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ABSTRACTS

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Etiology of Idiopathic Scoliosis – Do psychological issues contribute?

Weiss HR, ElObeidi N

Asklepios Katharina Schroth Klinik; Korczakstr. 2
D-55566 Bad Sobernheim, Germany

Background data and objectives: Psychological distress can influence a range of chronic health problems. Despite numerous studies reporting a correlation between idiopathic scoliosis (IS) and psychological disturbance; as well as case studies describing psychological disturbance as a cause of 'hysterical' or 'conversion' scoliosis, efforts to define cause and effect in etiology of IS have not been documented. The goal of this study was to test predictions of the hypothesis that emotional and psychological issues contribute to etiology of IS.

Material and methods: Two patient groups were established. The first group (Group I) (with a benign prognosis for significant curvature progression) of patients were mature girls with a Risser sign of at least 4, at least 14 years of age (range 14–17) and a Cobb angle of $\leq 35^{\circ}$ ($n = 47$). The second group (Group II) with poor prognosis for progression consisted of girls at least 12 years of age (range 12–17) and Cobb angle $\leq 50^{\circ}$ ($n = 27$). A depression test (DIKJ) and anxiety test (KAT) for adolescents were implemented, and results were analysed and compared to normal population as well as between the two test groups, using the z-test and T-test for independent samples respectively.

Results: There were no differences between the two test groups with respect to anxiety and depression. Both scoliosis groups showed *less* anxiety in the KAT test when compared to normal however there was no difference between the scoliosis test groups and normal in the depression test.

Conclusions: Within the limits of the defined parameters, no relationship was detected between presence of depression and anxiety, and prognosis as defined by curvature magnitude and skeletal maturity. The fact that there was a clear tendency of both test groups to have less anxiety than normal needs to be discussed. We cannot exclude that psychological issues may contribute to the etiology of Idiopathic scoliosis.

Growth and curve stabilization in girls with adolescent idiopathic scoliosis

Marco E[1], Escalada F[1], Duarte E[1], Muniesa JM[1], Belmonte R[1], Tejero M[1], Cáceres E[2]

[1] Physical Medicine and Rehabilitation. Hospital de l'Esperança. Institut Municipal d'Assistència Sanitària. Barcelona. Spain; [2] Orthopaedic Surgery Department. Hospital de l'Esperança. Institut Municipal d'Assistència Sanitària. Barcelona. Spain.

Objectives: The objective of this study was to detect changes in height and angle over time by the use of a mathematical model in idiopathic scoliosis (IS) patients.

Background data: Influence of growth on idiopathic scoliosis is not still completely known. Although it has not been completely demonstrated, it is accepted that a relationship exists among height growth and curve progression, as well as curve stabilisation occurs when growth ends.

Patients and method: Retrospective study of a cohort of 132 girls. Inclusion criteria were: juvenile or adolescent IS, Cobb angle $\geq 10^{\circ}$, menarche age well reported, follow-up of at least 2 years in 6-month controls. Main variables were: menarche age, height, Cobb angle and treatment. Height and angle changes over the time were adjusted by several curvilinear regression models. The slope between each consecutive time points (first derivative function) was calculated. Growth was considered stabilised when slope changed its sign or was negligible. Height and Cobb angle correlation coefficients for

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repeated measures were estimated within subjects for curves managed with observation and curves managed with a brace. Comparisons between these correlations were based on Fisher-Z transformation.

Results: Cubic was the function that best adjusted height values ($R^2 = 0.329$) and slope changed sign at one year post-menarche. Power function was the best for Cobb angle, but with a small adjustment ($R^2 = 0.038$) and slope was negligible around menarche time. There was a correlation between mean heights and mean angles, being higher for girls managed only with observation. When comparing mean heights in a semester with mean heights of the previous one, we observed statistically significant differences till 2.5–3 years post-menarche, although after the first year, differences were clinically irrelevant. Differences between mean angles were significant since 6 months pre-menarche to menarche.

Conclusions: Cobb angle and height in juvenile and adolescent IS managed with observation tend to become stabilised 2.5 years after menarche, meanwhile Cobb angle in patients treated with a brace tends to become stabilised around menarche time.

Physical exercises as a treatment for adolescent idiopathic scoliosis. A systematic review

Negrini S[1,2], Antonini G[3], Carabalona R[2], Minozzi S[4]

[1] ISICO (Italian Scientific Spine Institute), Milan; [2] Don Carlo Gnocchi Foundation ONLUS, Care & Research Institute, Milan; [3] I Scuola di Specializzazione in Ortopedia e Traumatologia, Ospedale G. Pini, Milan; [4] Center for the Evaluation of the Effectiveness of Health Care (CeVEAS), Modena. Italy.

Study design: Systematic review

Objectives: Verify the effectiveness of physical exercises (PEs) in the treatment of adolescent idiopathic scoliosis (AIS).

Materials and methods: We performed a systematic search on Medline, Cochrane Library, Embase, Cinhal, and an hand-search of the non-indexed pertinent literature. Inclusion criteria: diagnosis of AIS, patients treated exclusively with PEs, outcome Cobb degrees, any study design. A methodological evaluation of the quality of the retrieved study was carried out.

Results: 11 papers were found out of 576 considered. Design of selected studies: randomized 0, prospective 6, controlled 7, compared to historical controls 2, prospective and controlled 1. The methodological quality of these studies was found to be very poor. With one exception, the published studies demonstrated the efficacy of physical exercises in reducing both the rate of progression or the magnitude of the Cobb angle at the end of treatment.

Conclusion: Being of poor quality, the literature failed to provide solid evidence for or against the efficacy of physical exercises. Nevertheless, considering that exercises could be also proposed on the basis that other benefits than to avoid progression have been shown in the literature, and that the results here reviewed suggest an effect on the primary goal of preventing progression, there is a basis for discussion of this option with patients and their families.

Relevancy: Physical exercises as a therapy are proposed in many countries, while are negatively considered in others. This is the first systematic review on the topic.

Social acceptability of treatments for Adolescent Idiopathic Scoliosis

Negrini Stefano[1,2], Brambilla Caterina[3], Carabalona Roberta[2]

[1] ISICO (Italian Scientific Spine Institute), Milan; [2] Don Carlo Gnocchi Foundation ONLUS, Care & Research Institute, Milan; [3] Policlinico di Monza, Monza, Milan. Italy.

Study design: Observational study.

Objectives: Verify the social acceptability of treatments for adolescent idiopathic scoliosis (AIS).

Materials and methods: A validated questionnaire (socio-demographic section and five specific questions) was used to elicit the evidence-based opinion of families with children 11 to 14 years old. 100 subjects (PG) were directly interviewed (response rate: 100%), while all the children (3,162) attending a convenience sample of 10 schools from 4 northern Italian regions (SG) answered the questionnaire (response rate: 34%).

Results: The answers supported the use of screening (94.8%) at school, immediate bracing (76.4%) for scoliosis with a 60% risk of progression, but also therapeutic exercises (86.9%) in cases with a 25% risk of progression. Answers obtained from SG and PG were in some cases statistically different, but patterns and sizes of the responses were similar.

Conclusion: Even if the data were not statistically similar, they might be deemed socially (and clinically) relevant. Conservative options for AIS treatment may be more costly, more time-consuming, and create a greater psychological burden for families and their physicians than more aggressive approaches, but families

nevertheless appear to have conservative attitudes: AIS treatments should be carefully considered in the light of their social acceptability.

Relevancy: There is a growing tendency to consider not only the efficacy and efficiency of treatments, but also their acceptability. Acceptability could be important in areas (like AIS) in which definitive evidence is lacking and invasive approaches are proposed. This is the first study on the topic, and adds significant information to actual clinical approaches.

Compliance in patients with Idiopathic Scoliosis (IS) – How to improve?

Weiss HR, Reiter CH

Asklepios Katharina Schroth Klinik; Korczakstr. 2
D-55566 Bad Sobernheim, Germany

Objectives: A great number of studies show that results of the conservative scoliosis treatment are related to good compliance. Purpose of this study is to answer the question if an intensive inpatient rehabilitation programme can improve compliance to exercise at home regularily. A better compliance would mean a reinforced exercise intensity at home after inpatient Rehabilitation.

Study design: Retrospective questioning of scoliosis patients after end of bone growth with the help of a questionnaire.

Material and method: From the data bank of this scoliosis inpatient rehabilitation centre all those patients with scoliosis were chosen, who had an intensive inpatient rehabilitation (SIR) between 1993 and 1996 and were between 10 and 13 years old at that time. At the time of questioning in 2001 they were at least 15 years of age and thus at the end of growth. The questions referred to exercise intensity and exercise time before the first SIR, exercise intensity and time at home after the first SIR. The exercise intensity had to be marked within a scale from 0 to 3, the exercise time should be indicated in minutes per week. The Wilcoxon test was used to compare the rates before and after SIR.

Results: After SIR both, exercise intensity (1,4 before and 1,7 after SIR) and exercise time (65 Min. before and 83 Min. after SIR) reinforced significantly.

Conclusion: The compliance for doing the exercise programme at home improved after SIR. So the psychological intervention during SIR plays an important role to stabilize or to improve compliance of patients with IS.

Biomechanics of specific exercises to correct scoliosis in 3D

Rigo M, Quera G, Puigdevall N, Corbella C, Gil MJ, Martínez S, Villagrasa M

Instituro Elena Salvá. Vía Augusta 185, 08021

Study design: the back shape of thirty-four consecutive patients was prospectively evaluated before and after an intensive out-patient course of exercise therapy according to the Schroth method, using the formetric surface topography system.

Objective: To check the biomechanics of the exercise program by producing three-dimensional changes in back shape and spinal shape.

Methods: Formetric pictures were taken immediately before and after an intensive out-patient course of rehabilitation including specific exercises according to Schroth. Mean age was 15.2 y (9–41). The mean Cobb angle and the mean torsion angle according Perdriolle were 37.7° (15°–85°) and 20° (5°–45°) respectively. Sixteen out of thirty-four patients with no other treatment than exercises. Eighteen out of thirty-four patients had been in a brace at least three months before starting the exercises program. All changes were expected to be produced by the exercises. Four main values produced by the formetric system were evaluated: 1) Lateral deviation–root mean square (ldrms), which is value to describe the global shape of the spine in the coronal plane, and lateral deviation–maximum–(ldmax). 2) Rotation–root mean square (rotrms), which is a mean value for surface rotation and rotation–maximum (rotmax).

Results: Lateral deviation (ldrms) decreased from 13.5 mm to 10 mm, (ldmax) from 25.1 mm to 18.5 mm. Rotation also decreased (rotrms) from 6.8° to 5.6°, (rotmax) from 13.1° to 10.5°. $P < .05$ in all the values. Results were no different between braced and unbraced patients. Twenty-one patients showed individual significant differences in ldrms and or rotrms with no worsening in any value (Group 1). Thirteen patients did not show significant change in any value (Group 2). Age, Cobb angle as well as rotation were not significantly higher in G1 but there was a clear tendency. Initial formetric values were higher in G1 ($p < .05$). The correlation between initial lateral deviation and Cobb angle was higher in G1($r = .74$) than in G2($r = .56$). Also correlation between initial surface rotation and radiological rotation was higher in G1($r = .73$) than in G2($r = .65$).

Conclusions: An intensive out-patient course of rehabilitation according to Schroth can produce temporary

correction of the 3D back surface suggesting that the applied principles of correction are effective correcting the spinal midline in three-dimensions. Changes in the lateral shape of the spine were not quantified due to the initial variability but they are discussed. Patients with initial higher values (both formetric and radiological) and patients with higher correlation between back shape and spinal alignment seems to be easier to correct by exercises.

A non-invasive approach for scoliosis assessment

Ovadia D[1], Fragniere B[2], Dickman J[3], Leitner J[4], Rigo M[5], Dubousset J[2]

[1]Dana Children's Hospital, Tel Aviv; [2]St. Vincent de Paul, Paris; [3]OrthoScan Technologies, Yokneam; [4]Meir Hospital, Kfar Saba; [5]Instituto E. Salva, Barcelona

Objectives: To investigate the correlation of spinal deformity measurements with Ortelius800TM radiation-free system as compared to the standard radiographic measured Cobb angles.

To assess Ortelius800TM clinical value while enabling a significant reduction of x-ray exposure.

Methods: 102 patients diagnosed with AIS from three different medical centers were measured with the Ortelius800 TM system by the same standard protocol. The entire process required an average of 2 minutes.

The Ortelius800 TM measurements were correlated with the standard Cobb angle as measured on routine standing coronal and sagittal radiographs.

Results: Two hundred and five coronal Cobb angles were measured for scoliosis with a mean of 18° for thoracic curves and 17.7° for lumbar curves and a median of 17.0° for thoracic curves and 17° for lumbar curves. Thirty-eight sagittal Cobb angles were measured with a mean of 36° a median of 34.0°. No statistical difference was found when comparing median of Cobb angles measured by Ortelius800TM. The Pearson's correlation coefficient was 0.85 in both the coronal plane and the sagittal plane (P value of < 0.0001). The mean difference between Ortelius800TM and radiograph measurements was 0.29 [(95% confidence interval (-0.51; 1.09)]. The Wilcoxon signed-ranks test for matched pairs shows no statistically significant difference between the two measuring methods (P value $=$ 0.651).

Relationship between findings and existing knowledge: The golden standard for scoliosis assessment is the radiograph with Cobb angle measurement. The Ortelius 800TM provides a radiation-free method for scoliosis assessment in three planes (coronal, sagittal, apical) with simultaneous automatic calculation of the Cobb angle in both coronal and sagittal views.

Conclusions: The results reveal good correlation between the two measuring methods in both coronal and sagittal views. Comparison of results from the three independent sites and six independent examiners shows no significant difference. We propose the Ortelius800TM as a clinical tool for the routine follow-up measurements of AIS patients, thus enabling a significant reduction of radiation exposure.

Validity of clinical examination in adolescent spinal deformities

Monticone M[1], Negrini S[1,2], Grosso C[2], Paroli C[1], Carabalona R[2], Negrini A[3]

[1] ISICO (Italian Scientific Spine Institute), Milano; [2] Fondazione Don Gnocchi, ONLUS, IRCCS, Milano; [3] Centro Scoliosi Vigevano (Italy)

Study design: Reliability study

Objectives: To evaluate in a clinical setting the inter-examiner reliability of three non invasive measurement used in everyday clinical practice:

- angle of trunk rotation according to Bunnel (ATR; °);
- height of the hump during the Adam's test (HH; mm);
- distance of C7, T12 and L3 spinous processes from the plumbline in standing (DP; mm).

To correlate these measurements with the "gold standard" measurement in spinal deformities: the Cobb angle (CA).

Materials and methods: Retrospective study in a clinical setting. Two expert examiners during their everyday practice measured independently and in the same conditions all patients. The CA was obtained according to the individual clinical needs. The Intra-class Correlation Coefficient (ICC) and the Pearson's product-moment correlation coefficient were used. Population: subjects 116 (females 78); scoliosis 22.1 ± 11.2, kyphosis 45.9 ± 12.5, lordosis 50.6 ± 10.7 Cobb degrees.

Results: Range of ICC (reliability) according to location of the curvature: HH 90–91%, ATR 86–89%, DP 69–76%. Range of correlation with radiographic exam (R^2: Pearson's product-moment correlation coefficient) according to location of the curvature: HH 0-04-0.42, ATR 0.01-0.27, DP 0.03-0.36.

Conclusion: The high repeatability of ATR obtained in experimental settings was confirmed in clinical

everyday practice. Surprisingly HH, commonly considered not reliable, showed to be even better than ATR. Nor ATR or HH demonstrated to be correlated with CA. This was expected, even if in the literature a correlation between CA and ATR has been reported, because both ATR and HH measure the rotation of the spine in the horizontal plane, while CA measures the lateral flexion in the frontal plane: CA, ATR and HH are measurements of two different phenomenons of the same deformity. Interesting were also the results on the sagittal plane, where data in the literature are sparse.

A prospective randomized study of the natural history of idiopathic scoliosis versus treatment with the spinecor brace: interim results

Rivard CH, Coillard C, Zabjek KF

Research Centre, Sainte-Justine Hospital, 3175 chemin de la Côte Ste-Catherine, Montreal, Quebec, Canada, H3T 1C5.

Study design: Prospective randomized study.

Objective: The objective of this prospective randomized study is to perform an interim comparison of the natural history of Idiopathic Scoliosis patients with a Cobb angle between 15 and 30 degrees to a treated group with the SpineCor brace.

Methods: A cohort of 65 patients were randomly assigned to a control non-treated ($n = 36$; age = 12 years; Cobb angle: 20 ± 5 degrees) or treated group with the SpineCor brace ($n = 29$; age = 12 years; Cobb angle: 22 ± 5 degrees). Inclusion criteria included an initial Cobb angle between 15 and 30 degrees, Risser 0, 1 or 2, high risk of progression (increase of Cobb angle of 5 degrees or more within the last 6 months), girl or boy and no significant malformation of the spine. Each patient underwent a comprehensive evaluation (radiological and clinical) prior to commencing the study, at 4 month intervals during treatment and follow-up.

Results: From both groups there were 3 patients who withdrew from the study. For the remaining 33 control subjects there was a mean Cobb angle of 26 ± 8 degrees at the last available visit with 45 percent were stable, 12 percent improved, and 42 percent worsened. For the treated group, 20 are still in treatment with a mean Cobb angle in brace of 15 ± 7 degrees, with 76 percent improved, 14 percent were stable, and 5 percent worsened. The remaining 6 patients, in the treated group, have been weaned from the brace but for less than 1 year.

Conclusions: This is the first prospective randomized study on Scoliosis patients investigating the Cobb angle between 15 and 30 degrees. This interim evaluation reveals a strong tendency where 42 percent of the control group worsen, compared to the treated group who showed a worsening of only 5 percent. This interim result which shows this large difference in worsening between treated and non-treated patients questions the logic of continuing this prospective randomized study.

Experiences gained with the SpineCor Dynamic Brace in Hungary

Judit G Farkas MD

OSEI, Budapest, Hungary

Background data: Treatment of scoliosis is not considered a priority in Hungary. However, about 1000 of cases with a Cobb angle of more than 20 degrees are braced. 90% of these had Chêneau bracing and 10% used either the Milwaukee or Stagnara.

Material and methods: 18 patients with idiopathic scoliosis who were treated with Spine Cor Dynamic Brace are included in this perspective study. There are 15 female and 3 males. Age range is 8–16 years with mean age of 12.3 y. Risser sign ranges from 0–4. The types of scoliosis are:

RTh(III)	- 7 patients
RTh/L(II)	- 3 patients
LTh/L(I)	- 1 patient
LL	- 1 patient
LEu	- 2 patients
RTh/LL(III)	- 3 patients

Eight patients had physiotherapy treatment prior to bracing, 2 patients had rigid bracing initially, while 8 patients were treated by dynamic bracing from the beginning.

Results: Follow up ranges from 1–24 months. The mean height gain was 6.37 cm (Range 0.5–13.5 cm). The mean in Cobb angle change was 23 degrees (Range 15–44 degrees). No significant changes were found in 5 cases while 2 (Left Eu type) developed a secondary curve, of which one required rigid bracing and the other required surgical correction. In the other case Cobb angle was reduced by 54%.

Conclusion: 66.6% of the cases improved by dynamic bracing. In 5 cases–no change was detected, while one case deteriorated, requiring surgical correction.

Prevalence of surgery in patients with adolescent idiopathic scoliosis (AIS) following conservative treatment – A meta analysis

Weiss HR, Weiss GM

Asklepios Katharina Schroth Klinik; Korczakstr. 2
D-55566 Bad Sobernheim, Germany

Study design: Meta-analysis of outcome in terms of prevalence of surgery for adolescent idiopathic scoliosis in patients receiving conservative management compared to scoliosis centers with observation only.

Objectives: To determine whether centers with an active policy of conservative management have fewer patients who eventually undergo surgery for adolescent idiopathic scoliosis than a center where the practice is non intervention.

Background data: The efficacy of orthoses for the treatment of AIS was called into question in a recent publication. Because the prevalence of surgery in an untreated group of patients (28.1%) was not significantly different from that in a braced group from the US (22.4%), the authors concluded that bracing appears to make no difference. However the results from central European brace centers seem different with surgery rates of far less than 10% in comparable samples.

Methods: In the peer reviewed literature quite a few studies can be found addressing the topic incidence/prevalence of surgery in Patients with AIS. The prevalence of surgery from those studies was compared with that of published data from a center where the practice is nonintervention.

Results: Two Studies from central Europe and one study from Japan matched to the control study (28.1%) and presented surgery rates of 5–7%. One of the studies included a worst case analysis including all drop outs as failures. Statistically, comparing the rate of surgery untreated vs. conservative treatment, the differences found were highly significant.

Discussion: The results of this study is consistent with the hypothesis that conservative management reduces the prevalence of surgery. Prevalence of surgery in braced populations from the USA however are not significantly different from untreated controls. The bad results of braces from the US are obviously due to old concepts that need to be changed.

Conclusions: If conservative management does reduce the proportion of children with AIS that require surgery, it can be said to provide a real and meaningful advantage to both the patients and the community. We contend that conservative methods of treatment should never be ruled out from scoliosis management, because they offer a viable alternative to those patients who cannot or will not opt for surgical treatment. The standard of excellence seems to vary worldwide. Bracing concepts not changing prevalence of surgery have to be regarded as outdated not justifying the impact on quality of life of the patients treated.

Effectiveness of conservative treatment for idiopathic scoliosis – a combination of brace treatment and physical treatment

Toru Maruyama[1], Tomoaki Kitagawa[2], Katsushi Takeshita[3], Keiichi Mochizuki[3], Kozo Nakamura[3]

[1] Dept. of Orthopaedic Surgery, Teikyo University School of Medicine; [2] Dept. of Orthopaedic Surgery, Dokkyo University School of Medicine; [3] Dept. of Orthopaedic Surgery, Faculty of Medicine, The University of Tokyo

Background: Despite positive results obtained with brace treatment in a prospective controlled study conducted by the Scoliosis Research Society, its effectiveness remains a subject of debate. Physical treatment is generally considered not to be therapeutic for idiopathic scoliosis.

Objectives: Since 1986 we have been conducting conservative treatment for idiopathic scoliosis with a combination of brace treatment and physical treatment. In general, mild curves (Cobb angle $< 25^\circ$) and curves in skeletally mature patients (Risser sign of 4 or 5, postmenarche > 2 years), are managed only with physical treatment (side shift or hitch). Patients with moderately severe and/or progressive curves (Cobb angle $> 25^\circ$, Risser sign of 0 to 4, documented progression of $> 5^\circ$) are managed with a combination of part-time brace wearing and physiotherapy. The aim of this study was to evaluate the effectiveness of the conservative treatment for idiopathic scoliosis by 1) analyzing whether it could reduce the incidence of surgery and 2) analyzing the results of the skeletally mature patients who received only physiotherapy.

Materials and methods: 1) A total of 328 female patients with AIS who were at least 10 years of age at the first visit, with Cobb angle of 10° at the minimum were followed for 5 years in average until after 15 years of age or skeletal maturity. Incidence of surgery among these patients was investigated. 2) Sixty-nine patients who were Risser sign of 4 or 5 at the beginning of the treatment and who were treated only by the side shift exercise were followed for 4.3 years in average.

Curve magnitude of these patients before and after the treatment were compared.

Results: 1) The average Cobb angle was 32.4° and the average age was 13.8 at the first visit. Of 328 patients, 20 patients received surgical treatment. Incidence of surgery was 6.1%, which was significantly lower than that reported by the institution with non treatment policy. 2) The average Cobb angle was 31.5° at the beginning of the treatment and 30.3° degrees at final follow-up. Curves of four patients decreased 10° or more.

Conclusion: Conservative treatment was effective for idiopathic scoliosis.

Effectivity of SpineCor treatment during pubertal growth spurt in girls with Idiopathic Scoliosis (IS)

Weiss, HR; Weiss GM

Asklepios Katharina Schroth Klinik; Korczakstr. 2 D-55566 Bad Sobernheim, Germany

Study design: Comparison of the survival rates of two different bracing concepts with respect to curve progression during pubertal growth spurt.

Objectives: To determine whether the results obtained by the use of a soft brace (Spine Cor) is comparable to the results of the most practised bracing concept in central Europe during pubertal growth spurt.

Background data: In the recent peer reviewed literature the SpineCor is described as an effective method of treatment for patients with scoliosis. However the samples included were not homogenous enough to draw conclusions. Up to now no controlled study is presented comparing the results obtained with this soft brace to a sample treated with other bracing concepts. To our knowledge no sample has been investigated treated with the SpineCor exactly during pubertal growth spurt.

Methods: 12 Patients with Cobb angles between 16 and 32° during pubertal growth spurt are presented as a case series treated with the SpineCor. Survival rate of this sample is described and compared to a matched Group of patients treated with the Chêneau brace of the same age group. All girls treated in both studies were premenarchial with the first clinical signs of maturation (Tanner 1–3).

Results: During the pubertal growth spurt most of the patients (11/12) with SpineCor progressed clinically and radiologically as well (at least 5°). Progression could be stopped changing SpineCor to the Chêneau brace in most of the sample described (7/10). The average Cobb angle at the start of treatment with the SpineCor was 21.3°, after an average observation time of 21.5 Month 31°. The control sample primarily treated with the Chêneau brace ($n = 15$) showed at average no progression. Cobb angle at the start of treatment was 33.7° and after the observation time of 37 Month 33.9°. Radiological improvements can be reported for some of the cases (3/15) as well as progressions (3/15).

Conclusions: Soft braces do not change natural history of idiopathic scoliosis during the pubertal growth spurt. The use of the Chêneau brace seems to do so. There is no indication for soft braces, while hard braces with a certain standard of excellence seem indicated once the Cobb angle exceeds 25° in patients still growing. In patients with Cobb angles of less than 20–25° observation only or physiotherapy alone is justified, for those cases in general have a benign prognosis.

Survival analysis of the first weaned patients treated with the SpineCor brace

Rivard CH, Coillard C, Zabjek KF

Research Centre, Sainte-Justine Hospital, 3175 chemin de la Côte Ste-Catherine, Montreal, Quebec, Canada, H3T 1C5.

Study design: Prospective consecutively treated.

Objective: The objective of this study is to assess the success of treatment during the follow-up of a group of consecutively treated Idiopathic Scoliosis (IS) patients treated with the SpineCor brace.

Methods: A survival analysis was performed on 68 patients who had terminated treatment from a cohort of 200 consecutively treated patients with the SpineCor since 1994. A survival analysis was performed to estimate the probability of success at 1, 2, 3, 4 years post-treatment without brace. The difference between the initial radiological Cobb angle, and the last available Cobb angle during follow-up without brace was used to define a failure (aggravation of 5 degrees more) or success (stabilization, correction). The patient cohort was categorized as either less than 30° (G1), and greater than 30° (G2).

Results: For the total group of patients (Initial Cobb angle: $30° \pm 9°$) the trend during treatment was a decrease in spinal curvature at three months with a mean difference of 9° (SD: 6°), at termination of treatment (time = 23 months) a mean difference of 5° (SD: 7°); and at a follow-up time of 1, 2, 3 and 4 years there was a difference of 2° (SD: 7°), 6° (SD: 5°), 0° (SD: 8°), and 8° (SD: 4°) in reference to the initial condition. The survival analysis (G1 and G2) indicated a cumulative probability of success during follow-up without brace as follows. Year 1: probability (p) = 1.00,

(Confidence Interval (CI): 1.00 to 1.00) for G1, $p = 1.00$ (CI: 1.00 to 1.00) for G2; Year 2: (p) = 0.98 (CI: 0.93 to 1.00) for G1, $p = 0.92$ (CI: 0.82 to 1.00) for G2; Year 3: $p = 0.92$ (CI: 0.83 to 1.00) for G1, $p = 0.92$ (CI: 0.83 to 1.00) for G2; Year 4: $p = 0.88$ (CI: 0.76 to 0.99) for G1, $p = 0.92$ (CI: 0.73 to 1.00) for G2.

Conclusions: This initial cohort of patients demonstrated a general trend of initial decrease in spinal curvature in brace, followed by a stabilization and/or correction at the end of treatment which was maintained through 1, 2, 3, and 4 years follow-up.

Protocol for the prospective study on the effectiveness of bracing for scoliosis

Tomasz Kotwicki[1], Witold Dudziński[2], Andrzej Szulc[1]

[1]Department of Pediatric Orthopedics [2]Department of Rehabilitation. University of Medical Sciences. ul. 28 Czerwca nr 135. 61-545 Poznań, Poland
tomaszkotwicki@poczta.onet.pl

It is admitted to judge the effectiveness of therapeutic methods according to the principles of the Evidence Based Medicine (EBM). This requires prospective, randomized, double blind studies. Although methodologically attractive, the randomized studies can cause important ethical dilemmas in the situation when the natural course of the disease leads to irreversible deterioration. Then the use of a placebo or of an ineffective method as a control is not acceptable.

The study on the treatment of idiopathic scoliosis has to take into consideration the prevalence and the natural history of the disease. This implies studying the female population between 10 and 15 years of age. The periods of vertebral growth spurt accompany the periods of rapid progression of the curve. On the other side the effect of therapy can be best demonstrated in this period.

The methodology of the research on the effectiveness of bracing should contain: 1) creating the international working group, 2) establishing a multicenter study, 2) constructing a data base accessible by internet, 3) application of strictly defined inclusion criteria, 4) therapy applied by each of the members of the working group according to his personal conviction, 5) prospective evaluation, 6) adequate follow-up, 7) correct statistical analysis.

We propose the protocol for the prospective evaluation of patients treated with brace for idiopathic scoliosis. The protocol is already introduced in the departments of our Faculty of Medicine and is being prepared to be accessible on-line.

Material: Inclusion criteria: idiopathic juvenile or adolescent scoliosis, age > 10 years, Cobb angle from 20 to 40 degrees, Risser test value 0 or 1 or 2.

Method: Clinical exam is performed according to an established schema. The questionnaire accessible on-line guides the examination. Numeric parameters are considered for statistical purpose. The subjective parameters are eliminated. Radiological parameters include frontal Cobb angle, Perdriolle angle of axial rotation and others. Surface topography parameters are discussed.

Once a year clinical and radiological assessment is mandatory.

Results: Multicenter data base should be completed according to the decided follow-up.

Conclusion: The above proposed protocol can be helpful in obtaining well-founded results. Thus the comparison of different specific techniques of bracing would be possible. The evidence of the outcome of brace treatment versus natural history of scoliosis would support establishing standards of this therapy.

Three-dimensional postural parameters that differentiate scoliotic curves

Zabjek KF, Coillard C, Rivard CH

Centre de Recherche, Hôpital Sainte-Justine, 3175 Ch. Côte Ste-Catherine, H3T 1C5

Study design: Prospective study.

Objective: The objective of this study was to identify postural characteristics that differentiate scoliosis patients classified radiologically as Left Thoracolumbar (LThL), Right Thoracic (RTh) and Right Thoracic-Left-Thoracolumbar (RThLL).

Methods: In this prospective study, the postural geometry of 19 LThL, 25 RTh, and 18 RThLL Idiopathic Scoliosis patients was evaluated non-invasively with a stereovideographic system. Angular (rotation, tilt, version) and linear (AP and ML shift) parameters were calculated for the pelvis and shoulder girdle. A one way ANOVA was used to detect significant differences between groups.

Results: Significant differences were found between shoulder and scapular rotation relative to the pelvis (LThL vs RTh& RThLL), shoulder rotation relative to the scapula (LThL vs RTh & RThLL), gibbosity (G1 vs RTh), ML shift of T1 (LThL vs RTh & RThLL) and rotation (LThL vs RTh), tilt (LThL vs RTh, RTh vs RThLL) of the pelvis. The Thoracolumbar group was differentiated from the thoracic group by the rotation (-3.9° to 7.6°) and tilt (-0.7° to 4.9°)

of the pelvis, and the Thoracic group by its involvement with the thoracic cage that had an impact on shoulder (-6° to 13°) and scapular orientation (2° to -15°), and ML shift of the shoulder girdle (17 mm to -26 mm). The right thoracic left lumbar group had similarities to LThL and RTh.

Conclusion: The differences found between groups could be related to the side and apex of the curve where the skeletal structures most proximal to the deformity are the most affected. The postural evaluation of scoliosis patients is effective in identifying differences between patients classified radiologically. This information serves the basis for further investigation into the relationship between the spine and the posture of Idiopathic Scoliosis patients.

Oculomotor functional improvement in scoliotic children with bracing

Lamantia MJ, Deutchman G, Bagley Ch

Scoliosis Care Foundation. 2 West 86th Street. Suite 4. New York, NY 10024

Design: Three (3) pediatric case studies of patients with scoliosis were tested for oculomotor and vestibular function utilizing Video Electronystagmography (ENG). The studies were performed with the subjects both wearing and not wearing their scoliosis brace. The following tests were completed; saccade speed/latency/accuracy were recorded and measured for a random stimulus in all participants, and a fixed stimulus recording was made in two (2) of the participants, Optokinetic gain at 30 d/s, and sinusoidal smooth pursuit gain at 0.1 hz, 0.2 hz, and 0.4 hz. Vestibular testing was only performed without bracing with cool and warm water.

Objectives: The purpose of this study is to better understand the central neurological affects of Spinal Bracing on brainstem and cerebellar function as objectified by oculomotor testing.

Background: Cortical deficits, as well as vestibulocerebellar, and brainstem lesions have long been implicated as a potential contributor to idiopathic scoliosis. Video electonystagmography (ENG) is a standardized test which allows the clinician to objectively assess central control mechanisms of spinal posture and oculomotor function. The study of eye movements are considered to be a superior method of assessing brain function as reported by David Zee M.D. More current research has revealed common areas of the cortex, brainstem and cerebellum to be responsible for eye movements and spinal postures.

Methods: The patients were evaluated utilizing micromedical video electronystagmography (ENG). Testing was performed with the patient in a seated position 39 inches from a stimulus light bar. Testing was performed in a random ored with regards to braced vs. non-braced.

Results: Raw data results revealed a significant improvement in all measures of Saccade performance, (acc-8%–30%, lat-25% sp-100% > 275 d/s), sinusoidal (20%–40%) and optokinetic gain (30%–60%) during the "braced" testing. Vestibular testing revealed unchangeable unilateral or bilateral deficits in all participants.

Conclusion: Bracing of scoliotic patients caused immediate increased cerebellar afferentation or feedback, and improved central brainstem (oculomotor) function in the cases studied. These findings indicate that the affect of bracing is central in its nature, causing cerebellar and brainstem functional improvement. Further research in this area may give objective evidence that the success of bracing in scoliosis is due to central neurological rehabilitation.

Utility of peak angle velocity in the assessment of adolescent idiopathic scoliosis

Marco E[1], Escalada F[1], Belmonte R[1], Duarte E[1], Muniesa JM[1], Tejero M[1], Cáceres E[2]

[1] Physical Medicine and Rehabilitation. Hospital de l'Esperança. Institut Municipal d'Assistència Sanitària. Barcelona. Spain. [2] Orthopaedic Surgery Department. Hospital de l'Esperança. Institut Municipal d'Assistència Sanitària. Barcelona. Spain.

Objectives: Main objective of this paper was to study when peak angle velocity occurs in girls with adolescent idiopathic scoliosis and establish a correlation between height and angle velocities.

Background data: Relationship between height and angle in idiopathic scoliosis (IS) has not been adequately demonstrated. Although it has been demonstrated that peak height velocity is a predictive factor of progression in IS, little is known about importance of peak angle velocity.

Patients and method: Retrospective study of a cohort of 132 girls. Inclusion criteria were: adolescent IS, Cobb angle $\geq 10^\circ$, menarche age well reported, follow-up of at least 2 years in 6-month controls. Main variables collected were: menarche age, height, Cobb angle, curve progression and treatment. Height and angle velocities were calculated from height and angle values.

Comparisons between means of height and angle velocities were done using Student t test.

Results: In our sample, peak angle velocity occurs one year before menarche in progressive scoliosis and/or scoliosis managed with bracing followed by a negative growth around menarche time. Angle distribution did not allow to apply statistical tests to establish a relationship between height and angle velocities.

Conclusions: Although, graphic data suggest a relationship between angle and height curves in IS, the lack of a linear distribution in angle progression makes difficult the application of statistical tests to correlate height and angle velocities.

Efficacy of antilordotic TLSO braces to reduce spondylolisthesis in adolescents: preliminary results from a clinical retrospective study

Negrini Stefano[1,2], Monticone Marco[1], Paroli Chiara[1]

[1]ISICO (Italian Scientific Spine Institute), Milan; [2]Don Carlo Gnocchi Foundation ONLUS, Care & Research Institute, Milan. Italy.

Study design: Retrospective clinical series

Objectives: The use of braces for spondylolisthesis in adolescents has been proposed in the literature to reduce symptoms, but not deformity. Aim of this paper is to review retrospectively some clinical data on the efficacy of antilordotic TLSO braces to reduce spondylolisthesis in adolescents.

Materials and methods: Inclusion criteria: 20–25 ± 5% isthmic spondylolisthesis; Risser sign 0–3 at start, at least 4 today; at least 2 years of treatment. Design: consecutive recruitment of all patients matching inclusion criteria. Population: 19 subjects (6 males); spondylolisthesis 20.0 ± 5.6% (range 15–30); age 13.5 ± 2.7 years at start, 16.8 today. Treatment: full-time antilordotic brace, progressively reduced according to bone age; stabilizing physical exercises. 14 subjects still wear the brace night-time, while 5 reached a 6 months follow-up.

Results: Spondylolisthesis: 12.2 ± 8.4% according to radiographs after at least 12 hours without brace (up to 6 months). Average treatment time: 3.3 ± 1.9 years. 1 case progressed (from 15% to 22%), 1 did not change, 9 improved of more than 50%, 5 of more than 90%, 3 reached 0. 5 patients reached the end of treatment and showed, at the 6 months follow-up, a reduction of spondylolisthesis between 0% and 9%, stable at dynamic radiographs.

Conclusion: These results suggest the possible usefulness of braces for spondylolisthesis in adolescents, even if a controlled study is needed.

Relevancy: There are no results on this topic in the literature, and no conservative therapies are proposed to date to reduce spondylolisthesis in growing age.

Reliability of the Scoliosis Research Society – 22 patient qsuestionnaire (Italian version) in mild adolescent vertebral deformities

Monticone Marco[1], Carabalona Roberta[2], Paroli Chiara[1], Negrini Stefano[1,2]

[1]ISICO (Italian Scientific Spine Institute), Milan; [2]Don Carlo Gnocchi Foundation ONLUS, Care & Research Institute, Milan. Italy.

Study design: Reliability evaluation

Objectives: Validation of the Scoliosis Research Society-22 Patient Questionnaire, Italian version (SRS-22-I), in adolescents with mild vertebral deformities.

Material and methods: Study design: forward-backward translation, final version according to a group evaluation, pre-test for comprehension, 1 week test/retest. Population (pre-test): 35 subjects (22 females), age range 8.5–19 years, 28 idiopathic scoliosis (17° ± 7°), 7 hyperkyphosis (54° ± 4°). Population (test/retest): 20 subjects (11 females), age range 11–17 years, 15 idiopathic scoliosis (16° ± 8°), 5 hyperkyphosis (55° ± 5°). Statistical analysis : Spearman rank test, percent of agreement. Statistical significance: 0.05. Software: Statgraphics 3.0.

Clinical results: All patients answered all questions. Total score: median 3 (range 1-5); results for different domains: function/activity 4 (range 3–5), pain 5 (3–5), self image/appearance 3 (2–5), mental health 4 (3–5), satisfaction with management 4 (2–5).

Reliability results: Time required to answer the questionnaire: range 5–20'; 11–19 years old subjects: 5–10'. Pre-test: difficulties with questions on pain, the questionnaire was changed accordingly. Test/retest: Spearman's rho range 0.43–1, it was not significantly different from null value for question 21, and consequently for management domain; question 12: $0.05 > p$ value < 0.1. Percent of agreement (question 11) was 100%.

Conclusion: The SRS-22-I was: found to be reliable for young patients with mild vertebral deformities of different type. The not reliability of question 21 should be better understood.

Relevancy: Till now the SRS-22 questionnaire has been applied and validated only in USA populations,

and in idiopathic scoliosis. Moreover, only one study has been proposed including patients with mild idiopathic scoliosis.

Scoliosis correction with TLSO by apex translation

Landauer F, Behensky H, Wimmer C

Department of Orthopaedic Surgery. General Hospital SJS. Müllner Hauptstr. 48. 5020 Salzburg. AUSTRIA. f.landauer@lks.at

Objective: This study was performed to evaluate whether derotation and/or translation are the correction mechanisms of bracing with TLSO (Cheneau brace) in treatment of adolescent idiopathic scoliosis.

Methods: Curves were measured according to Cobb, rotation of apex vertebra was determined according to Perdriolle. Translation of the apex vertebra perpendicular to the central sacral line was measured according to Mason and Carango. Measurement were performed on standing radiographs AP and were taken immediately before starting therapy, six months afterwards and at least one year after treatment. Compliance was judged as follows: regular and frequent control examinations, obviously used brace and visible skin signs. Therefore two groups of patients were formed (group A: good compliance, n-32; group B: bad compliance, n-22).

Results: In group A continuous curve correction of 6° Cobb angle was evident. Patients of group B showed a mean curve progression of 4° (t.test; $p = 0.003$). After six months therapy both groups demonstrated significant apex translation (group A: $p = 0.0001$, group B: $p = 0.003$; difference between groups not significant), but no significant derotation of apex vertebrae. At follow up patients with good compliance showed almost same apex distance as before therapy, whereas a deterioration was evident in group B ($p = 0.01$; difference between groups significant, $p = 0.04$). Apex rotation worsened significantly in both groups (group A: $p = 0.02$, group B: $p = 0.03$; difference between groups was not significant).

Conclusion: Curve correction in idiopathic scoliosis with TLSO (Cheneau brace) is a translation process and can be determined as a shift of the apex vertebra to the central sacral line.

Correction of thoracolumbar and lumbar curves with a new short brace for Idiopathic Scoliosis

S. Lupparelli[1], A.G. Aulisa[2], G. Mastantuoni[2], E. Pola[2], F. Larosa[2] and L. Aulisa[2]

[1] Centro Orthopedico Umbro, Perugia, ITALY; [2] Clin. Orthop. Pol. A. Gemelli–Universitá Cattolica del Sacro Cuore, Roma, ITALY

Design: A retrospective study was performed.

Objective: In this paper the results of patients treated with the Progressive Action Short Brace (PASB) are presented.

Background data: Recent reports suggested that bracing can stop idiopathic scoliosis progression, whereas long-term correction has not been achieved.

Material and methods: Inclusion criteria were a single major thoracolumbar or lumbar idiopathic curve and 2 year minimum follow-up. 70 patients satisfied the criteria. X-rays were performed at treatment start t_1, best correction in brace t_2, intermediate time t_3 between t_1 and t_4, end of weaning t_4, 2-year minimum follow-up t_5 from t_4. Curve magnitude C_M, torsion of the apical vertebra T_A and mean torsion of all vertebrae in the curve T_M were measured with Cobb and Perdriolle method. C_M, T_A and T_M variations were assessed by ANOVA ($P < 0.01$). Results were analysed assuming that C_M t_5–t_1 be not within ± 5 error range. Three situations were distinguished: correction (C_M t_5–$t_1 < -5°$ Cobb), stabilization (C_M t_5–$t_1 \geq -5$ and $\leq 5°$ Cobb) and progression (C_M t_5–$t_1 > 5°$ Cobb).

Results: There were 20 lumbar and 50 thoracolumbar curves. Mean follow-up length was 36.0 ± 1.6 months. C_M was 23.6 ± 6.3 at t_1 and 16.2 ± 8.4 at t_5; T_A was 12.0 ± 6.1 at t_1 and 9.2 ± 6.7 at t_5; T_M was 8.7 ± 4.2 at t_1 and 6.8 ± 5.1 at t_5 ($P < 0.000$). Correction, stabilization and progression were respectively obtained in 63%, 33% and 4% patients.

Conclusions: Results would indicate that the PASB, by its peculiar biomechanics, may achieve correction of thoracolumbar and lumbar idiopathic curves.

Evolution of orthopaedic management of idiopathic scoliosis with the introduction of new materials

Rotllant R

Hospital Universitario de Bellvitge. Barcelona, Spain

Background: Orthopaedic management remains crucial in modifying the natural history of idiopathic scoliosis (IS) and EDF plaster braces affect in an important manner. The management is complex and it requires a high grade of dedication both by the practitioner as well as the family. This study is designed to expedite the complete process.

Objective: The purpose of this study is to demonstrate that the introduction of fibre-glass in the making of

EDF braces reduces the global cost without significant loss in the correction of Cobb angle nor apical rotation, both of the major and the minor curve.

Material and method: This is a consecutive study carried out at Hospital Universitario de Bellvitge on the orthopaedic management of idiopathic scoliosis. IS was studied in three groups of patients still in process of growth who have been treated with EDF method made in Abbot-Cotrel frame, with several variations in every one.

In group A (hospitalisation $n = 19$), all patients, before EDF brace, have required admission to the hospital remaining in continuous vertebral traction an average of 7.5 days. EDF has been carried out with plaster bandages.

In group B (day-hospital $n = 19$), patients have not required previous continuous vertebral traction. They have stayed in the hospital an average of 5 hours and EDF brace has been carried out with plaster bandages. In group C (outpatient $n = 25$), patients have not required previous continuous traction. They have stayed in outpatients department an average of 2.5 hours and EDF brace has been carried out with fibre-glass bandages.

Statistical method: Level of statistical significance was considered to be lower than 5% ($p < 0.05$) in all parameters.

Non-parametric Kruskal-Wallis test has been used to analyse the homogeneity of these three groups; significant differences were not found in diagnosis age, Cobb angle and pre-EDF vertebral rotation of the major and the minor curve in the three series.
No significant differences are observed using x^2 test in the location of the apex of the major curve in the three groups, $p > 0.1$.

Results: No significant differences are found in the correction of Cobb angle and vertebral rotation after EDF among the three series. However, there is an important decrease in the treatment cost in group C because no previous hospitalisation is required, the number of visits is reduced as well as the duration of physiotherapy and shorter hospital visits.

Conclusions: We do believe that the introduction of fibre-glass in orthopaedic management of idiopathic scoliosis has meant an improvement of the entire process. Costs are reduced, whilst still maintaining the correction.

Excellence of Chêneau braces for patients with Idiopathic Scoliosis (IS)

Werkmann M

Sanomed Orthotic Centre; Staudernheimer Str. D-55566 Bad Sobernheim, Germany

Objectives: To evaluate the excellence of bracing in a leading German brace company serving one of the most frequented centre for conservative management of spinal deformities worldwide.

Background data: The efficacy of brace treatment is in question no more. In a recent publication it has been demonstrated that braces of a certain standard are able to reduce the incidence of surgery. Most of the braces from that study were constructed by Sanomed Orthotic Centre. Although the current principles of construction have been applied not all curves have been corrected to our satisfaction. For this reason the distribution of excellence in a consecutive number of braces has been investigated. This distribution may serve as a baseline value for further developments.

Methods: A rating scale was established on the basis of the primary correction effect in the brace. A correction effect of more than 50% in the brace was regarded as excellent, a correction effect of 30–49% was regarded as good, a correction effect 20–29% was regarded as sufficient and less than 20% as poor.

Results: From a total of 59 Patients with an average Cobb angle of 54° (25–102°) braced during 2 months consecutively 14 (24%) were rated excellent, 26 (44%) good, 11 (19%) sufficient and 8 (14%) poor. Average correction effect for all curves was 39%, for thoracic curves 35%, for lumbar curves 41% and for thoracolumbar curves 47%. Braces for single curve pattern corrected better than braces for double curve pattern. The bigger the Cobb angle the lest the correction effect was.

Discussion: The X-rays in the brace were made at average less than one week after the first brace application. Usually the x-ray in the brace is taken about 6 weeks after the start of the treatment so our results are not necessarily comparable to other out patient bracing centres. However average correction effects seem better than found with the application of other bracing concepts (Boston brace, Wilmington Brace, Milwaukee brace) published in the peer reviewed literature.

Conclusions: The Chêneau principles of bracing seem to be the most successful ones when applied by experienced technicians (>400 braces/year), however more than 10% of the braces do not correct satisfactory. Improvement of quality is necessary to also improve the outcome. A standardization of correction principles for different curve pattern is desirable. Improvement of excellence can be rated by measuring the primary correction effect in the brace and by comparing this

correction effect to the baseline value from our centre using the same rating scale.

Intra-observer reliability of a new classification correlating with brace treatment

Rigo M

Instituto E.Salvá. Vía Augusta 185, 08021 Barcelona.

Study design: The radiological pattern (SRS nomenclature) according a new classification correlating with brace design was determined by one observer in two occasions.

Objective: To determine, as a first step, the intra-observer reliability of the new classification, by the original author.

Methods: Standing coronal radiographs were evaluated of 111 patients with IAS by one observer in order to classify each one according the new classification. It includes 6 thoracic types, 2 double major, 2 thoracolumbar and thoracic double major divided in 5 subtypes according the lumbopelvic configuration. The classification also includes lumbar type as well as three particular patterns , two of them first described by the author as independent types. A number 1–18 was given to each type in order to correlate the results with a second assignment made two weeks later by the same observer.

Results: There was an agreement of 91.8% in both assignments. Intra-observer correlation was $r = 0.93$ ($p < .001$).

Conclusion: The new classification has a good intra-observer reliability considering that it was tested by the original author. Further studies are necessary to evaluate intra- and inter-observer reliability by independent observers.

Functional evaluation for idiopathic scoliosis: comparison with a normal control group

Romano M, Gerosa L, Ferrari E, Negrini S

ISICO (Italian Scientific Spine Institute), Milan, Italy

Study design: Controlled study

Objectives: Definition of a set of functional test to plan and monitor physical exercises programs developed to increase not only morphology but also physical functional abilities of idiopathic scoliosis patients. The first aim has been the comparison of the results obtained in a normal sample and in a group of patients with idiopathic scoliosis.

Background: There are many papers published on functional deficits of patients with idiopathic scoliosis compared with normal controls, but no one studied a complete set of tests with our aim.

Methods: Inclusion Criteria: age between 13 and 16, idiopathic scoliosis between 6 and 20 Cobb degrees. Population: 20 scoliosis patients, 7 males, 13 females, age 14 years, Cobb degrees 14° (range 6–20). Controls: 20 subjects for each gender and age group between 11 and 15 years. Functional evaluation: 20 test, grouped in hypermobility tests (2), range of motion and muscular elasticity (7), strength (4 isotonic and 2 isometric), neuromotor control (4).

Results: A stastically significant difference between the populations have been shown in at least one test for each group (hypermobility: 1 out of 2; range of motion and muscular elasticity: 4 out of 7; strength 2 out of 6; neuromotor control 2 out of 4). In particular, in scoliosis patients compared to controls we found: a 30% reduction of the passive RoM in extension of the spine, and a 50% decrease in isometric abdominal strength and in the ability to perform the ''pendulum'' exercise.

Conclusion: Presumably to obtain more significant information this study will require an evaluation of patients with higher degree of pathology, even if exercises are applied also in this kind of population. Next steps of this research will include a test/retest evaluation and the application in new populations to verify the possible applicability in everyday clinical activity.

Biomechanics of the conservative treatment in idiopathic scoliotic curves in surgical ''grey-area''

Lupparelli S[1], Mastantuoni G[2], Aulisa AG[2], Pola E[2], and Aulisa L[2]

[1]Centro Orthopedico Umbro, Perugia, Italy; [2]Istituto di Clinica Ortopedica, Universitá Cattolica del Sacro Cuore, Roma, Italy

Objective: to determine by biomechanical studies if it's possible to extend the conservative treatment to scoliotic curves that are usually included in the surgical or orthopaedic ''grey-area''.

Background: evolution of spine deformities is determined not only by biological factors, but also by the mechanical behaviour of abnormal system geometry. Several previous biomechanical studies have defined limits of both orthopaedic and surgical treatment for scoliotic spine instability. Whereas indications to surgical treatment of ''grey-area''-scoliotic curves has been usually determined according only to the Cobb method, two additional factors, the residual potential growth of

the vertebrae and magnitude of the elastic deformation of the discs, should be considered.

Biomechanical Study: biomechanical analysis of the G modulus of torsion rigidity of the intervertebral disc, and the ability of his residual growth potential to influence the history of a scoliotic curve treated conservatively, have been performed.

Results: the biomechanical study on the analysis of the G modulus of torsion rigidity of the intervertebral disc shows that the G values progressively increase through growth, which favors the progression of early scoliotic curves. At the same time, however, early structural scoliosis is more amenable to conservative treatment owing to the residual growth potential of the spine. Two additional factors affect the change of correcting a scoliotic curve: the first is the residual growth potential of the vertebrae. In fact, a longer residual growth allows for external forces to be applied so as to change the growth model of the scoliotic spine, which ensures a stable correction of the deformity when these external forces are removed. The second is the magnitude of the elastic deformation of the intervertebral discs. It has been suggested that a deformation beyond the disc elastic behaviour, by producing hysteresis of the disc, renders the disc less susceptible to transferring the load to the neighbouring vertebral bodies, thus impairing remodelling.

Conclusions: the limits of the orthopaedic treatment have been discussed in this paper.

Correction of thoracolumbar and lumbar curves with a new short brace for idiopathic scoliosis

Lupparelli S[1], Aulisa AG[2], Mastantuoni G[2], Pola E[2], Larosa F[2] and Aulisa L[2]

[1]Centro Orthopedico Umbro, Perugia, Italy; [2]Istituto di Clinica Ortopedica, Universitá Cattolica del Sacro Cuore, Roma, Italy

Design: A retrospective study was performed.

Objective: In this paper the results of patients treated with the Progressive Action Short Brace (PASB) are presented.

Background data: Recent reports suggested that bracing can stop idiopathic scoliosis progression, whereas long-term correction has not been achieved.

Material and Methods: Inclusion criteria were a single major thoracolumbar or lumbar idiopathic curve and 2 year minimum follow-up. 70 patients satisfied the criteria. X-rays were performed at treatment start t_1, best correction in brace t_2, intermediate time t_3 between t_1 and t_4, end of weaning t_4, 2-year minimum follow-up t_5 from t_4. Curve magnitude C_M, torsion of the apical vertebra T_A and mean torsion of all vertebrae in the curve T_M were measured with Cobb and Perdriolle method. C_M, T_A and T_M variations were assessed by ANOVA ($P < 0.01$). Results were analysed assuming that C_M t_5-t_1 be not within ± 5 error range. Three situations were distinguished: correction (C_M $t_5-t_1 < 5^\circ$ Cobb), stabilization (C_M $t_5-t_1 \geq -5$ and $\leq 5^\circ$ Cobb) and progression (C_M $t_5-t_1 > 5^\circ$ Cobb).

Results: 20 lumbar and 50 thoracolumbar curves have been treated. Mean follow-up length was 36.0 ± 1.6 months. C_M was 23.6 ± 6.3 at t_1, 12.5 ± 7.2 at t_2, 14.3 ± 6.5 at t_3, 16.2 ± 8.4 at t_4, and 16.2 ± 8.4 at t_5; T_A was 12.0 ± 6.1 at t, 11.3 ± 7.4 at t_2, 8.5 ± 5.6 at t_3, 9.1 ± 5.0 at t_4, and 9.2 ± 6.7 at t_5; T_M was 8.7 ± 4.2 at t_1, 8.2 ± 4.5 at t_2, 5.6 ± 3.8 at t_3, 6.6 ± 4.6 at t_4, and 6.8 ± 5.1 at t_5 ($P < 0.000$). Correction, stabilization and progression were respectively obtained in 63%, 33% and 4% patients.

Conclusions: Results would indicate that the PASB, by its peculiar biomechanics, may achieve correction of thoracolumbar and lumbar idiopathic curves.