UTILIZATION OF THE METRECOM WITH RESPECT TO WIELKI'S DATA IN THE STUDY OF THE ANGLES OF THE CURVATURES IN THE SPINE

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INTRODUCTION

The vertebral column permits free movement in all directions and must support the rest of the body (Hay and Reid, 1988). This support must also service to anchor muscles that function by pulling on the vertical column, must act as an efficient shock absorber under various conditions, and must protect the essential and delicate spinal cord. Each region of the vertebral column is composed of distinctive vertebrae: thoracic (chest), consisting of twelve vertebrae, each of which articulate with a pair of ribs; five lumbar (back) vertebrae which have no rib attachments; five fused sacral (pelvic) vertebrae, and coccygeal vertebrae (Solomon and Davis, 1988). The human spine has four curves - cervical, thoracic, lumbar and sacral - that are maintained by a combination of muscle tone and ligament tension. It has been stated that these curves develop before birth and during childhood (Solomon and Davis, 1988), but specifically when this development occurs has not been identified.

The spine is an anatomical region where a variety of disease conditions and pain is diagnosed. For example, lower back pain can develop gradually or may occur suddenly. The ailment may range from minor symptoms, to obvious displacements and fractures, through to permanent paralysis and impaired nerve function that would ultimately confine a person to a wheel-chair (Commonwealth of Australia, 1987).

As many as 80% of the adults in industrialized countries such as Australia will suffer from low back pain at some time in their lives, with more than half of this group suffering this pain more than once. Reports have indicated that over a one year period, 10-15% of the population could suffer from low back pain (Department of Human Movement Studies, University of Queensland, 1985). Back injuries are identified as a major threat to the health and economy of the Australian Community. In 1982 the Federal Government estimated that work accidents cost Australia at least $4,000 million per annum. About 25% of all compensatable injuries involved the back, and injury statistics presented in Table 1 provide an indication of the seriousness of the situation. Recent information from Workcare (Victoria) indicated that there was a back injury every five minutes of every working day, with an average cost per claim of $4,600. Extending these figures nationally puts the estimated total cost of back injuries at $1,125 million per annum, or $3.08 million per day (Commonwealth of Australia, 1987).

By the year 2005, one in every seven persons will be over the age of sixty (Australia DR Weekly, 1990), with the greatest proportional increase in these figures being for women over the age of eighty (Social Report Victoria, 1983). Jackson (1979), a gerontology specialist, stressed that little is really known about the aging experience indicating that future health strategies need to be based on sound research. As negligible research in the aging process addresses the differences between women and the differences between women's age-groups, the need for future research on women and health is of utmost importance (Garner and Mercer, 1989).

Table 1. Estimate of back injuries derived from Australian Industrial Accident Statistics.

State	Back Injuries	Year of Statistics
New South Wales	27,190,000	1981 - 1982
Victoria	11,556,000	1974 - 1975
Queensland	11,937,000	1985
Western Australia	7,180,000	1985
South Australia	2,920,000	1985
Tasmania	1,860,000	1985

(Commonwealth of Australia, Bureau of Statistics, 1987)

Indications are that the musculo-skeletal function and structure decrease with age and thus increase the severity of sprains and strains which occur. It is not surprising that statistics show slip and fall injuries become increasingly traumatic in the elderly. Decreases in muscle strength with aging are associated with a decrease in muscle mass. Reasons for increased severity of back injury in older persons (compared with an injury to the spine at a younger age) could lie within yet undefined aging factors of the spine (Rossignol et al., 1988). Also stated was the fact of osteoporosis becoming a common factor of aging in women. This major musculo-skeletal problem is associated with disability in aging women and represents a significant threat to the mobility and maintenance of independence (Garner and Mercer, 1989).

With an emphasis on the necessity to obtain musculo-skeletal data on the spinal structure, as well as the population of women it is fundamental that international comparisons be made where possible. Wielki and Kruchoski (1988) stressed that it is necessary not only to compare normative typology of the spine from different countries, but also of different age-groups. In order to make a fundamental study of the development of the curves of the spine, it is necessary to establish a normative typology data base for age-groups and sex (Wielki, 1990).

Research issues have traditionally focused on male subjects or have not differentiated findings in relation to gender or age (Garner and Mercer, 1989). Kraus and Shapiro (1989) state that it is important that structural causes of serious injuries be recognized early, particularly in the skeletally immature. Thus, the opportunity to be aware of the normal aging process of women, and the resultant structural changes that occur in the spine is of significant importance.

METHODOLOGY

Use of the "Radius Method with 'Intersection' Point" takes into account the relationship between the lengths of the dorsal and lumbar curves. A total of 10 indices are used, as characterized in Table 2: four are concerned with the complete rachii curve, three indices for the lumbar, and three indices for the dorsal curves. These provide the opportunity to characterize the evolution of the spinal curves (Wielki and Kruchoski, 1988).

Metrecom Skeletal Analysis System is a noninvasive, radiation-free technology which allows a cursor to be moved down the spine to achieve three dimensional data of the co-ordinates (spatial digitizer).

Table 2. The normative typology of the spinal curvature displaying the ten indices used for the rachis curve.

<u>4 indices for both parts of the rachii:</u>

Dorso-Lumbar Index : DLI = (AC : B) x 100 (1)

Curve Relative Index : CRI = (h1 : h2) x 100 (2)

Relative Summation Index : RSI = /(h1+h2) : AB/ x 100 (3)

Inclination Index : II = (BI : AI) x 100 (4)

<u>3 indices for the dorsal part:</u>

Dorsal Top Index : DTI = (AF : FC) x 100 (5)

Dorsal Curve Index : DCI = (h1 : AC) x 100 (6)

Radius Dorsal Curve : RDC = $(h1^2 + S1^2) : 2hl$ (7)

<u>3 indices for the lumbar part:</u>

Lumbar Top Index : LTI = (CG : GB) x 100 (8)

Lumbar Curve Index : LCI = (h2 : CB) x 100 (9)

Radius Lumbar Curve : RLC = $(h2^2 + S2^2) : 2h2$ (10)

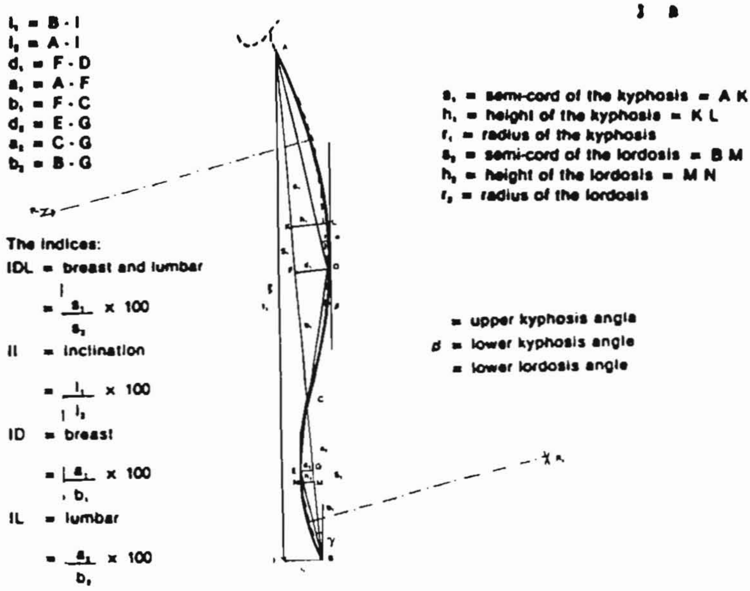

Figure 1. Scheme of the analysis of the physiological curves of the spine by the intersection point.

SOFTWARE METHOD FOR AUTOMATED ANALYSIS OF SPINAL CURVES

The Metrecom stores data to an ASCII file. A custom-written program reads the X, Y, and Z co-ordinate data from this file. The X data represents the spinal curvature in the sagittal plane. These data are transformed so that there is one data point for each mm in the range of Y (vertical) co-ordinates. As required by the Wielki intersection point method, the program generates a line joining the most proximal digitized spinal point (C7) to the most distal (L5 + 4mm). The intersection of this line with the spinal curve is then determined.

The location of the intersection point with the proximal-distal line divides the spinal curve co-ordinates into a kyphosis curve and a lordosis curve. The heights of the kyphosis and lordosis are determined at the midpoints of the curves, perpendicular to the proximal-distal line. Additionally, vertical tangents are constructed at the maximum and minimum values of the kyphosis and lordosis curves, respectively. The lengths of lines perpendicular to the proximal-distal line to these tangents are determined. These procedures result in the automatic measurement of the basic curve parameters, from which Wielki's indices are then calculated.

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