Analysis of trunk movility in children with scoliosis

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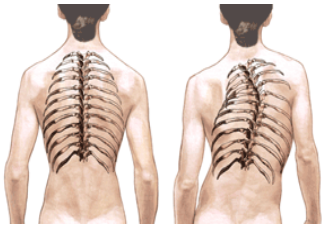
Scoliosis

- The Scoliosis Research Society defines this condition as a lateral curve of the spine with rotation of the vertebrae within the curve. The deformity really is tridimensional and the radiological magnitude of it must be superior to 10 degrees.



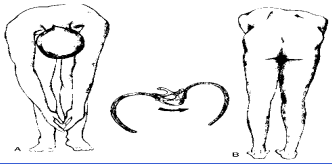
- The highest frequency is between 9 to 14 years of age in women, with a 3.5:1 relation with men respectively.
- The prevalence is 0.6 to 4% and according to its etiology idiopathic scoliosis is the most common.

Zurita Ortega, F. "Cribado de la escoliosis en una población escolar de 8 a 12 años de la provincia de Granada", *AnPediatría (Barc).* 2008;69(4):342-350

Diagnosis

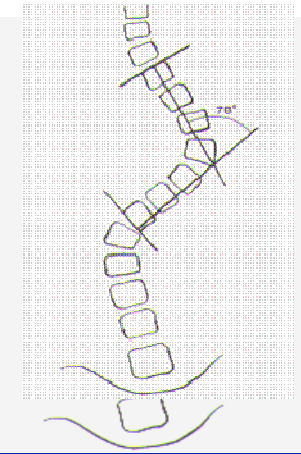
- The diagnosis of scoliosis firstly is determined by the clinic evaluation.
- The relationship between the articular and the osseous prominences are examined to register the presence of unevenness and asymmetries.
- Adam's test is done indicating to the patient to forward bend with its arms hanging freely and the legs extended. If a deformity is observed then the test is positive, the sensibility is of 92%.

George Sapkas, MD, et.al Prediction of Cobb Angle in Idiopathic. orthopaedics and related research number 411, pp. 32-39 2003.



- The magnitude of the curve is determined by the Cobb's method, a line is drawn over the upper plate of the cranial vertebrae and another line on the inferior plate of the caudal vertebrae. The perpendiculars are drawn and the angle that forms its intersection is measured.

George Sapkas, MD, et.al Prediction of Cobb Angle in Idiopathic. Adolescent Scoliosis. Clinical orthopaedics and related research number 411, pp. 32-39 2003.



- In order to walk, the human beings have developed mechanisms that optimize the displacement , with the finality of decreasing the variability in the movement of the gravity centre, given by the oscillation of the trunk during this activity.

- When the mechanisms are affected the mobility of trunk is severely involved during gait, modifications in the mobility have to be expected.

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- Clinical and radiographic studies as well as analysis of movement have been used, with the objective to evaluate the trunk in a dynamic way with data that establishes its capability of movement.

- Systems of superficial topography have also been developed to measure and analyze the spine in 3D; this technique allows diminishing the exposition to radiation.
- Once the image and the 3D reconstruction of the spine are acquired, the system automatically analyzes and describes the line of symmetry.
- Systems like this allow a more accurate and reproducible analysis of the measurements.

- Some other useful and important radiographic techniques are: the Computed Axial Tomography (CAT), which scans with tridimensional reconstruction to discard malformations and the Magnetic Resonance Imaging (MRI) when neurological problems are found.

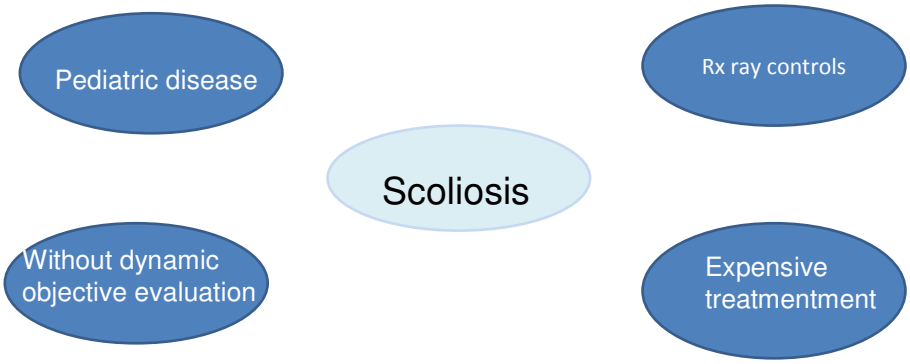
- Kotwicki et al. participated in the Society on Scoliosis Orthopedic and Rehabilitation Treatment meeting, and obtained information about which data are fundamental for the evaluation of patients with scoliosis.
- They got information about general data, clinical evaluation, radiographic evaluation, superficial topographic examination, computed photography and tomography, magnetic resonance, ultrasound, thermography.
- They reported that in order to evaluate the trunk, the clinical aspect is a priority in association with the radiographic evaluation and the clinical photography.
- In this study, the evaluation of trunk using computed analysis of movement was not considered.

- In another study the characteristics of the muscular activation during gait in patients with scoliosis were evaluated.
- The data before the surgical treatment were compared with the data obtained after spine surgery intervention for the correction of the scoliosis; these data were compared with normality range, too.
- The main result was the presence of asymmetry in terms of muscular activity, with an increased activity on the convex side of the scoliosis.

Engsberg, Jack R. PhD. "Prospective Comparison of Gait and Trunk Range of Motion in Adolescents With Idiopathic Thoracic Scoliosis undergoing Anterior or Posterior Spinal Fusion" *Spine* (September 2003) Vol 28-Issue 17: 1993-2000

- Further studies described the mobility of the spine in patients with scoliosis (pre and post surgical intervention).
- The trunk mobility, the gait pattern in adolescent with idiopathic scoliosis and the mobility of the trunk were analyzed.
- Gait was evaluated in adolescents who had received surgical treatment with two different techniques, finding out that the mobility of the spine on the 3 planes was reduced subsequently to surgical treatment, in both the studied groups.

Engsberg, Jack R. PhD. "Prospective Evaluation of Trunk Range of Motion in Adolescents With Idiopathic Scoliosis Undergoing Spinal Fusion Surgery" *Spine* (Jun 2002) Vol 27-Issue 12: 1346-1354



The objective of our study is to use of the analysis of movement to evaluate the trunk in children with scoliosis, during gait.

Materials and methods

- We evaluated two pediatric patients with clinical and radiographic diagnosis of scoliosis (8 years old boy and a 12 years old girl) and two healthy subjects as a control group (a 7 year olds boy and an 11 years old girl); the two control subjects were height matched with the pathological subjects.

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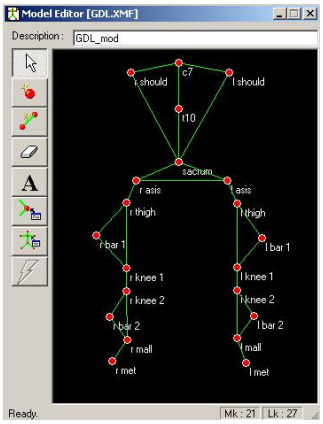
The selection criteria of the pathological participants were:

- They should have had a clinical and radiographic diagnosis of osteoarticular scoliosis.
- No other concomitant neurological (central or peripheral) problems.
- For the control group a clinical evaluation was conducted to determine the absence of scoliosis.

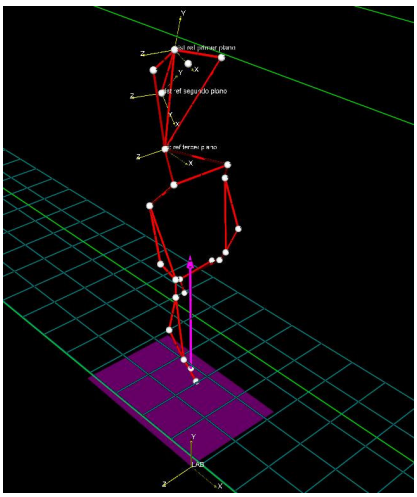
- GDL Movement Analysis Lab
  BTS Co Italy.
  8 Infrared light cameras
  1 platform
  2 video cam sistem
  EMG surface

- The model used in this study: starting from Davis protocol, we added a marker on the skin over the spinous process of the 10th thoracic vertebrae.



Instrumentation and procedure

- An optoelectronic system was used for the analysis of the human kinematics (ELITE, BTS, Italy) able to reconstruct the coordinates of infrared passive reflecting markers.
- A three-dimensional (3D) model was developed to obtain quantitative values of the mobility of the trunk during posture and gait.



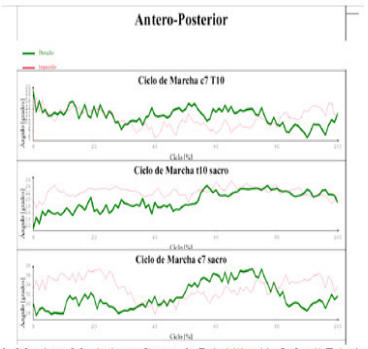
Starting from the markers' position, we computed the angle between the segment connecting C7-T10 and the segment connecting C7-Sacrum, on the coronal, sagittal and transverse planes.

- Similarly, the distanc

Each of these values was evaluated during posture and gait, as follows.
Each evaluated patient and healthy control volunteers realized an acquisition of posture and subsequently six gait tests.

Figure 2. Anteroposterior mobility during gait cycle.

- A multimedia report was created to show the mobility curves from each segment, as well as the distance between acromion and anterior superior iliac spine from each body side, during posture and during gait.



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- The kinematics of the referred segments was analyzed during posture and during each gait trial.

- The obtained values during the postural acquisition were compared between each child with scoliosis and healthy subjects.

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- The consistency of gait analysis data was considered.
- The obtained values during gait were compared between each patient with scoliosis and healthy subjects.
- The Student's T test was used to evaluate the presence of significant differences between healthy subjects and those with scoliosis.
- An analysis of variance was realized for the gait test.

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- In the posture evaluation the results show that the children with scoliosis present differences between right and left side in terms of distance between the acromion and the anterior superior iliac spine, resulting in an asymmetry.
- In healthy children symmetric values were found.

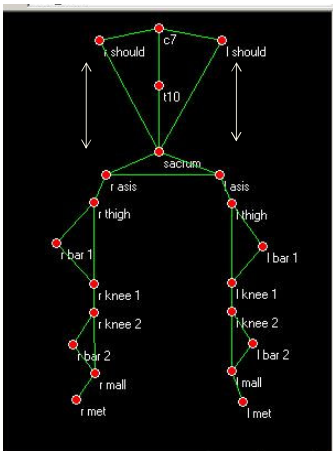

Table 1. Values during bipedestation

Subject	Distance between the acromion and the anterior superior iliac spine, right in cm.	Distance between the acromion and the anterior superior iliac spine, left in cm.
Healthy boy	33.8	33.9
Scoliosis boy	28.9	30.9
Healthy girl	35.7	35.7
Scoliosis girl	40.7	38.9

Gait Laboratory and movement Centro de Rehabilitación Infantil Teletón Occidente.

- The six gait trials did not show statistically significant differences.
- Showing consistency in the obtained data and reliability of the study realized with the designed model.

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Table 2. Results values ANOVA for spine mobility during gate, comparing the six tests of each patient

	Mean (+- SD)				
	Healthy boy	Scoliosis boy	Healthy girl	Scoliosis girl	P '
Average distance between Acromion axis right (cm)	31.63(.002)	29.70(.003)	36.07 (.002)	38.95(.006)	
Average distance between Acromion axis left (cm)	32.93 (.004)	29.37(.002)	37.20(.002)	36.95(.002)	
ROM C7-T10 mediolateral R.(°)	7.17(2.6)	4.13(.72)	5.70(.89)	3.43(1.4)	
ROM C7-T10 mediolateral L.(°)	7.2(2.05)	4.23(.88)	6.19(1.35)	2.91(.29)	
ROM C7-Sacrum mediolateral R.(°)	16.90(3.93)	10.06(1.47)	10.53(1.98)	7.98(.59)	
ROM C7-Sacrum mediolateral L.(°)	7.26(5.01)	10.36(1.05)	9.99(1.61)	7.84(1.52)	
ROM C7-T10 anteroposterior R.(°)	16.56(3.37)	13.23(4.08)	8.86(3.36)	7.24(4.48)	
ROM C7-T10 anteroposterior L(°)	16.32(2.51)	12.73(2.88)	8.32(2.52)	5.23(.65)	
ROM C7-Sacrum anteroposterior R.(°)	16.55(4.36)	10.23(2.00)	9.28(3.10)	7.91(3.11)	
ROM C7-Sacrum anteroposterior L.(°)	18.48(6.75)	9.71(4.19)	9.63(2.07)	6.41(1.56)	
ROM C7-Sacrum rotation R.(°)	20.79(2.32)	13.80(2.95)	29.86(2.71)	12.26(2.68)	
ROM C7-Sacrum rotation L.(°)	22.76(4.46)	13.84(1.86)	29.70(3.70)	12.06(1.81)	

- In the comparative study between the results of each patient with scoliosis and healthy controls, statistically significant differences were found, showing that the patients with scoliosis display less mobility during gait than the healthy subjects

- P> 0.05

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Discusion

- In this study a biomechanical model has been proposed and it allowed obtaining quantitative and consistent values during gait.
- The comparison of the results between the patients with scoliosis and their controls revealed differences between right and left side, in terms of distance between the acromion and the anterior superior iliac spine, showing asymmetry. These data are consistent with the nature of the pathologic process.

- It was observed that during gait the patients with scoliosis showed restrictions in their movements if compared with the control children, who had a higher mobility during the test.
- These differences were statistically significant.
- Several studies measured the gait pattern in patients with scoliosis under different conditions, but only a few studies have been quantified the mobility of trunk during gait.

Conclusion

- Since the scoliosis is a pathology that severely compromises the functionality of movement, as well as the structures and vital organs, it is important to obtain more objective data to establish a timely treatment.
- The use of equipment generally present in the Laboratories for the analysis of human movement allows measuring the behavior of each body segment, in a non invasive way.

Considerations of TRAMA Project

- I would like to say that I am very thankful for the opportunity to participate in the TRAMA project.
- Thanks to the coworkers of each laboratory I visited, people that always in a nice way showed their work dynamics and their tools.
- To the doctors, experts in the area, that shared their knowledge about gait analysis, in the basic research and clinic area.
- To all of my coworkers that participated as grant holders, for your support and friendship.
- To Veronica, Chiara and last but not least to Manuela Galli FOR EVERYTHING, THANK YOU!