Effect of obesity and low back pain on spinal mobility: a cross sectional study

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Introduction
Obesity is nowadays a pandemic condition. Obese subjects are commonly characterized by musculoskeletal disorders and particularly by non-specific low back pain. However, the relationship between obesity and LBP remains to be clarified: it is an objective measurement of the mechanical behaviour of the spine and its morphology in obese subjects. Such analysis may provide a deeper understanding of the relationship between factors and the onset of clinical symptoms. To objectively assess the posture and function of the spine during standing, flexion and bending in obese subjects with and without non-specific low back pain (LBP) and to investigate the role of obesity in LBP.

Materials and methods
Thirty-one volunteers were recruited. In our Department of Orthopaedic Rehabilitation were recruited: 13 obese patients with no LBP (Group O) (age: 38 ± 9 years; BMI: 28 ± 10 kg/m²), 13 obese patients with osteoarthritis (OA) LBP (Group OA, age: 41 ± 9 years; BMI: 34 ± 16 kg/m²), and 10 healthy subjects with no history of musculoskeletal complaints at the control group (Group C, age: 39 ± 9 years, body mass index: BMI: 20 ± 1.2 kg/m²). We considered these groups of female subjects in order to take into account the same mass distribution typical of women and the prevalence of LBP in younger women. At the time of the study, LBP patients were not under any treatment. The study was approved by the Local Ethics Committee and all the participants gave written informed consent.

Experimental setup
The study was conducted at the Laboratory of Gait and Posture Analysis of our Institute. Data were acquired with a 6-segments, optoelectronic motion analysis system (Vicon 450, Vicon Motion Systems, Oxford, UK) operating at a sampling rate of 100 Hz. The reflective markers were spherical with a diameter of 14 mm. The location of the markers, the movements, and the angles definitions have been previously described. In brief, five markers were placed along the spine (Figure 1) two on the thorax (T7 and T12), two on the lumbar vertebrae (L1 and L5-L7), and one on the sacrum (S1). Four markers were placed on the pelvis, right anterior superior iliac spine (ASISR), right anterior inferior iliac spine (AIISR), left anterior superior iliac spine (ASSL), and left anterior inferior iliac spine (AIISL). As the movements analyzed, two different tasks were considered: forward flexion and lateral bending both sides. Subjects were instructed to perform the test comfortably at their own speed with both feet apart at shoulder width. Each movement was repeated three times in order to evaluate the inter-subjects variability.

Modelling and data processing
Three-dimensional data from the optoelectronic system were processed using the multi-purpose biomechanical software SMArt Analyser (SMA, Italy). For forward flexion, we defined the angles shown in Figure 2 to characterize trunk mobility in the sagittal plane. Specifically, we considered forward flexion (inclusion (GIT) pelvic (PB) (mi) angle), related to lordosis (A1), lumbar movement (A2), angle related to kyphosis (A3), and residual movement (A4). The angle between pelvis was calculated at the initial standing position (START) and minimal forward flexion (MAX). The range of motion (ROM) between START and MAX was also calculated. For lateral bending, similar angles were calculated as for forward flexion (Figure 3). The trunk inclination (ELT), pelvic (PB) (mi) angle, lumbar movement (ELT), dorsal movement (ELT), and loss of lordosis (ELT) were calculated. Again, for this angle, we calculated the difference between maximum left and right bending. We also computed the same metric for trunk inclination (ELT), adopting the difference between the movement left and right, and taking into account the moments of rotation (M), a non-parametric index used to locate the centre of rotation based on the trajectories of the markers in the frontal plane during the lateral bending. In particular, we identified the CoR by defining different axes determined by the markers (Figure 6).

Results
We considered the mean values of the forward flexion and lateral bending repetitions correctly performed by each subject. Parameters acquired from markers which were not visible during the tests were excluded from further analysis.

Forward flexion
The ROM of spine flexion was reduced in O and LBP patients compared to C (asFETT ROM). This reduction was mainly influenced by the different standing position (asFETT). The O and LBP patients presented an increased pelvic tilt angle (asFETT) START) but only LBP patients had a significantly reduced flexion in ROM compared to C.

The pelvic angle moved at the initial standing position (START) and at maximum forward flexion (MAX). The range of motion (ROM) between START and MAX was also calculated. For forward flexion, similar angles were calculated as for forward flexion (Figure 3). The trunk inclination (ELT), pelvic (PB) (mi) angle, lumbar movement (ELT), dorsal movement (ELT), and loss of lordosis (ELT) were calculated. Again, for this angle, we calculated the difference between maximum left and right bending. We also computed the same metric for trunk inclination (ELT), adopting the difference between the movement left and right, and taking into account the moments of rotation (M), a non-parametric index used to locate the centre of rotation based on the trajectories of the markers in the frontal plane during the lateral bending. In particular, we identified the CoR by defining different axes determined by the markers (Figure 6).

Lateral bending
LBP patients showed a significant reduction in lateral bending as compared to O and C (asFETT ROM). No difference in pelvic obliquity was observed among groups. Furthermore, LBP patients showed a significantly reduced motion of the lumbar curve (asFETT, ROM) but no differences among groups were observed in lumbar movement (asFETT). The dorsal curve (asFETT, ROM) was statistically different among the three groups, with the LBP patients presenting the most limited. LBP patients also showed a significant reduction in dorsal movement (asFETT, ROM) compared to O and C.

A significant reduction in stoically movement (asFETT, ROM) was observed. The qualitative analysis of frontal bending by locating the CoR showed different trajectories among groups: subjects in C showed an "oblique" shape (Figure 5A), while O and LBP showed a "crown" shape (Figure 5B and Figure 5C). CoR was located between T3 and T5, while, LBP and C subjects were located between T3 and T5 and right anterior superior iliac spine (ASISR) in O and LBP (CoR Zone 1).

Conclusions
Our data show that obesity induces static and dynamic adaptations in the kinematics of the spine: under static conditions, obesity appears to generate an increased pelvic tilt; under dynamic conditions, to impair the mobility of the lumbar spine. Obesity with LBP is associated with a higher spinal movement than obesity without LBP and the presence of LBP is associated with increased lumbar lordosis. Bending is performed in a qualitatively different mode in obese and normal BMI individuals, and the LBP patients present a more limited range of mobility. It is important to distinguish between these two functional components of obesity. Other studies of our study of habit forms of intervention in obese patients should include strengthening of the lumbar and abdominal muscles as well as mobility exercises for the spinal erector muscles and passive tissue.

The clinical usefulness of an osteopathic approach is already widely acknowledged by the standardisation of gait analysis in the rehabilitation of elderly people musculoskeletal and orthopaedic conditions. However, further studies are needed to assess the role of osteopathic approaches in improving mobility function in healthy subjects. Our study suggests that osteopathic treatment can represent a non-invasive, effectively useful technique for functional rehabilitation in various spinal conditions and evaluation of effectiveness in rehabilitation.

References

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