s); (2) the swing phase – from takeaway to beginning of contact phase; (3) contact phase – from the burst of common forearm flexor muscle activity to ball strike; (4) post contact phase – a 0.1 s period after ball strike. To Kao et al. (1995) the golf swing takeaway phase occurs from the address until the club is horizontal and the backswing phase from that point to the backswing top.

Although the small differences reported, we analyzed the retrieved data with respect to the most-used swing phases: (1) backswing; (2) downswing; (3) acceleration; (4) early follow-through; and (5) late follow-through (Fig. 2).

3.3. The golf swing: EMG data

The retrieved studies focussed mainly on four different body parts: trunk, shoulder, forearm and lower limb.

From the 19 retrieved articles, six analyzed the trunk (Pink et al., 1993; Watkins et al., 1996; Horton et al., 2001; Bulbulian et al., 2001; Cole and Grimshaw, 2008a,b), four studied the shoulder (Jobe et al., 1986, 1989; Pink et al., 1990; Kao et al., 1995), two the forearm (Glazebrook et al., 1994; Farber et al., 2009), one the lower limb muscles (Bechler et al., 1995). Six papers were