

Biomechanical Etiology of the So-called Idiopathic Scoliosis (1995 - 2007). New Classification: Three Groups, Four Sub-types. Connection with "Syndrome of Contractures"

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ABSTRACT

The presented article discusses biomechanical etiology of the so-called idiopathic scoliosis (adolescent idiopathic scoliosis - AIS) (1995-2007) based on asymmetry of movement of hips, what is connected with "syndrome of contractures" and next connected with function - "walking" and "standing". In the article there are described etiopathogenesis and types of scoliosis (AIS). New classification - three etiopathological groups (epg): "S" shaped scoliosis - I epg (some cases lordoscoliosis), "C" scoliosis - II/A epg, "S" scoliosis - II/B epg (some cases kyphoscoliosis) and "I" scoliosis - III epg.

The "S" I epg scoliosis is connected with "standing 'at ease' on the right leg and with "walking, "C" II/A epg and "S" II/B epg scoliosis is connected only with permanent "standing 'at ease' on the right leg", "I" epg scoliosis (stiff spine, without any big curves) is connected only with "walking". For every type of scoliosis is adequate "typical model of movements of hips" (2006).

The contracture, or only difference in adduction (smaller in the right hip) is connected with the "syndrome of contractures" in newborns and babies described by many authors but thoroughly and very exactly by Prof. Hans Mau.

The new classification makes clear therapeutic approach to every etiopathological group of scoliosis and gives us possibility to introduce causative prophylaxis.

Key words: Biomechanical etiology of the so-called idiopathic scoliosis, "Syndrome of contractures". New classification

INTRODUCTION:

Through many years etiology of the so-called idiopathic scoliosis (AIS) was unknown. Many researchers searched for "etiologi- cal factors" of scoliosis like: genetic, hormonal factors, growth abnormalities, neuro- muscular influences, disorders in bones, disorders in muscle and fibrous tissue, growth rate, left - right symmetry / asymme- try (and here directional asym- metry, anti-asymmetry, fluctuating asymmetry), anterior - posterior symmetry / asymme-

try (and here directional asym- metry, anti-asymmetry, fluctuating asymmetry), asym- metry in growth of spinal cord and vertebra bodies and in "asymmetry concept" - arm length, facial structure, trunk, hand & foot preference, "reduc- ing" asymmetry with age, ner- vous system lateralization, dermatoglyphics, developmen- tal instability, "boy gait" versus "girl gait", thoracic-spinal de- formity primary as concept for idiopathic scoliosis, "complex" - "multi-factorial" - "silent" con- cept, CNS, immature scoliotic vertebrae, circulating factor and plenty of other hypothetic influ- ences (taken from *Second Round EFG 6 / International Federated Body on Scoliosis*

Aetiology (IBSE) / Electronic Focus Group-6 (EFG-6), P. Dangierfield).

The biomechanical etiology of so-called idiopathic scoliosis was described in Lublin/Poland and presented since 15 years (Karski). In 2001-2004/2006 also the new classification was given: 3 groups and 4 types of scoliosis.

First presentation on "biome- chanical influences for develop- ment of spine" was in 1995 in Hungary. The biomechanical etiology of the so-called idio- pathic scoliosis is based on asymmetry of movements of left and right hip and in result asymmetry of loading during gait, leading to asymmetry of growth between left and right

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side of the body with results in time as scoliosis. All children with so-called idiopathic scoliosis have the habit of permanent standing "at ease" only on the right leg. This is connected with "real abduction contracture" or only limited adduction of the right hip often with co-existing flexion and external rotation contractures in comparison to the left hip. This makes, that the right hip - the right leg is "stronger", "more stable", and because of this "more easy for standing on". This asymmetry of movements is connected with the "syndrome of contractures" in newborns and babies ("Siebenersyndrom" - Mau ^(1, 2)).

2. Clinical signs of syndrome of contractures"

The "syndrome of contractures" has been described primarily and in detail by Prof. Hans Mau - Tübingen / Germany - as *Siebener (Kontrakturren) Syndrom*" (syndrome of seven contractures) ^(1, 2). This syndrome has been also described by: Hensinger ⁽³⁾, Horworth ⁽⁴⁾, Green & Griffin ⁽⁵⁾, Vizkelety ⁽⁶⁾, Komprda ⁽⁷⁾, Karski ^(8-12, 15-18), Tarczyńska, Karski & Karska ⁽¹³⁾, Heikkilä E. ⁽¹⁴⁾. In 1932 Prof. W. Dega / Poland described the "syndrome of contractures" as "ultra positioning" of fetus ⁽¹⁹⁾. The causes of the syndrome of contractures" can be related with fetus itself: heavier, longer body; or with mother conditions: small belly during pregnancy, lack of amniotic fluids, pelvic bone type: "androidal" or "platypeloidal"- inconvenient for proper fetus growth ⁽¹³⁾. Prof. Mau

underlined influences of CNS on development of "syndrome of contractures".

Mostly we observe the left sided "syndrome of contractures". That is connected with the "first fetus position" during pregnancy - 80% - 90% (Oleszczuk) et al ^(20, 21). In "syndrome of contractures" according to Mau there are:

1. skull deformity /*plagiocephaly*/ - flattening mostly of left forehead and *os temporalis*, left chick atrophy, eyes - nose and ears asymmetry / deformations
2. *torticollis muscularis (wry neck)* / shortening of sterno-cleido-mastoideus muscle/ - usually left-sided, related with plagiocephaly or / and traumatic delivery or with congenital "*tumor neonatorum*" (*fibrous tumor*)
3. *scoliosis infantilis* (infantile scoliosis) - other than idiopathic scoliosis. Usually recedes spontaneously at 80% of cases ⁽²²⁻²⁴⁾ or even at 100% (Mau) ^(1, 2)
4. contracture (shortening) of adductor muscles of the left hip. Untreated contracture can lead to development of hip dysplasia, which primarily can be observed only at 10% of newborns ⁽⁶⁾. The remaining 90% of dysplasia are cases of secondary deformity resulting from the contracture and are classified as "developmental hip dysplasia" (DDH - Klisiè).
5. contracture (shortening) of abductor muscles and soft

tissues of the right hip (Karski) ^(8-12, 15-18), described as *Haltungsschwäche* ("weak posture") by Mau ^(1, 2). This contracture may cause oblique positioning of pelvic bone observed at X-ray picture of hip joints in babies. With time asymmetry in movement causes asymmetry during gait and loading; and with time asymmetry of growth and development of spine - as result: scoliosis (Karski, Karski & coll. 1995-2006) ⁽²²⁻²⁴⁾

6. pelvic bone asymmetry - the oblique pelvis positioning visible during X-ray examination for hip joint screening - (see above points 4 & 5)
7. feet deformities - such as: *pes equino-varus*, *pes equino-valgus*, *pes calcaneo-valgus*

In Lublin we also include to "syndrome of contractures and deformities in newborn and babies" excessive shank deformity (*crura vara*) which can lead with time to Blount disease. The development of this deformity and the causes are described in German in "*Orthopädische Praxis*" (Karski & coll. ⁽²⁵⁾)

3. Clinical sign of "syndrome of contractures" in children with so-called idiopathic scoliosis in literature

The asymmetry in movement between hips (see points 4 & 5 in chapter 2) and asymmetry in movement of right and left side of pelvis during gait disturb

spine growth and function since a child starts walking. First clinical symptoms of scoliosis in the I epg develop many years before the deformity is clearly visible in X-ray examination. In children with developed scoliosis, by exact examination of the patient, many researchers saw such distant deformities described in "syndrome of contractures" like: plagiocephaly, torticollis, asymmetry of temporal bone, tilt of pelvis and asymmetry of the whole body. The authors noted in their research as quoted by Normelli (26-28) and others:

a/ Willner (1972) quot. (26) ... *in general the left leg tends to be shorter than the right in childhood and this leads to development of the left convex lumbar curve. Pelvic obliquity has been observed in structural scoliosis*"

b/ Magoun (1974) quot. (27) ... *asymmetry of temporal bones has also been associated with scoliosis*"

c/ Wynne-Davies (1975) quot. (28) ... *plagiocephaly has been considered to be closely related to infantile idiopathic scoliosis*"

d/ Dangerfield and Col. (1995) quot. (29) ... *as with the plagiocephaly, the body asymmetry (in children with scoliosis) is as yet unexplained*"

e/ Estève de Miguel C. (1991) quot. (30) ... *the difference in the length of extremities, /.../ pelvic tilt - secondary scoliosis*"

f/ Tylman D. (1995) quot. (31) ... *tilt of pelvis is important sign of development of scoliosis*"

g/ Gardner A. (2000) quot. (32) ... *so-called idiopathic scoliosis commonly occurs in combination with a characteristic pattern of soft tissue asymmetries in the hip and pelvis region*".

All these precise observations confirm the connection between "syndrome of contractures" and scoliosis.

The sensibility to new rehabilitation exercises (18, 23, 33, 34) underlines the biomechanical influences coming from the "syndrome of contractures" in early development of so-called idiopathic scoliosis.

4. Other observations important for biomechanical etiology in "new history of scoliosis"

Clinical observations indicate that progression in I epg is especially fast in children with joint laxity, rickets, pelvis and lumbar spine anatomy anomalies (*spina bifida occulta*), chest and ribs deformities (*pectus infundibuliforme*). Early important clinical signs in very young children with danger of scoliosis are among others signs of "straight position of trunk (of spine)" or later "stiffness of spine" with "flat back" and habit of permanent sitting straight up and standing "at ease" only on the right leg (Karski (34)).

5. Material of children with so-called idiopathic scoliosis

The whole material consists

of 1450 patients examined with spine problems over the period of 25 years (1980 - 2005). 364 of patient constituted control group. In this control group the adduction of both hips was symmetrical or nearly symmetrical. The axis of spine at these children was normal and model of "hips movements" was as in (Fig. 1).

In the studied material there were patients from I epg, II/A epg, II/B epg and III epg group of scoliosis (described in chapter 6). The observed period was one to ten years. Age of patients was - 3-rd to 21-st year of life. The largest group were children from 6-th do 14-th year of life. Distribution of the three groups: I epg group 593 children (41 %), II/A epg and II/B epg group 333 (23 %) children, III epg group 131 (9 %) patients - mostly young people, congenital scoliosis 29 (2%). In about 20% of patients there were radiological signs of *spina bifida occulta* and sometimes *pectus infundibuliforme*. In about 3% slight symptoms of minimal brain damage (MBD). In 10% of patients we observed family history of scoliosis. Mothers of 2% of examined children were previously treated with scoliosis.

6. Three etiopathological (epg) groups of development of scoliosis (I epg, II/A epg, II/B epg and III epg)

I-st etiopathological group of scoliosis (I epg) (Fig. 2) (Karski 2001)⁽¹⁵⁾ ("S" deformity = double curve scoliosis)

In children from this group

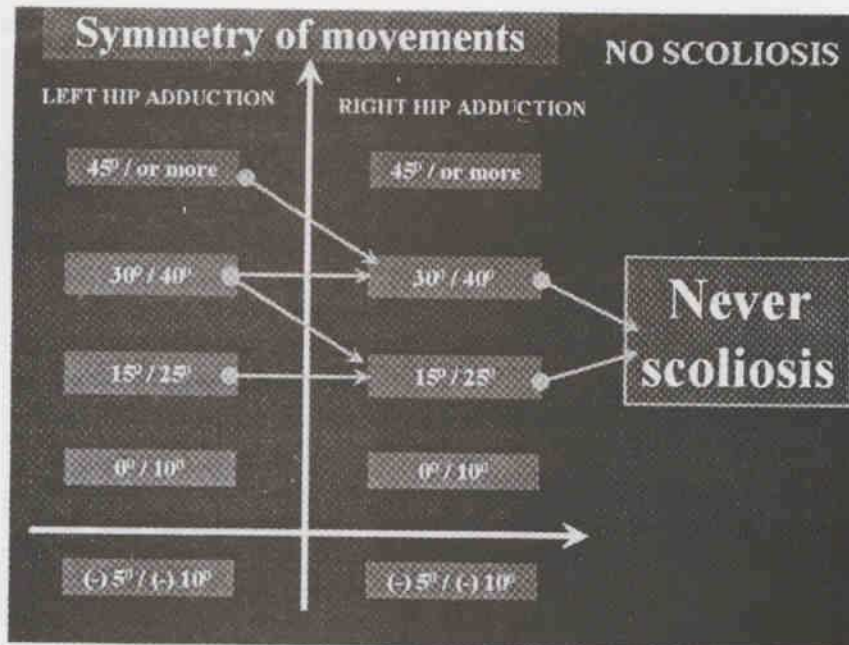


Fig.1 : Model of hips movements. Symmetrical adduction of both hips. No danger of scoliosis, no scoliosis.

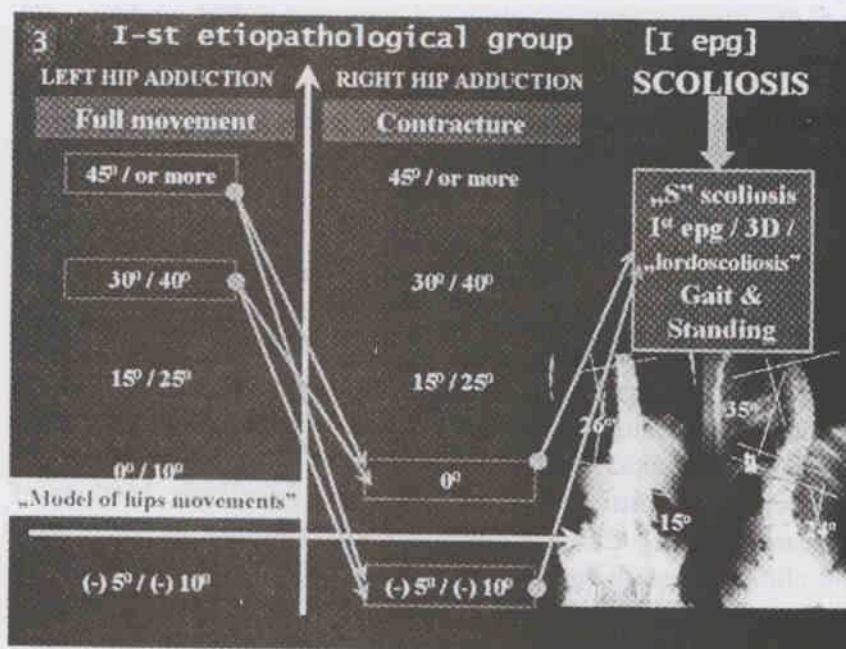


Fig. 2: Model of hips movements in I-st epg- "S" shaped double scoliosis.

there is a real abduction contracture of the right hip 5-10 degree or adduction 0 degree. The adduction of the left hip is large: 40 - 45 - 50 degrees (see fig. Nr 2 - model of hips movements). Examination should be

introduced in extension position of the hip joint. Development of this spine deformity is connected with gait! Additionally pathological influence is connected with habit of stand position "at ease" only on the right

leg and lasts many years. Beginning of this type of scoliosis is to be observed just in small 3-4 years old children. The first is rotation deformity confirmed in computer gait analysis (35). As result of rotational deformity - the spine becomes to be stiff with "flat back". Some cases in I epg are "lordoscoliosis". Here are following three stages connected with severity of deformity: a/ disappearing of spinous processes (Karski (22, 23) (35)) during "bending test" (Adams, Meyer (35)) or "side bending test" to the left and right leg (Karski), b/ flat back - hipolordosis lumbalis, hipokyphosis thoracalis during flexion examination (Vlach et al (36), Palacios-Carvajal (37)), c/ lordotic deformity in thoracic part of spine during flexion examination (Adams, Meyer (35), Tomaszewski & Popp (38) and others). After 2 or 3 years, sometimes later, the rib hump develops on the right side (*gibbous costalis*) and is easy to see. This type of scoliosis is progressive especially in acceleration period of growth.

II-nd etiopathological group of scoliosis - II/A epg and II/B epg (Karski 2001)(15). It is "C" left convex scoliosis - lumbar or lumbo-sacral or lumbo-thoracic as II/A epg type or double curves "S" scoliosis as II/B epg (Fig. 3).

In these children there is only limited adduction of the right hip in comparison the left side. Adduction of the right side is 10-15-25 degree; adduction of the left side is 35-45-50 degree (see fig. Nr 3 - model of hips

movements). Examination should be introduced in extension position of the hip joint. Firstly we observed physiological side movement of spine to the left by "stand position of the right leg", next gradual fixation of "C" shaped spine curve with clinical symptoms and changes of spine axis in X-ray picture in older children - at age 10-12-14 years. Pathological influence is connected only with the permanent habit of standing "at ease" on the right leg through many years. Beginning of lumbar or lumbo-sacral or lumbo-thoracic left convex scoliosis is - if the child starts to stand and scoliosis become to be clearly visible if the child is over 10 years old. This type of scoliosis is not "paralytic scoliosis" as described by many authors. It is also not "primary degenerative scoliosis" as thought some others authors (lecture of Prof. Stewart Weinstein at SICOT 2005 in Istanbul). To this patients with "spondyloarthritis" we could explain - scoliosis is the first and degenerative changes occur later after many years of life. The scoliosis II/A epg and II/B epg are without progression or small but with lumbar pain problems at adult age, typical for *spondyloarthritis lumbalis, lumbago, ischias*. In the II/B epg there is "S" shaped scoliosis with double curves. The thoracic right convex curve is the secondary one. Some cases from this (II/B epg) group are kiphoscoliosis.

III-rd etiopathological group of scoliosis (Karski 2004 - "scoliosis without curves or with small one".

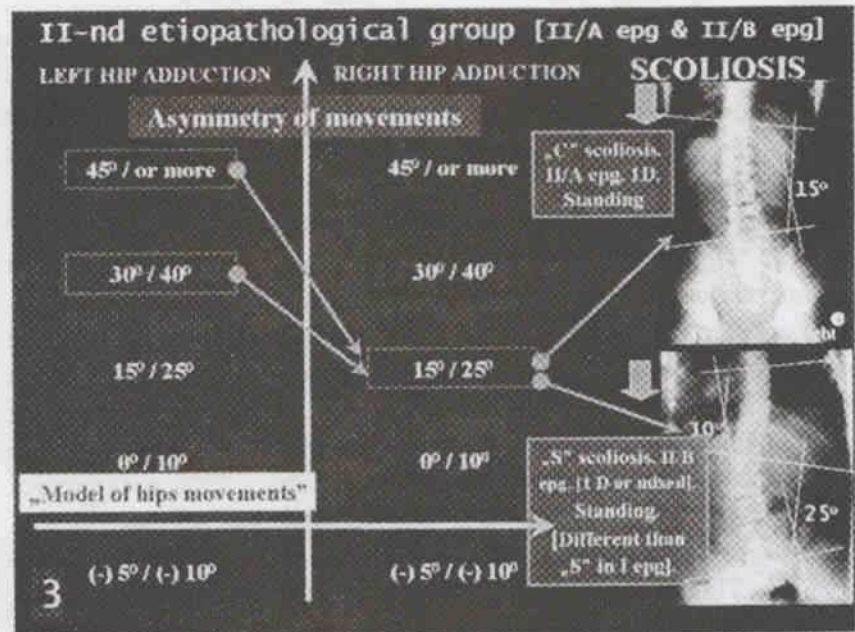


Fig. 3: Model of hips movements in II/A epg and II/B epg - "C" shaped scoliosis or "S" shaped scoliosis.

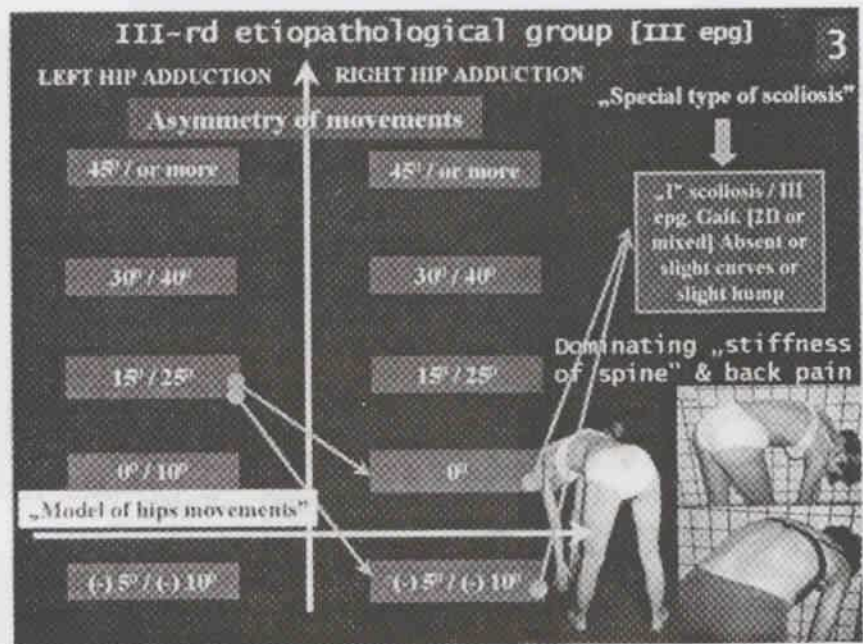


Fig. 4: Model of hips movements in III epg - "stiffness of spine" in lumbar and thoracic part of spine.

The main symptom in this group is the "stiffness of spine". As was told - in I epg of scoliosis, the first stage is the rotation deformity, which causes stiffness of spine. In patients from III group progression

stopped (!) because of specific models of hip movements (see fig. Nr 4 - model of hips movements) and other manner of standing habit. In III epg - the same time or almost the same time standing is "on right and on

left leg". In this group clinically and in X-ray examination we see no curves or only slight deformities. We see also no rib hump or slight. So, there can be "scoliosis without any curves" or with "sight curves" - unimportant clinically. These patients were mostly not treated before and through many years they did not know about the "spine problem". In youth period they have problems with sport activities. At adult age they show very large range of "back pain" (Fig. 4). The patients from this group need "differential diagnosis" because some general doctors or internists diagnosed rheumatism, heart pain, circulatory problems and pulmonary illnesses like bronchitis or pleuritis, neurological or gynecologic problems.

7. Syndrome of contractures" and geography" of the so-called idiopathic scoliosis

"Syndrome of contractures" can provide explanation to some unanswered questions in past time in etiology of idiopathic scoliosis:

- Development of scoliosis is connected with "growth period" and connected with "gait" and "standing 'at ease' on the right leg" (Karski^(12, 24, 34))
- Scoliosis develops because of asymmetry of movement of hips, because of asymmetry of loading of right and left leg (pelvis and spine). These asymmetries are connected with "syndrome of contractures" (Mau^(1, 2)),
- Scoliosis occur mostly in

girls because the contracture of the right hip connected with the "syndrome of contractures" comes mostly in girls (ratio boys: girls is 1: 5)^(1, 2).

- Lumbar left convex and thoracic right convex scoliosis and rib hump on right side are connected with the left sided "syndrome of contractures" witch occurs at 85% - 90% pregnancies (Oleszczuk et al^(20, 21)). The S", C" and "I" types of scoliosis (I epg, II/A epg, II/B epg and III epg groups) depend on the range of right hip abduction contracture or limited adduction in comparison to the left hip adduction - look "model of movement of hips" (2006) and other causes (Karski⁽²²⁾).
- Progression of scoliosis in acceleration period of child's growth is related to asymmetry of growth of bones and soft tissues^(8-12, 15, 16). Contractures (right hip abduction contracture also with flexion and external rotation contracture) - Karski^(8-10, 12, 15, 16), Cheneau & Matussek⁽³⁹⁾ do not grow and do not lengthen; only bones grow. This leads to fast progression of scoliosis because of bigger biomechanical influences especially in I epg^(22, 23). The faster growth of legs than trunk was also observed by Dimaggio⁽²⁵⁾ (EPOS Meeting).
- No scoliosis in blind children confirmed the biome-

chanical influences (gait) in development of scoliosis

- Absence of scoliosis in some countries (Mongolia - Prof. J. Hyaneek - Czech Republic - discussion during Symposium in Prague 2006) confirms the biomechanical influences (gait) in development of scoliosis. The riding on horses of many Mongolian children protects against scoliosis.

8. Discussion to biomechanical etiology

Through years nobody could confirm the hypothetic "etiological factors" of scoliosis like described above⁽⁴⁰⁻⁵¹⁾. Observations from the years 1981 - 2007 show that the cause of development of idiopathic scoliosis is strictly biomechanical. In 1995 "the causative chain of pathological factors leading to the so-called idiopathic scoliosis" was for the first time presented in Hungary and in 1996 described in medical literature in Germany (Karski⁽⁸⁾). The chain of development of deformity on the example of I epg is as follows: a/ the asymmetry in movement between right and left hip, b/ asymmetry of loading of right and left side during gait, c/ as result the disturbing of spine growth and development of scoliosis since a child starts walking. This observation makes clear that the beginning of scoliosis is early - in first years of life but at this time the symptoms of scoliosis are unclear and untypical (if we look to previous literature about scoliosis). In many orthopaedics books it is written that "scoliosis

develops from the apex of curve". Now it is clear that scoliotic deformity is going from the "bottom of spine" it means from pelvis and sacro-lumbar region up to the upper spine.

In I-epg the first symptoms of AIS are only clinical ones and these should be "observed" for many years before the deformity is clearly visible in X-ray examination. The new clinical tests which may help with early diagnosis of AIS: a/ pathological "side bending test for scoliosis" (Karski / Lublin test), b/ disappearing of spinous processes under the skin during "flexion of spine" (in Adams "bending test for scoliosis" or in "Lublin test"), c/ asymmetry in adduction of hips, d/ observation of permanent "stand 'at ease' position" on the right leg, e/ rotation test of pelvis (new Lublin test - 2006).

In children with developed AIS, by exact examination, many researchers saw such distant deformities like: plagiocephaly, torticollis, asymmetry of temporal bone, asymmetry of the whole body described in "syndrome of contractures" (3-5,26,29,-32,41,47,48). These observations confirm the connection between "syndrome of contractures" and scoliosis. If we take in consideration "the syndrome of contractures" in the biomechanical aetiology of the so-called idiopathic scoliosis, we can explain among others: 1/ gender of patients - mostly girls ("syndrome of contractures" is mostly at girls), 2/ three etiological groups of scoliosis - connection with gait and

"stand position at ease" only or mostly on the right leg, 3/ geography of scoliosis - lumbar left convex, thoracic right convex; rib hump on the right side (connected with "left sided syndrome of contractures" coming from 85% - 90% left situated pregnancies - Oleszczuk) et al (20, 21), 4/ enlargement of scoliosis in the acceleration period of child's growth (52, 53, 54) especially at children with difference of growth between trunk and lower limbs, when lower limbs grow faster than trunk. Our observations confirm also A. Dimeglio (Paris EPOS Meetings) and 5/ sensibility for the new rehabilitation exercises" which include removal of contractures (asymmetrical shortening of soft tissues).

In discussion I want to express that sometimes we observe other types of scoliosis like: other curves direction, "three curves scoliosis" (rare). Other types of scoliosis in many European countries, as described in chapter above, are connected with wrong, strengthening-extension exercises applied in AIS. Habit of "standing 'at ease' position on the right leg" explains also: larger deformity of *crus varum dextrum* in children, *genu valgum dextrum* in children and more often right hip arthrosis in adults (Karski (34)).

CONCLUSIONS:

1. The so-called idiopathic scoliosis is connected with the right hip abduction contracture often plus flexion and plus external rotation con-

tracture of this hip; or with big difference of adduction movement of both hips. The groups of scoliosis in new classification (2001 - 2004 / 2006) are divided in connection to "model of hips movements" (2006).

2. Development of scoliosis is connected with function - "gait" and stand position 'at ease' - only or mostly on right leg.
3. The abduction contracture of the right hip or only restriction of adduction is connected with the "syndrome of contractures" of newborns and babies described precisely by professor Hans Mau from Tübingen and also by many others authors.
4. Detailed examination of newborns and babies is necessary to discover symptoms of syndrome of contractures". Early prophylaxis in these children should be introduced in accordance to type of skeletal deformation of: skull, neck, spine, hips, feet.
5. Children in age of 2-4-6 old should be examined to discover the difference of adduction movement of hips and shape of spine in flexion (Adams test or Lublin test). In case of asymmetry of adduction and habit of standing "at ease" position on the right leg they should undergo periodical precise spine examination and should make simple, flexion exercises for spine as prophylactics.

6. Asymmetry of pelvis at X-ray picture of babies (in DDH screening) should be later remembered as possible danger for spine development at children 3-4 years old and later.
7. There are three etiopathological (epg) groups of development of so-called idiopathic scoliosis. The first group (I epg) - double "S" scoliosis with rib hump - is connected with the asymmetry while walking, asymmetry in loading and growth of spine. The lumbar and thoracic curves appear at the same time, sometimes very early at the age 4 - 6 years. In small children the curve even of 5 degrees (X-ray) and "stiff spine" should be for doctors an "important sign of scoliosis problem".
8. In I epg - the first is rotation deformity which causes "stiffness" of spine with three stages: a/ disappearing of *processi spinosi*, b/ flat back and flattening of lumbar spine, c/ lordotic deformity in the thoracic part of spine. This type of scoliosis is progressive. Because of severe rotation deformity some cases in this group are called "lordoscoliosis".
9. The second group - II/A epg - "C" scoliosis or II/B epg - "S" scoliosis - is connected only with the habit of "permanent stand position 'at ease' on the right leg" since first years of life. In this group the first and the only one (II/A epg) is the lumbar or sacro-lumbar or lumbo-thoracic left convex scoliosis. In these children we do not see rotation deformity with essential stiffness of spine, nor thoracic curve. In II/B epg "S" scoliosis, the lumbar curve is the first, the thoracic the second, the rib hump small or not any. Some cases in this group are "kiphoscoliosis".
10. There are also patients from the III epg group. In new classification from the 2004 (after discussion with Prof. K. Luk and Prof. K. Cheung in Hong Kong, China, 2004) in this group of scoliosis we note only "stiffness of spine" and in adult patients "back pain". This type of scoliosis is without or with very small curves or rib hump.
11. The II/A epg, II/B epg and III epg groups of scoliosis are non-progressive.
12. According to "biomechanical etiology" we should introduce the new stretching - flexion asymmetric exercises and special sport programs for the children endangered with scoliosis or with already beginning scoliosis. Neo-prophylaxis is possible, is very effective but it should be started very early already in small children in kindergartens and in first classes of primary schools.
13. All children should sit physiologically, never straight up; sleep in fetus position and stand "at ease" on the left leg or on both legs. For early prophylactics programs the best are

stretching exercises like "warm-up" in martial art techniques: karate, kung fu, taekwondo, tai chi, aikido, yoga etc.

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