

Reference Manual for the Lyon Scoliosis Brace

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The Reference Manual for the Lyon Scoliosis Brace is dedicated to the inventor of the brace: Pierre "Pieral" Stagnara (1917-1995)

History of the Lyon Bracing Management

The Lyon Bracing Management evolved since 1947 as cooperation between Pierre Stagnara MD and Bouillat & Terrier CPO. The Lyon management results of a reduction with a plaster cast from one to four months, before moulding the brace. It is a below arm adjustable brace without any superstructure. Very early braces were made from a combination of steel and leather.

After the second world war, Pierre Lecante CPO noticed that the cockpit of a Messerschmitt fallen close to his country house "La Douve" is made of very resistant plastic. The plastic allows tapping and direct screwing. The use of the plexidur™ was born and would replace leather.

There are many braces that are called Lyon Braces, but strictly speaking, there is not one Lyon brace but a Lyon Bracing Management with a plaster cast and a brace.

Now that the controlled study by the Scoliosis Research Society has shown that braces can be effective, it is even more important that the braces are designed so they can control curvature.

The Lyon Bracing Management for Scoliosis

The Lyon Bracing Management uses two steps.

The first step is the lengthening of the concave soft tissue with a plaster cast in order to obtain a true CREEP of the structure.

The second step is a custom made adjustable below arm brace to maintain the visco-elasticity of the structure.

Lyon Scoliosis Brace Terminology

Different curves require different pushes placements according to curve severity and location. In order to minimize confusion we utilize the following terminology based on the highest component of the brace:



Lyon classical Thoracic or Double Major Brace

It is composed of a pelvic girdle with two hemi shells and two posterior and anterior bars which allow the adjustments. A medial thoracic push (T7-T12), a high thoracic push (T4-T7), a lumbar push (T12-L4), a forward chondro-costal asymmetric push and an axillary balancing-

scapular support.



Lyon Lumbar Brace

"Low three points from Michel & Allègre" (1971)

There are three components:

- An iliolumbar push (T11-L4) on the convex side
- A trochanteric hemi circle on the concave side
- A thoracic push (T6-T12) on the concave side.



Lyon Thoraco-Lumbar Brace

(High three points)

Large thoraco-lumbar push (T6-L2), there is no lumbar shell. High thoracic push (T4-T7) The lever arm is maximal in the coronal plane.

Soft Lyon Brace

in polyethylene can be used for neuromuscular patients.

Terms integral to the Lyon Brace:

Abdominal shell

Refers to the anterior shell of the brace that extends enough laterally specially on the concave side to drive in derotation the anterior counter rib hump and cephalad to contain the abdomen and just barely cover the margins of the ribs and xyphoid process. This shell is a key point for kyphotisation and derotation.

Kyphotisation

It refers to the bending of the posterior bar to correct hypokyphosis.

Axillary balancing support

It refers to the upper hemi circle band on the convex side of the brace intended to balance the shoulders.

Tight waist

It refers to the special upper form of both hemi pelvic shells. Its function is to prevent distal or proximal migration of the brace, and to aid in positioning the pelvis in a posterior directed tilt (lordosis).

Anterior and Posterior bars

It allows adjusting the brace during growth. It is possible to lower the pelvic girdle and to drive up the axillary supports.

Thoracic push

It refers to the plexidur shell and sometimes pad extending along

the rib hump and intended to contact laterally lower thoracic ribs.

Thoracic stop

It refers to the plexidur shell and sometimes pad extending along the axillary line on the opposite side of the thoracic push and intended to contact laterally upper thoracic ribs.

Lumbar-abdominal stop or drive

It refers to the plexidur lumbar shell on the opposite side of the thoracic push. Usually the lumbar stop and the abdominal shell are not separate. We use the lumbar abdominal stop when the lumbar curve is less structural than the thoracic one.

Lumbar push

It refers to the plexidur lumbar shell on the opposite side of the thoracic push. Usually the lumbar stop and the abdominal shell are independent. We use the lumbar push when the lumbar curve is structural like double major curves.

Thoraco-lumbar abdominal push

It refers to the plexidur thoraco-lumbar shell which goes on the abdominal concave side

Manubrial clover

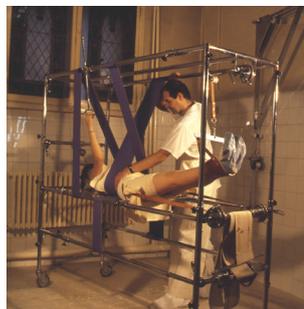
It refers to the triangular metal piece which maintains the upper part of the anterior bar, and both axillary shells.

Principles of the Lyon Bracing System

Overview

Each individual Lyon Brace should be conceived and constructed according to a basic set of principles outlined in this manual. By consistently using these principles, we believe that braces of the highest caliber will be constructed. We are convinced that all the orthesists can carry out a Lyon Brace. Each one can bring a final touch with the same effectiveness. The principles of fabrication of the Lyon Brace can be listed as follows:

- The plaster cast
- Custom plaster cast moulding or full electronically moulding like Orten™
- Brace blueprint
- Lumbar and pelvic flexion
- Active and passive curve correction
- Push pressure at the apex and below
- Relief opposite every area of force
- Force couples
- Coordinated physical therapy program
- Team approach



The Plaster Cast

It is carried out in an Abbott's frame of reduction allowing the Elongation, Derotation and Flexion (EDF). This frame comprises in longitudinal axis, a system of pelvic traction independent for each hemi pelvis and a system of cervical traction with dynamometer. Laterally one has on the right and on the left 3 adjustable bars of inflexion and derotation, 2 low bars, 2 medial bars in the

plane of the child and 2 high bars. On each bar, mobile cursors facilitate the fixing of the soft tapes.

The child is prepared with the physical therapist by supplings.

The thorax of the child is covered with 2 jerseys; the first jersey of 20 cms is wider to cover the edges, the 2nd jersey of 15 cm encloses the child well and makes it possible to avoid the creases.

- One slips at the pelvic level between the 2 jerseys 2 beveled square felts of 15 cm side to protect the iliac crest.
- The child is placed in the frame lengthened in a lying position

on a strong removable ticking band.

- A transverse metal bar is placed at the lower end of the sacrum, and another under the head of the child.

- Pelvic traction then is installed and one sets up the cervical traction. Axial traction is controlled by a dynamometer. This traction will always be weak, approximately 12 Kilograms (twice the weight of the head). An excessive traction makes lateral bending difficult, derotation and especially kyphotisation; it is interesting only for one important angulation exceeding 40°.

- Installation of the ticking tapes: If we take the example of a right thoracic and left lumbar double-major scoliosis, the technique with 4 tapes is used.

- The first tape from 20 to 25 cms wide is placed under the thoracic rib hump, its horizontal lower segment leaves on the left concave side, it is rolled up upwards i.e. from the spine towards the anterior part of the thorax, it is reflected in an oblique way on the higher bar of the frame on the left concave side.

- The second tape, about 20 cms wide is placed on the level of the lumbar rib hump in reverse order, i.e. that the lower horizontal segment leaves of the right concave side and is rolled up upwards, carefully marking the iliac crest and the fold of the waist protected by the pelvic felt. It reflected at the level of the abdomen in an oblique way on the higher bar of concave right side of the frame. It can be also reflected vertically if one seeks a lordosis effect.

- The third tape, about 15 cm wide is placed on the axillary right level; it produces a counter-push and rebalances the spine. It is symmetrical with the lumbar tape.

- The fourth tape, about 5 cms wide is placed on the level of the pelvis. It is essential each time there exists a coronal pelvic tilt. It is a tape of purely horizontal shift which surrounds the right hemipelvis. One makes a node on the level of the left trochanter for reasons of facility of rolling out the tapes and one fixes it on the left medial horizontal bar.

- One puts in partial tension the ticking tapes to balance the child, and then we place 2 beveled longitudinal felts of 5 cms thickness, 25 cms broad and 60 cms length under the ticking tapes. The felts must largely overflow on the axillary level.

- Then one carries out the setting in final tension while being progressive, by alternating inflexion-derotation and axial traction without exceeding 12 kilos, and while making sure the spine is kept balanced in axial plane.

- When the spine is well balanced, the plaster tapes are unrolled in a derotation way i.e. like the ticking tapes. One uses initially 2 circular tapes of 20 cms broad to cover completely the ticking tapes. Then, 4 plaster splints of 30 cms broad are placed forward, backward and laterally. We cut out the circular tapes carefully all around the ticking tapes. 3 Circular tapes of 20 cms stabilize the braces definitively. Making the plaster cast, one carefully models the counter anterior rib hump on the left and one try to improve kyphosis on the level of the rib hump by raising a little the shoulder girdle, this is why we prefer on the axillary level a ticking tape reflecting itself on the high bar. One can also raise a little the bar of cervical traction to carry out an effect of hammock.

- The plaster cast dries in the frame during approximately 10 minutes, then the child is standing up and the first cuts are carried out in upright position.

The physician delineates trim lines according to the X-rays.

- On the level of the pelvis, one largely releases the inguinal fold to allow a 90° flexion of the thighs.

- On the level of the shoulder girdle, cutting is asymmetrical to release the right arm of the child and to allow him more functional independence, but especially to facilitate the rehorizontalisation of the upper limit vertebra.

- On the level of thoracic and lumbar concavities, one cuts out a window intended to facilitate maintenances of skin and to allow a possible felting of the rib humps.

- At the abdominal level, a triangular window with xiphoidian peak facilitates maintenances of skin and makes it possible to check the stomach in the event of gastric dilatation.

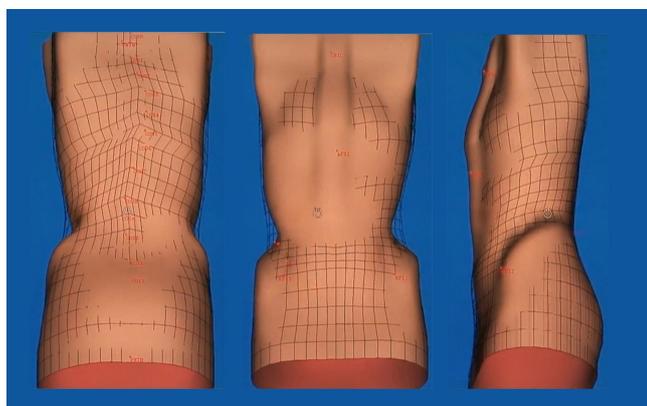
- At the thoracic level, one releases the chest by reinforcing the stabilization of the chondro-costal band and the sterno-clavicular support.

We will insist particularly on the completions:

- unfolding of the protection felt on the axillary level ,
- cut out first surface jersey at the border of the windows,
- the edges of the abdominal windows and concavities are plastered with a quite wet pad and the skin jersey is then folded back on the edges of the window. One can also use for the large window small splints on which the jersey will be folded back.
- At the ends the jersey is stretched before being folded back to avoid the skin folds.
- When all the edges are stabilized, one recovers the surface with a circular plaster band in order to carry out smoothing with the plastic of protection of the plaster tapes soaked beforehand in water.
- Felting is carried out after 3 hours of drying before the departure of the child. One starts at the level of the lumbar region. One slips the felt of 5 mm coated with tissue glue, between the skin and the plaster cast. The child is in genu-pectoral position, with a small cushion of protection under the abdomen, not to deform. A small spatula facilitates the slip. It is necessary to avoid the folds during this felting by stretching to the maximum the felt by the windows. One also requests with the child to release oneself from the plaster cast while contracting abdominal muscles and while inspiring to the maximum.

The food regimen avoiding any starchy food and fizzy drink is immediately started and controlled the antitetanus jab. The first skin maintenance will be very cautious and will release scrape of plaster cast formed at the time of the realization of the windows. For the first hours, the exothermic reaction causes a puffiness of the skin identical to a heatstroke so that any maintenance of skin is not recommended before 3 days.

Custom plaster cast moulding or full electronically moulding like Orten™



We think that “custom made” is better than prefabricated standardized symmetric modules. The full electronically moulding advantages to the orthotist in terms of saving time, space and fabrication are obvious. Perhaps more importantly, the oriented moulding is carried out immediately after the weaning of the plaster cast. The scoliosis was already corrected in the coronal plane and one can insist on the sagittal plane with the “cat walk” position of the top models.

Brace Blueprint

A brace blueprint is performed for each patient. The blueprint allows the application of Lyon Brace principles to the individual patient and allows the orthotist to convert the medical prescription to an individual orthosis based on the individualized design. The brace blueprint does not require the patient's x-ray. The brace blueprint focuses attention on the structurality of the curve to choose between a push, a drive or a stop and we believe allows for a much more accurate design and placement of shells.

Lumbar and pelvic flexion

The symmetrical pelvic girdle and its tight waist ensure a perfect

stability. The ante version of the pelvis gives lumbar lordosis and will allow thoracic kyphosis. We don't use pelvis pads to avoid pelvis intrinsic deformation during growth.

Active as well as passive correction

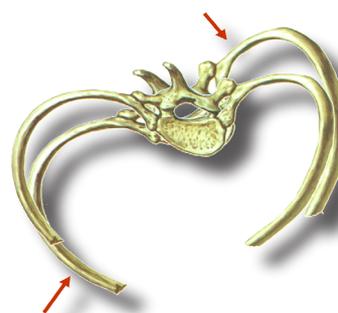
Passive correction is a fundamental principle of any brace, especially during night time. Due to the symmetrical construction of the Lyon brace, it's the plexidur rigid structure of the shells which allows a spontaneous active correction. The brace forms a rigid structure. If the patient carries out an active auto correction, the pressures decrease, more than a polyethylene structure.

Push pressure at the apex and below

Empirical evidence and mathematical modeling dictates that push pressure should be at the apex of the curve and below for thoracic and thoraco-lumbar deformities. In the thoracic spine this is interpreted as pressure in the midaxillary line at the apical rib and below. With the lumbar level, the pressure is carried out on the level of the transverse processes centered on the apex of curve. Lumbar lordosis improves lumbar correction and derotation.

Relief opposite every area of force

Lyon brace principles dictate that opposite every force there should be an area of relief so that the trunk may shift. A good example is the thoraco-lumbar and lumbar Lyon brace. For the thoracic Lyon brace, we must maintain a stop on the concave side to avoid an excessive rib horizontalisation.



Force couples

Rotational deformity is an important component of scoliosis. In addition to emphasizing lateral curve correction, the Lyon Brace emphasize correction of rotational deformity. We believe that the application of rotational forces is potentially much more effective when “force couples” are used.

Thus, for every rotational force applied another force opposite the desired center of rotation, in the same rotational direction, is applied to enhance the rotational force. Thus an anteriorly directed derotating force in the lumbar spine is counter balanced by (coupled with) a posteriorly directed force in the anterior abdomen. At the thoracic level, it's possible to add a pad on the medial side of the rib hump.

Physical therapy and Sports

An individualized exercise program is recommended for patients wearing braces. Exercise selection is based on the results of an individual evaluation. A well designed, realistic home exercise program helps patients to successfully wear her brace, continue to participate in activities and help to improve the overall positive outcome of the brace program. Some individuals have asymmetric hip abduction contractures, or other abnormalities such as thoracic hypokyphosis that require specific attention. There are some limitations for sport according to rib asymmetry and rotation.

Team approach

The team approach is emphasized in brace construction, brace application and especially management of the brace and patient over time.

Summary

The Lyons brace initially used for the thoracic infantile rachitic scoliosis is now adapted to the thoraco-lumbar and lumbar curves. The brace is:

- **Adjustable** on seven centimeters of growth, it's efficient. We do not need to change the brace every six months.
- **Active:** Because of rigidity of the plexidur structure, the child is stimulated. The active axial auto correction decreases the pressures.

- **Disc decompression:** It is the consequence of the "Adjustable". The effect of extension between the two pelvic and scapular girdles decreases the pressure on the intervertebral disc and allows a better effectiveness of the pushes.
- **Symmetrical:** In addition to the esthetic aspect, the brace is much easier to build.
- **Stable:** The stability of both shoulder and pelvic girdles facilitates the intermediate corrections.
- **Transparent:** Usually, it is not necessary to use the "pads", we can thus control directly on the skin the pushes, stops, drives and reliefs.

Patient Evaluation by the Orthotist

Background Idiopathic scoliosis usually occurs as a painless deformity in the pre-adolescent child which has been noticed on routine screening evaluation at school or by the pediatrician. The incidence of idiopathic scoliosis requiring brace treatment in girls is approximately eight times that of boys. Frequently the family history will reveal first degree relatives also with scoliosis which required treatment. The age of onset of scoliosis is variable but the major period of worsening of the curvature is correlated to the major adolescent growth spurt. The high probability of the curve progression with the adolescent growth spurt is often an indication to initiate a bracing program.

Physical Assessment

Review the patient clinically. The physical examination of the child with scoliosis should always involve the presence of a parent or same sex chaperone. Have the patient undressed enough to really see the spine, hips and trunk -a bathing suit is ideal- or stockinet can be used over underwear to make the patient comfortable, yet allow an examination. Stand back and observe for asymmetries. Are the iliac crests, waist, arms and shoulders level? Place your hands on the iliac crests to assess pelvic obliquity and leg length discrepancy. The alignment of the pelvis can be determined by palpation of the anterior and posterior iliac spines; the pelvis should be level to the floor while the patient is in double leg stance. Pelvic obliquity can also be assessed by the use of measuring blocks placed under the short leg until the iliac crests are level. Pelvic obliquity can have many bony causes: a flat or small foot, a short leg, or an underdeveloped or malformed pelvis on one side. Pelvic obliquity can also be caused by asymmetric hip flexion contracture, hip adduction or abduction contracture, or even an ilio-tibial band or knee flexion deformity. Pelvic obliquity due to infra-pelvic deformity (leg length discrepancy or joint contracture) or intra-pelvic deformity (sacral hemi agenesis or iliac dysplasia) may require the use of a lift (if there is true leg length discrepancy), physical therapy (if there is a hip flexion or abduction contracture), to correct the deformity. Anatomic leg length is measured from the anterior superior iliac spine to the medial malleolus. A leg length discrepancy of greater than 2 cm usual requires a shoe lift to level the pelvis prior to bracing. Less than 1 cm is regarded as physiological. Between 1 and 2 cms we will compensate if the lumbar rib hump decreases.

Check the patient's tissue tone and postural habits. The general body shape should be observed for height/weight proportionality. Are there any prominent bony areas that must be relieved of excessive pressure? The physique of the child may present brace wear problems. For example, obese children are difficult to fit due to soft tissue impinged in the brace and failure of the brace to control the pelvis while the excessive slender child presents a challenge in dealing with body prominences such as in Marfanoid patients. Bony prominences at the sternum (pectus carinatum), posterior ribs (razor back deformity) or at the iliac crest should be noted so that the positive plaster cast should be reload on the level of the bony prominences.

Observe for café au lait spots on the skin that may suggest that the scoliosis is related to neurofibromatosis. Unusual skin malformation such as with vascular malformation syndromes may require

alteration in the standard brace design. Foot deformity, such as a cavus foot or unilateral clubfoot, may be a manifestation of intraspinal lesions like spina bifida causing muscle imbalance. Neurological examination of muscle strength, sensation, and reflexes should be performed by the physician.

Particular attention should be paid to the examination of the hip muscle. Hip flexor tightness will impede proper brace wear and requires a physical therapy stretching program. The extension of the hip while lumbar flexion is maintained by ipsilateral hip flexion is the standard test to assess for hip flexor contracture (ilio-psoas). Similarly, the ilio-tibial band and the hamstrings should be examined for tightness (refer to physical therapy section).

Palpate the spine and observe the suppleness of the curves. Note the rib hump in the thoracic area and/or of the fullness in the lumbar area at the transverse processes at the convexity of the curves. Spinal examination is carried out to observe the sagittal shape (lateral view) and the coronal (frontal) shape. The normal sagittal shape of the spine is characterized as cervical lordosis, thoracic kyphosis, lumbar lordosis, and sacral kyphosis to balance the head and shoulders over the pelvis. Alterations of the normal pattern are seen in spinal deformity such as idiopathic scoliosis where the thoracic spine becomes relatively lordotic (either hypokyphosis or true lordosis) and the cervical spine has a diminished lordotic curve. The hypokyphosis is compensated by bending the bars.

Excessive kyphosis associated with scoliosis is an atypical pattern. Coronal plane deformity of the spine (scoliosis) is the prominent feature of idiopathic scoliosis. This is noted on examination of the spine by a lateral shift of the thorax from the normal position (directly above the sacrum in the erect position). For the right thoracic pattern of scoliosis, which is the most common pattern, the lateral shift is accompanied by shoulder elevation on the same side and a waist crease on the opposite side. Deviation of this pattern suggests the presence of additional spinal curves so that the double thoracic pattern will have shoulder elevation opposite of the right thoracic lateral shift and the double pattern of thoracic and lumbar curves will show minimal waist asymmetry. The lateral deviation of the spine in idiopathic scoliosis is associated with rotational deformity characterized by a rib hump in the chest or paravertebral prominence in the lumbar region. The rotation deformity is best seen during the forward flexion test (Adam's forward bend test) and can be quantified with a scoliometer as the asymmetric trunk rotation angle or with the plumb line in millimeters.

The findings of the physical examination of the spine should be compared to the radiographs to assure correct identification of the location of the curves and correct labeling of the radiograph (this is particularly important for the atypical left thoracic curve which requires brace construction opposite to the usual positions). Evaluate the patient's and parent's attitudes toward bracing.

X-RAY

The x-ray is an important tool for the orthotist when treating scoliosis. It is far too easy to be misled by palpation of the spine. Exact curve apices can only be determined by the use of x-rays. A full complement of initial anterior-posterior and lateral and follow-up films under plaster cast must be available whenever the orthotist sees the patient. Radiographs should be made without a breast shield so that the ribs may be seen to plan and observe the location of thoracic pads of the brace. Radiation exposure can be minimized by the use of the posterior-anterior projection and the use of "fast" radiographic film. It is optimal to have the entire spine on a 30x90 cm cassette radiograph. Flexion-extension and lateral bending films are not used for the construction of the brace.

Anterior-Posterior (or PA) View

The "standing" anterior-posterior x-ray is placed in a view box with R on your right and L on your left, viewing the x-ray as if you were looking at the patient's back. The rotated pedicles demonstrate rotation of the vertebral body and are most important when analyzing for proper shells placement. Differences in the size and shape of the two iliac crests must be considered when reviewing

x-rays. Vertebral bodies and disc spaces are checked for wedging and the apex of the curve or curves are noted and recorded. Observe the extent of iliac apophyseal capping and closing of the vertebral ring apophysis to get an idea of remaining growth. This may affect the frequency of the follow-up visits.

Lateral View

The "standing" lateral x-ray demonstrates the degree of lordosis and kyphosis. It is important that the x-rays are carried out in the standard position described by Stagnara and de Mauroy. In this position, normal thoracic kyphosis measures 37° degree by the Cobb method. Spondylolysis or spondylolisthesis may be seen in the lower lumbar spine. 20% of the lumbar scoliosis is accompanied by a spondylolysis. The level of deformity is seen and the forces anticipated correcting this abnormality. Should there be true lordosis in the thoracic area, (normally a contraindication for bracing) forces will be needed to alter this deformity. Imagine a line going through the axilla and trochanter which will reveal the severity of the unbalanced curve or curves. Usually there exists an alignment Tragus-Acromion-Trochanter-Malleolus. This pre-bracing documentation is necessary if, after treatment, the patient develops thoracic lordosis.



Cobb angle measurement

This is the favored method of measurement of the spinal curvature. With a straight edge, the cephalad and caudal vertebrae of each curve are defined. Perpendicular lines are constructed to allow measure of the angulation on the radiograph for documentation and comparison in the future. This method may be used to measure the frontal deformity (scoliosis) or the sagittal deformity.

The same technique can be used in the lateral X-ray to measure kyphosis and lordosis:

Growth, Maturity

Assessment

Age at presentation is a major risk factor for progression of scoliosis. The more growth that remains, the more likely the curve is to

continue to worsen. Growth is completed by most girls at age 15 and age 17 in boys. An estimate of skeletal maturation can be made from observations of the iliac apophysis ossification and fusion of the growth plate. The Risser staging system divides the ossification center into quarters and growth is assumed to occur from an anterior to posterior direction until skeletal maturity.

Assessing maturity, growth remaining:

- Chronologic age
- Menarche
- Bone age
- Risser sign
- ossification of iliac apophysis:

The Risser staging can be quite variable when compared to other methods of estimation of skeletal maturity. Skeletal age as determined by a wrist and hand radiograph compared to standards of skeletal maturation is a more accurate method of assessment of remaining growth. Additional accuracy in estimation of remaining growth can be obtained with serial measurements of incremental growth in height over time and assessment of the physical signs of puberty (Tanner staging).

Brace Prescription

Indications for the use of the Lyon Brace

Curve Magnitude

The goal of the Lyon bracing management is to allow non-operative treatment of scoliosis by preventing progression of the scoliosis in the growing child. A better understanding of the natural history of idiopathic scoliosis has refined the indications for brace treatment. Brace treatment is begun when the likelihood of progression of scoliosis is high. The patient with a mild curve near the completion of growth is unlikely to have further progression of the scoliosis and probably does not benefit from brace wear.

The preadolescent with a moderate scoliosis (curvature >30°) is at significant risk for progression of the scoliosis and may derive great benefit from brace wear.

The adolescent with a 45-degree curvature and growth remaining may achieve curve control with bracing or can be served by surgical treatment. In general, for the adolescent with a curvature 25-45 degrees and growth remaining, Lyon bracing management is indicated and will stop progression in 55% of patients, improve curvature in 35% and curve progression will continue in spite of bracing in 10%. Bracing large curves in the younger child may delay surgery and allow further spinal growth before fusion. In juvenile idiopathic scoliosis, brace wear is initiated when the curvature exceeds 20°. In the adolescent or late onset idiopathic scoliosis, the following guidelines are suggested by SRS:

APPROXIMATE GUIDELINES FOR BRACE TREATMENT OF ADOLESCENT IDIOPATHIC SCOLIOSIS (Juvenile curves should be braced much earlier- probably if over 20°)

0° - 20°	Observe for progression
20° - 25°	Brace if substantial progression documented and large amount of growth remains, otherwise observe (night time bracing)
25° - 30°	Brace if progressive and growth remains
30° - 40°	Brace if growth remains
40° - 45°	If growth remains, consider bracing if all prognostic factors favorable.
> 45°	if family refutes surgery

Curve Location

The Lyon brace makes it possible to treat all curves, except primary high thoracic curves for which we advise the use of the orthotic devices of Milwaukee. Fortunately this pattern of scoliosis is less evolutive than others.

Hypokyphosis and Thoracic Lordosis

The restoration of thoracic kyphosis requires:

- The stability of the lumbar spine in lordosis,
- The anterior xiphoidian stop,
- bending of the posterior and anterior bars

Contraindications to bracing

Severe thoracic lordosis (thoracic kyphosis < 0°) is a contraindication to brace treatment of adolescent idiopathic scoliosis. All braces that apply transverse forces with lateral pressure push the spine via a rib articulation and may worsen the lordotic spine. Surgical treatment is recommended for progressive curves with true thoracic lordosis.

The Lyon brace remains an elitist treatment. When the child and his family accept the plaster cast, (approximately 2/3 of the cases) the brace which follows the plaster cast will be well accepted. It appears useless to us to spend money for a brace not worn, and when the scoliosis evolves, it is better to consider surgical treatment.

Massive obesity may make effective bracing for scoliosis impossible. The brace is designed to grip the pelvis bony prominences and

apply corrective forces on the spine with asymmetric pushes. Obesity diminishes the effectiveness of the pushes and the bony prominences may be impossible to define. However good short and long-term correction has been achieved with bracing obese patients, a trial of bracing with assessment of short and medium term in-brace correction is advised.

The inability of the patient to actively shift the trunk away from the lateral pushes may lead to severe skin ulceration. Alternative bracing systems such as the Soft Lyon brace in polyethylene may be of benefit for the non-surgical treatment of scoliosis in the neuromuscular patient.

Choosing the correct brace

The reductibility in plaster cast is the guide for choosing and constructing the proper brace to treat each type of scoliosis. The brace is named according to the highest curve being treated by the brace. Single curves with an apex superior to T-6 or the upper curve of a triple spinal deformity may not be effectively treated by a spinal orthosis.

The Lyon Lumbar Brace (3 points low) is used for curvatures with apex below L1. The stability requires a particular iliolumbar shell, with an horizontal part upon the iliac crest.

The Lyon Thoracolumbar Brace (3 points high) is used for single curves with apex at T-10 to L-1 or double curves with a flexible upper thoracic curve the upper half of which will not be braced.

The Lyon Thoracic Brace is used for curves with apex of scoliosis from T-6 to T-10, or double curves. This is the classical brace with a lumbar and medial thoracic push. According the Lenke classification, we can remove the axillary balancing support for the Lenke 3 pattern (double major curve with thoracic curve with heightening of the right shoulder).

The Soft Lyon Brace in polyethylene may have a role in treatment of selected patients with paralytic scoliosis. The material of the brace requires that the patient have sensate skin and sufficient neuromuscular function to withdraw from the pressure points at the sites of push placement.

Brace Design

Principles of Brace Design

The goal of "Brace Design" is to convert clinical and radiological data, to an individual orthosis fabricated for the specific needs of one patient.

In the manufacturing of most objects, the availability of a "blueprint" facilitates the transition between an abstract design and a finished product. Likewise, in the fabrication of a Lyon Brace it is helpful for the orthotist to have a "blueprint". Using the Cobb method the physician measures the patient's initial x-ray and the degree of curvature is documented on the x-ray. Both radiological and clinical assessments will now become the "blueprint" for the fabrication of the brace.

The PA x-ray should be sufficiently long to include the entire spine and the femoral heads. It must extend laterally beyond the rib margin (rather than be collimated to show only the spine). It is important that the cassette is mounted vertically so that the lateral margin of the x-ray can be used as a true vertical. Alternatively, a metallic plumb line can be incorporated in the x-ray behind or beside the patient. It is important that the patient stand erect when x-rays are taken. A length discrepancy of more than two centimeters should be corrected with a lift before x-ray.

The gonads should be properly shielded.

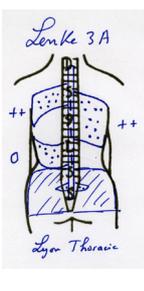
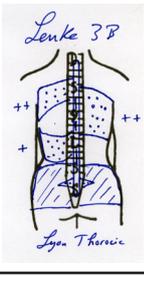
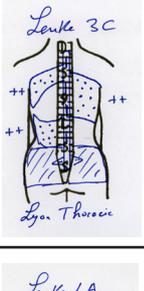
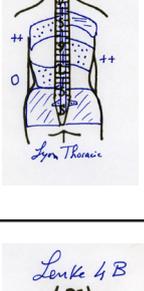
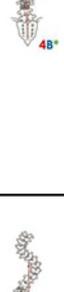
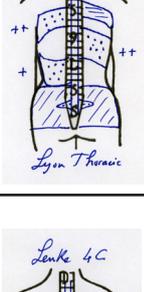
The Brace Blueprint

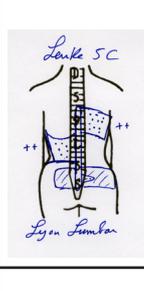
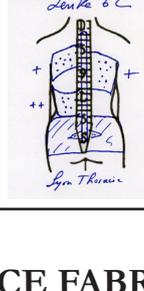
To create a "blueprint" an orthotist must do the following:

1. Measure curves with Cobb's method. Determine the Lenke type
2. That's all

The bending of the bars in the sagittal plane will be suitable according to the sagittal pattern.

		Lyon thoraco-lumbar 3 points high Without axillary balance support	Right Thoraco-lumbar Push T5-L2 Left Thoracic Push T4-T7
		Lyon thoracic With lumbar stop Without axillary balance support	Right Thoraco-lumbar Push T5-L1 Left Lumbar stop L1-L4 Left Thoracic Push T4-T8
		Lyon thoracic With lumbar drive Without axillary balance support	Right Thoraco-lumbar Push T5-L1 Left Lumbar Drive L1-L4 Left Thoracic Push T4-T8
		Lyon thoraco-lumbar 3 points high	Right Thoraco-lumbar Push T8-L2 Left Thoracic Push T5-T7 Right axillary balance support
		Lyon thoracic With lumbar stop	Right Thoracic Push T8-L1 Left Lumbar Stop L1-L4 Left Thoracic Push T5-T8 Right axillary balance support
		Lyon thoracic With lumbar drive	Right Thoracic Push T8-L1 Left Lumbar Drive L1-L4 Left Thoracic Push T5-T8 Right axillary balance support

		Lyon thoracic With lumbar stop Without axillary balance support	Right Thoracic Push T5-T12 Left Lumbar Stop L1-L4 Left Thoracic Push T4-T7
		Lyon thoracic With lumbar drive Without axillary balance support	Right Thoracic Push T5-T12 Left Lumbar Drive L1-L4 Left Thoracic Push T4-T7
		Lyon thoracic With lumbar push Without axillary balance support	Right Thoracic Push T5-T12 Left Lumbar Push L1-L4 Left Thoracic Push T4-T7
		Lyon thoracic With lumbar stop	Right Thoracic Push T8-T12 Left Lumbar Stop L1-L4 Left Thoracic Push T4-T7 Right axillary balance support
		Lyon thoracic With lumbar drive	Right Thoracic Push T8-T12 Left Lumbar Drive L1-L4 Left Thoracic Push T4-T7 Right axillary balance support
		Lyon thoracic With lumbar drive	Right Thoracic Push T8-T12 Left Lumbar Drive L1-L4 Left Thoracic Push T4-T7 Right axillary balance support

		Lyon lumbar 3 points low	Left Ilio-lumbar Push T12-L4 Right Thoracic Push T7-T12 Right Trochanteric Hemi Circle
		Lyon thoracic With thoracic drive Without axillary balance support	Left Lumbar Push T12-L4 Right Thoracic Drive T6-T12 Left thoracic Drive T4-T8

BRACE FABRICATION AND FITTING

Positive Plaster Cast Preparation

- Final improvements of positive plaster cast (five steps)
- Step 1 Erase with 90° on tight waist for a Lyon lumbar brace
 - Step 2 Erase the lower part of the breasts to increase the surface on the lower ribs
 - Step 3 Surfacing with the grater
 - Step 4 Reload of plaster cast on the iliac crest
 - Step 5 Smoothing of the surface area before thermoforming

Establishing Initial trim lines and Thermoforming

1. Initial trim lines should be drawn on the plaster positive cast. See the blueprint guidelines for the location of these trim lines.
2. Check out your blueprint trim lines with your clinical findings. You may need to make alterations.
3. Thermoforming of all the shells on the positive plaster cast. The shells must exceed the trim lines drawn on the positive plaster cast.

First Assembly on the Positive Plaster Cast

1. The thermoformed shells are fixed on the positive cast with nails.
2. The metal bars are curved and a first provisional assembly is carried out.
3. The final trim lines and the final adjusting of the shells will be carried out at the time of the initial fitting.

Initial Patient Fitting



Shells Placement

The goal of brace treatment is to prevent progression of the scoliosis by:

1. Correcting the lateral curve
2. Correcting the malrotation
3. Returning the torso to a balanced position over the sacrum
4. Properly aligning the spine in the sagittal plane

These goals are achieved by appropriate trim line or shape of the shells and then shell placement.

1. Check that the iliac crests are equal (if not, ask if the child uses usually a shoe lift and fit with the compensated shoes).
2. Sit behind the patient and fit the shells from the pelvic girdle to the axillary support. The shells can be fixed with an adhesive tape or the provisional metal bars.
3. Draw trim lines on the patient according to the blueprint and the definitive positioning of the shells. You can ask the child to carry out a corrective bending for better positioning the shells.
4. Remove the shells from the patient for intermediate trimming of excess material.
5. Patient and parent may now take a break while the final fabrication of the orthosis is being finished.

Final Patient Fitting by the orthotist

1. Ask patient to sit on a firm chair with hips flexed at 90°. In this position there should be one finger width space between the anterior inferior trim line and the thigh, and posteriorly four finger width between the brace and the seat of the chair.
 2. There should be no impingement of normal flexion or rotation of the hip joints.
 3. Supine, there must be a space between the abdomen and the anterior shell.
 4. The breasts should not be compressed by the anterior shell.
- Final Fabrication

Aerate shells

In some parts of the world any apparel is uncomfortable due to extreme heat and the wearing of an appliance becomes intolerable. Aerating the module helps make it tolerable in most areas.

- The number of 3 mm holes will depend on the climate in which the patient lives.
- No holes should be placed within 2 cm of the edge of shell.
- In high stress areas of module, fewer holes are drilled.

In the usual case of a flat back, the bars are bent in Kypho-lordosis.

Physical Therapy Management

The principles

- No complex material. All the exercises have to be repeated at home.
 - No sportive counter indication. The sport practiced by the child must be continued:
 - By adapting if necessary the sportive gesture (avoid the deep quick inspiration, and the flexion of the trunk forward)
 - By completing if necessary the sportive activity thanks to physiotherapy.
- The exercises are symmetric in the frontal plane.
- No chapel and miracle exercise. Choosing the best technical way for every child, at every age, and every therapeutic sequence.
 - No revolution, therefore but an evolution in the exercises which are repeated few minutes a day at home.
 - We treat a child and not a scoliosis or an X-ray. The look of the child is fundamental. Sometimes asymmetric with plagiocephaly, it evokes a juvenile scoliosis, but most of all it expresses a mood: worry, scare, anxiety, despair, indifference, disappointment, ag-

gressiveness. It is our role to change this look to reliance and complicity.

Objectives, means, obstacles

Physiotherapy during the Lyon Brace treatment

OBJECTIVES	MEANS	DANGER-CARE
<i>Modification of the spoiled body image of the scoliotic</i>	When we first see the patient, back and vertical height difference pictures are shown to the child He has to be conscious of the deformity thanks to the mirror or a video tape	The cortical representation of the back is weak and damaged by the fast growth, but let's be careful not to devalorate and depreciate the image of the body
<i>Suppling up of the retracted elements of the concavity</i>	Still posture (Mézières, RPG)	The rigidifying scoliosis curve may be a natural element of stability. An excess of the suppling up can lead to a progressive revival of the scoliosis.
	Dynamical mobilization	In some double curves case, the mobilisation is the same on the right and on the left, in fact the bendings show us that 80% of the movement happen in the correction sense and 20% in the worsening sense.
	Manual modelling of the vertical height difference	Be careful not to favour the empty back. The support has to happen on the internal side of the vertical height difference. A cushion is put under the left chondro costal canopy and the transversal movement leads to exhalation.
<i>Suppling up of the girdle</i>	Segmentar and analytical correction of the deficit of the extension of the hip measured by Biot at 43%, since the youngest time of the patient	The belts have to compensate
<i>Improvement of the vital capacity</i>	Highering of the VEMS Blow a balloon every night	The deep inspiration favours the rotation (Geyer) thus slow inspiration and quick exhalation.
<i>Saving of the spine Diminution of the mechanical constraint on the axis</i>	Development of the compensation at the belt level and the membres on a trunk which is still close to vertical	
<i>Reharmonisation of the static</i>	Repositioning of the head on the gravity line in the frontal and sagittal plane. Exercise to carry big charges. We look for the global balance, the sand pack must stay on the head, the harmony and the movement coordination. The walk must be synchronised with breathing. For lumbar scoliosis and thoraco-lumbar : learning of the shift.	A pelvis unbalance or of the scapular belt can compensate a scoliosis, we have to respect them. All types « C » of Lenke, the opening of the ilio-lumbar angle goes in the direction of the accentuation of the lumbar curve. In the sagittal plane, we have to avoid favouring the lordosing vertebral rear.
<i>Strengthening of the muscle in order to make the behavior in a corrected position easier</i>	Reinforcing of the fibres of the deep paravertebral muscle structure and muscles stabilizing the belt such as the psoas, the abdominals and the pectorals by powerful slow static contraction supported in a corrected position.	« The brain ignore the muscles and only know the movement » In the frontal plane, The exercises are symmetric because we do not know the role of the asymmetry concavity convexity. In the sagittal plane, the anterior flexion increase the rotation, therefore we have to strengthen in a neutral position. No body building which concerns the superficial muscle structure.
<i>The 24 hours of the back : adaptation of the scoliosis to the environment and of the environment to the scoliosis</i>	Control of the sitting position when listening and writing according to the morphotype Dealing with the school bag	

OBJECTIVES	MEANS	DANGER-CARE
Stimulate the maturation and the balancing postural system	Proprioceptive rehabilitation kyphotisation from : Feet sensors, ocular sensors, cutaneous sensors	Some patients have a postural reflex when there is an unbalance situation, which leads to a worsening of the scoliosis
Physiological valorisation Stimulate the global mobilisation of the spine in an automatic way	Sport practice Coordination of the gesture, harmony of the move	
Psychological valorisation Well being and self confidence	To be upbeat with the scoliosis « The scoliosis is not a disease but a symptom »	

Brace Evaluation and Critique

We show the results of 1338 scoliosis treated in France and in Italy according to the indications above. All the assessments have been done by the same doctor. The data are automatically written on the Excel table by the secretary during the check up 2 years after the weaning of the brace. For two years, according to the SRS norms, we have included the scoliosis treated previously thanks to Milwaukee brace. The failures with evolution towards surgery are included. Every scoliosis not checked at least two years after the weaning of the brace are excluded. Considering our recruitment, most of the scoliosis are idiopathic. We have excluded the patients in Soft Lyon Brace and Elastic Lyon Brace.

The evaluation criteria are classical. The average case is a 13 years and 10 months old girl (+1.7) at the beginning of the treatment. Her height when she is standing up is 159,81 cm (+11), her weight is 47,04 Kg (+9), her vital capacity of 2,20 l (+7). 2 years after the resection of the Lyon brace, her height is 165.00 (+6,7), her weight is 54,85 (+8.17), her vital capacity is 2,63 (+6.2).

We grouped all the scoliosis according to the kind of Lyon Brace realized. The results are expressed according to Cobb's angulation in percentage of reduction according to the initial angulation in Table III.

	Cobb initial	Cobb plaster	Cobb Brace	Cobb weaning	2 years after
Lyon Thoracic (thoracic) 285 cases	33.28(+8)	10.98(+8.53) 67%	15.09(+9.16)	27.52(+10.62)	29.29(+11.65) 12%
Lyon Thoracic (double major) 351 cases	31.45(+8.88) 28.81(+8.14)	12.39(+8.25) 9.27(+7.40) 61% / 68%	15.78(+9.17) 11.66(+6.81)	27.15(+10.52) 22.16(+8.60)	27.92(+10.68) 21.70(+8.69) 10% / 25%
Lyon Thoraco-Lumbar 279 cases	28.54(+6.98)	5.65(+6.62) 80%	9.41(+7.76)	20.64(+8.99)	21.81(+9.68) 24%
Lyon Lumbar 450 cases	27.97(+6.33)	6.07(+5.79) 78%	7.24(+6.50)	17.45(+7.66)	17.92(+7.83) 36%

Table III – Angular results in Cobb's degree and percentage of reduction compared to the initial angulation

We have, as well, put together the esthetical results at the rib hump level (Rib H) measured in mm. Table IV

	Rib H initial	Rib H Corset	Rib H weaning	2 years after
Lyon Thoracic (thoracic) 285 cases	25.43(+8.68)	10.12(+7.52)	15.54(+8.39)	17.03(+8.70) 33%
Lyon Thoracic (double major) 351 cases	19.32(+9.61) 13.82(+7.32)	7.55(+5.86) 2.69(+3.12)	11.96(+7.13) 6.19(+4.39)	13.21(+7.71) 6.92(+5.45) 32% / 50%
Lyon Thoraco-Lumbar 279 cases	21.72(+7.31)	6.20(+5.35)	11.23(+5.73)	11.62(+6.74) 46%
Lyon Lumbar 450 cases	17.42(+7.37)	2.55(+2.70)	5.59(+4.42)	6.33(+5.43) 64%

Table IV – Results in mm about Rib Hump

In accordance to international norms, we evaluate the results 2 years after the weaning of the brace divided between :
 - Good that is to say a gain of more than 5° according to the initial curve
 - Stable that is to say +/- 5° according to the initial curve
 - Failure that is to say a curve loss above 5° according to the initial curve
 For double major scoliosis, we compared half the sum of the two curves.

	Gain >5°	Gain +/- 5°	Loss > 5°
Lyon Thoracic (thoracic) 285 cases	140 54.26 %	85 32.95 %	33 12.79 %
Lyon Thoracic (double major) 351 cases	208 59.26 %	127 36.18 %	16 4.57 %
Lyon Thoraco-Lumbar 279 cases	189 67.74 %	76 27.24 %	14 5.02 %
Lyon Lumbar 450 cases	362 80.44 %	84 18.66 %	4 0.88 %
Total 1338 cases	899 67.19 %	372 27.80 %	67 5.00 %

Table V – Results at +/- 5°

We isolated a group of 174 scoliosis, which treatments were initialised at Risser 0. We can, thus, compare the results obtained comparing the average of the main and secondary curves.

	Cobb initial	Cobb plastered	Cobb Brace	Cobb weaning	2 years after
Total cases 1338 cases	28.51(+7.14)	8.09(+7.16) 72%	10.75(+7.69)	21.27(+9.09)	21.80(+9.48) 24%
Group Risser 0 174 cases	27.23(+6.46)	5.24(+6.65) 81%	8.85(+6.88)	21.85(+8.98)	22.31(+10.22) 18%

Table VI – Angular results in Cobb's degree and percentage of reduction compared to the initial angulation.

We can study, as well, the 2 groups according to a gain above 5°, a stability at +/- 5° and a loss of more than 5°.

	Gain >5°	Gain +/- 5°	Loss > 5°
Total cases 1338 cases	899 67.19 %	372 27.80 %	67 5.00 %
Group Risser 0 174 cases	85 48.89 %	54 31.11 %	35 20 %

Table VII – Results at +/- 5°

DISCUSSION

The Lyon braces have followed the progress of the technology while conserving the fundamental biomechanics principles.

For 20 years, the Lyon Brace is realised and evaluated in the same way in some public and private structures either in France or in Italy. The results are coherent and the variations in time are linked to the screening and an early take in charge.

The initial reduction by a plastered cast enables a moulding on the spine already moulded. The X-Ray with the plaster cast is used as a reference to adapt the orthosis. This reduction enables a nightly wearing of the brace, which is very appreciated by the child, for the curves below 30°.

Lenke's classification seemed to us well adapted to the prescription, the doctor just has, therefore, to classify the curve in order to help the orthosis technician to realise the most adapted brace.

In my opinion, it is the brace that must adapt to the child itself and we will use according to the cases all the range of the actual braces. The best indication for the Lyon Brace is the puberty growth, when the constraints on the rib cage do not risk leading to tubular thorax. The statistics do not correspond to all the scoliosis we treat, but to some patients that we select because we think the Lyon Brace will be more effective.

When a treatment has been done before, the initial angulation is the one before the plastered cast.

The realisation of a plastered cast at the beginning of the treatment may select the most motivated patients, who think compliance is the best. In the same way, we lose many tracks of the patients at the end of the treatment and only the motivated ones come to the check-up.

When a patient is operated, he is included in the statistics and we repeat the angulation before surgical intervention.

The important Standard Deviation of the Cobb's angle of our series shows the important amplitude of indication, from the weaker curve to the most important; the only variable is going to be the time of wearing the brace during the day.

The best results are obtained for lumbar scoliosis. The brace is short, well tolerated and those curves are often painful at adult time. Those are the

ones which evolve towards rotatory dislocation.

The double major curves react well to the Lyon Brace, despite the short lever arm in the frontal plane.

The thoraco lumbar curves react well, in the same way, to the Lyon Brace type 3 points high. The excellent lever arm enables a good correction thanks to the plaster cast; nevertheless, it is in this group that we find again most of the scoliosis which evolve towards surgery even if we follow the treatment acutely. We insist on the strict wearing of the brace, despite the impressive corrections which we can sometimes note when the patient wears a plastered cast.

The rib hump is better corrected than the angulation which is reduced of 1/3 at the thoracic level and more than 50% at the lumbar level. The esthetical aspect is always better than the x ray.

The excellent global index of effectiveness of all the curves is 0.95, and it can be explained thanks to the selection of the patients. The index is only 0.87 for the thoracic curves. The most characteristic group to judge the effectiveness of the Lyon Brace is the Risser 0 group. In this group the index of effectiveness of the most progressive scoliosis is only 0.80.

But if we compare the average curves of the Risser 0 group with the average curves of the general statistics, the two curves are almost the same, as if the Lyon Brace was stopping the scoliotic curves whatever the age of the child.

Even if the index of effectiveness seems to be better, it is very hard to compare the results of the Lyon Brace with the one of the other braces published in the literature. The latest indication at puberty growth may explain the good results.

Conclusion

Almost sixty years after the beginning of the Lyon Brace management, we can confirm its effectiveness. Little by little, we precised the indications related to the Lyon Brace and we managed to make the all treatment ambulatory even for the realization of the plastered brace. Nowadays, the electronic moulding enables a precise realization according to Lenke's classification.

The Lyon Brace management is a conservative orthopaedic treatment very effective and this fact is proved by the last results that we highlighted in this study. The ambulatory realisation of the plastered cast and the Lyon Brace is cheap and enables the child to keep on going to school.

The easiness of the prescription of the brace coming from Lenke's classification is reachable for everyone.

The easiness of adaptation of the brace during puberty growth enables a precise and optimal adjustment.

It is a complement to other orthosis and must be included in the therapeutic range of the scoliosis specialist.

This treatment provides the maximum chances to the child and it provides the maximum chances of success to the doctor.

References

- [1] Cotrel Y, Morel G. - La technique de l'E.D.F dans la correction des scolioses. Rev. Chir. Orthop., (1964); 50 (1): 50-57.
- [2] de Mauroy JC, Stagnara P. - Résultats à long terme du traitement orthopédique lyonnais des scolioses inférieures à 50°. in Journées de la Scoliose. ALDER édit. Lyon, (1979); 255-260.
- [3] de Mauroy JC. La scoliose : traitement orthopédique conservateur. Sauramps édit. Montpellier, (1996), 279 pp.
- [4] de Mauroy JC, Fender P, Cerisier A. Résultats 2 ans après l'ablation de 1228 orthèses PMM. Med. Phys. Readapt., (2006) ;22(1) :18-21
- [5] Lenke LG, Betz RR, Bridwell KH, et al. Intraobserver and interobserver reliability of the classification of thoracic adolescent idiopathic scoliosis. J Bone Joint Surg Am. (1998);80:1097-1106.
- [6] Lenke LG, Betz RR, Harms J, et al. Adolescent idiopathic scoliosis: a new classification to determine extent of spinal arthrodesis. J Bone Joint Surg Am. (2001);83:1169-1181.
- [7] Michel CR, et coll. - Appareillage des scolioses en période évolutive. Rev. Chir. Orthop., (1970); 56 (5): 399-470.
- [8] Ollier M. - Technique des plâtres et corsets de scoliose. Masson édit., Paris, (1970) ;130 pp.
- [9] Stagnara P, de Mauroy JC. - Résultats à long terme du traitement orthopédique lyonnais. in Actualités en rééducation fonctionnelle et réadaptation. Masson, Paris, (1977); 2° série 33-36.
- [10] Stagnara P, Desbrosses J. - Scolioses essentielles pendant l'enfance et l'adolescence : résultats des traitements orthopédiques et chirurgicaux. Rev. Chir. Orthop., (1960); 46: 562-575.
- [11] Stagnara P, Mollon G, de Mauroy JC. - Rééducation des scolioses. Expansion scientifique, (1978).
- [12] Stagnara P. - Les déformations du rachis. Masson édit, Paris, (1985).

APPENDIX 1

PRESCRIPTION FOR A PLASTERED BRACE OF THE TRUNK

- 1 - Make daily care of the skin with:
 - Alcohol at 70°
 - Band of crepes 10 cm wide Velpeaucrêpe } to change :
- 2 - Alimentary diet :
 - Avoid the starchy food and sparkling drinks.
 - Have 4 meals a day.
- 3 - In case of nausea:
 - position knees against pectoral (seen during physiotherapy)
- 4 - In case of throwing up :
 - Ask the nurse an injection of IM of PRIMPERAN
 - Call the doctor who will decide if a hospitalization, for a gastric intubation and a ionic balancing is necessary.
- 5 - Repeat every day the rehabilitation exercises: vertebral and respiratory taught and checked by the physiotherapist.
- 6 - Call the insurance : in case of the practice of a collective sport, or driving a car.
- 7 - The amenorrhea is frequent and there is no need of a systematic gynecological consultation.
- 8 - Call us :
 - If a compress shows a blood stain during the cure
 - If the plaster brace is breaking down
 - In case of digesting trouble.

APPENDIX 2



Brace Evaluation by the Physician

Evaluation

with the brace
The child is asked to come to the check up with the brace on him and if possible the same kept from the former night.

- 1 In a standing position we check in the frontal plane the global balance of the occipital axis, and the mettalic core grid : anterior and posterior masts. We check, as well, the distance between the edge of the brace and the hollow of the axilla area; in the sagittal plane we check the Tragus Trochanter-Acromion malleol alinement, we check the vital capacity with a spirometre. It must not be below 20% of the one measured during the first consultation.
- 2 In a standing position the inferior edge of the pelvic belt must not compress the inguinal fold anc we check the sitting writing position feet behind, bottom in the front, before arms on the counter.
- 3 In decubitus the anterior mast must not disturb the thorax inhalation

and the abdominal pads must not compress the soft parts (+2cm). Laterally, the pads must be against the thorax. In this position we will check better the tightening.

2. Examination without any orthosis.

We will check if the redness, at the pads level, are regular, the principle being to spread as much as we can the pressure on all the pads. When the redness persists half an hour after the wearing of the orthosis, we have to untighten the pads.

3. The criterias of a child accepting well his orthosis

We are fully assured when :

- The orthosis is decorated with stickers
- The child is in place and can take off his brace by himself during the first consultation.

For the successive controls, we will appreciate the wear-out of the metallic pieces and the fastenings according to the time of the wearing of the orthosis. The practice of a regular sport is a compliance factor as well.

APPENDIX 3

Management of the Lyon Brace

1. protocol of the wearing of the orthosis

The protocol of the wearing of the orthosis is précised during the first consultation according to the angulation of the curves and is confirmed if the reducibility with a plastered brace is more than 50%.

The time of wearing of the orthosis is increased if the reducibility is less than 50%.

2. Practice of sport

The wearing is authorized without any time limitation for the practice of sport.

We, generally advise the sports favouring the suppling up of the muscular ligamentar paravertebral structure during puberty growth: such as swimming, climbing. From the first period and at the end of the body growth, we advise sports with impacts such as running, dance, to favour the fixation of the calcium on the bone and the constitution of an important bony mass.

In a specific way when the ribs are asymmetric we recommend to avoid deep and quick inhalation which favours the vertebral rotation and therefore the breathlessness during the practice of sports.

For lumbar curves, we advise, as well, against the quick flexions of the trunk forward or the position extending with an anterior flexion of the trunk.

3. Body cares

The perfumes and colouring have to be avoided and we will use a neutral soap or alcohol. The undershirt under the orthosis is in cotton long enough to cover the pelvis and if possible seamless, like a shirt. In France, 8 under shirts like the one described are delivered with the orthosis.

4. Feeding

The straightening up of a scoliosis can modify the esophagus gastric passing through the diaphragm.

The inflation of the stomach has to be reduced by spreading over the day the meals, and avoiding all the sparkling drinks.

5. The sitting position

We have to dissociate the « listening » sitting position: feet forward, ischios behind the bottom, and back against the dorsal support, from the « writing » sitting position: feet backwards, ischios in front of the bottom, brace against the anterior edge of the counter, the two forearms lying on the counter.

6. At night,

The mattress has to be thick, a little pillow stabilizing the cervical spine. If the patient complains of a superior member falling asleep, we have to make the high thoracic counter-push or the little balancing crutch to avoid the “pull apart tyre” effect. If the swarming remains, it may be a costo clavicular compression and we advise a second pillow to move aside the arm in abduction.

APPENDIX 4

SOME COUNCILS WITH THE YOUNG PEOPLE PRESENTING THIS DISEASE.

All starts one morning...

Miss vertebra awakes very anxious. One has just discovered a scoliosis to her.

She seeks to get information.

It is really not simple, all is so new for her! Fortunately that Doctor Ortho is there to explain and answer her questions...

What is scoliosis?

It is a painless deviation of the spine. It can occur at any age. The physician poses the diagnosis by examining you then by making you X-rays of the spine.

You can have one or more curves on the level of the spine, which normally is right.

The side of curve is defined by its convexity which corresponds to the top of the deformation thus a dextro-convex scoliosis is a scoliosis deformed towards the right.

Claims with your physician show you that on the X-rays. He will also show you how the angle of the scoliosis is calculated, which enables him with other criteria to determine the best treatment for you.

It will be necessary to keep all the X-rays and to bring them each time in consultation so that the physician can see the changes and your progress.

This deformation is accompanied by a rib hump.

The hump is a hump in the back, due to the rotation of the vertebrae and the deformation of the ribs. It is sometimes difficult to see in upright position and it is better seen when one is bent forward.

The origin of this affection is not known, this is why it is qualified “idiopathic”. On the other hand, it is not due to a nasty attitude, nor with the carrying of the school bag.

On the other hand, it is known that it concerns between 3 and 4,5% of the children and that it affects more the girls. Often other people in the family have a scoliosis.

But why make a treatment if that is painless?

The scoliosis is likely to worsen until the end of growth and especially during puberty. It thus should be cured as soon as possible when it is evolutive.

If you do not follow your treatment correctly, curve and rib hump will increase and involve a disharmonious hump, and you will be perhaps constrained (pain, esthetics) in the life of the every day.

Perhaps this scoliosis will have a day to be operated.

The treatment by brace will not correct totally the deformation, nor to cure your spine; but it will prevent that the scoliosis does not worsen and will slow down its evolution.

How that will it occur?

According to the case, you can have:

a removable brace from the start, made after a moulding (Milwaukee or another brace...)

or to need a reducing plaster cast made on a frame who makes the best correction of your scoliosis. It is the best method when it is necessary to treat more extremely (at the time of a more important, or more evolutive, or stiffer scoliosis). The duration of this plaster cast, its renewal (one, two or three times) also depends on these other factors. This time is necessary to stiffen your spine in the corrected position.

Then, one carries out a moulding of your spine (a plaster cast which is immediately removed and makes it possible to manufacture your custom brace).

You will need a fitting, and with the delivery, test your brace with the orthotist who will explain you how to put it and carry out the last adjustments. X-rays are made with the orthotic device (another name of the brace).

The first technical control is envisaged one week after to check that all occurs well at the same time as the doctor visit. Of course if a problem occurs, return as quickly as possible. The physician will see you every six months. Put the questions which you want if there is anything that you do not understand.

In general, the X-rays are required at the time of the consultations every six months. They must be made before the consultation and are carried out without the brace (it should have been removed six hours before the X-ray).

If the correction is insufficient or if there exists an aggravation, one checks the adaptation of the brace, one modifies it, one modifies its protocol of wearing (one increases the time of wearing). Sometimes it is necessary

- to remake a correct plaster cast,
- to change the brace when the precedent is considered to be ineffective or badly tolerated.

The physician prescribes you sessions of physical therapy to learn how the correct exercises to make with and without brace.

When could I remove it?

It is the physician who decides with you, but it is waited always at least until you finished growing. The weaning of the brace is progressive and increases two hours per day every fifteen days while passing from a protocol of 23:00 to a protocol of 20:00, until 16:00 with a control in consultation with three and six months.

How to put my brace?

You can put your brace upright, the spine against a wall opposite a mirror or supine, and you can do it all alone.

It is important to tighten the brace sufficiently so that it is effective, moreover it hurts if it moves and if it is badly fixed.

In addition, the orthotist put reference marks of tightening at the time of the first check, then you cannot be mistaken. These reference marks are checked with you during the successive surveillances.

Why I must carry it so a long time?

The brace is carried permanently as plaster cast, from the delivery, and it is necessary to respect well the protocol of wearing prescribes by the physician. Often it should be carried 23 hours out of 24, sometimes 16:00 on 24, and that for one period of time of 18 month at several years. It is only in this way that the treatment will be effective. The protocol is proposed according to the type of curve or scoliosis and according to its evolutivity.

The vertebrae are more delicate, they become deformed while growing and the brace is the stake which allows the spine to rectify itself, and less to collapse.

The brace is also carried the night because you grow during the night, therefore it is effective at this time; it is difficult at the beginning, but one is quickly accustomed to sleep on the spine and at the end of the treatment there is even difficult to sleep without brace!

And if I grow?

The brace is changed if you grew much and because the brace is not suitable any more. For example: you could increase from 7 cms and 5 kilograms. In fact, the need for changing the brace depends on the type of brace, of height and weight but also on the modifications of the shapes of the thorax and the pelvis.

Must I carry my brace to the school?

Yes if you have a protocol of port of 23:00 on 24. It is in sitting position that the vertebrae become deformed more.

Will my friends make fun of me?

"I have the look of a robot, the device makes me stiff, the contact is tough, I have the impression to carry a carapace, it is unaesthetic, it's visible, I am not like the others.

But the brace protects me, I have the impression to be strong, I am held better, it is necessary courage for me to face the others, I make efforts."

If the others know, if you explain to them, they will not make fun of you, do not be afraid to speak about it and you will see. Other people can help you, other young people perhaps have the same problem. Your friends, the professors, the parents can render service to you to arrive there.

Are there particular maintenances?

To wear the brace requires a undershirt. It will be selected out of cotton without lateral seam, or carried upside down to prevent that the seams do not mark the skin. Small sleeves protect the hollow axillary. It will be sufficiently long to exceed of the lower part of the brace. It will be washed with the neutral soap without dye and fragrance (standard household soap) to avoid the allergies, and will be changed the every day.

Maintenances of hygiene will be daily, you perspire more with the brace, especially in summer. Then take a shower or a bath each day, or better twice a day, morning and evening.

There too, you will take a neutral soap without dye and fragrance or a dermatologic product without soap if you have the delicate skin.

Be wary of the heatstrokes: use creams with total protection.

If a part of the skin is irritated or painful speak with your physician, you can all request from him; moreover is your tetanus vaccination up to date?

Must I follow a food regimen?

Yes, quite simply to prevent that your belly does not inflate too much, which would involve a compression in your brace which is not elastic. One should not eat too much during a meal but to eat more often, 4 meals per day for example, and the fizzy drinks are prohibited.

Certain food materials are to be consumed with moderation:

- Those which always make inflate: all the cabbages (cauliflowers, Brussels sprouts, red cabbage, curly kale, broccolis...), lenses, garbanzos, white beans, flageolets
- Fresh bread
- The starchy foods (rice, pastes, potatoes, semolina)
- Certain fruits like banana, cherries
- Pastries and Viennese pastries especially if you want to keep the line

And remember: no fizzy drinks, but water and always water, at least 2 liters per day, and even more if you make sport.

Do I have to quit the sport?

Especially not!

You can continue the sport or the activities which you had before the brace, and if possible start others of them. The contraindications with the sports practice are exceptional.

If the brace obstructs you, you will remove it for the strict length of time of the sport.

Do not forget that you need muscles to support your spine, now and also when one removes the brace definitively.

More over when you move, calcium is fixed better on your vertebrae which need some to grow and to solidify itself. And never forget to drink, during and after the effort.

Must I make it in addition to kinesitherapy?

The sport enables you to move, and kinesitherapy to better move. They are two complementary activities. It is also important to make each day the exercises of kinesitherapy which you learned.

These exercises are different according to the type of scoliosis which you have, the physical therapist and your physician check and control these exercises, some are to be made in brace, others without brace.

For the lumbar scoliosis, the shift is very important to make anywhere, as often as possible any time.

For the thoracic scoliosis, without the brace it is necessary to work in kyphosis because it becomes flat in its high part where you have the scoliosis.

And if I must be operate?

Sometimes, in spite of a treatment of well followed brace, the scoliosis worsens and a surgical operation can be necessary to the end of growth.

The surgical procedure consists in rectifying the deformation of the spine with metal rods, hooks, and a bone grafting which fix the vertebrae. The surgical procedure depends on your age, of your scoliosis. The purpose of it, is to block the spine in corrected position so that the deformation does not worsen any more. The surgery rigidifies the spine. It is the surgeon who decides the method of treatment according to your own situation.

The surgical procedure proceeds under general anesthesia, before you will give a little of your blood so that one can give again it to you during the surgical procedure. After the surgical procedure, the brace is generally not necessary. The hospitalization is not very long. It is proposed if possible during school vacations and you can normally go back to school after surgery. The surgeon that you will see explains what he will do and why; All the questions should be asked to him.

To avoid the surgery, the treatment by brace is very important and this is why this treatment should be observed as well as possible. It also makes it possible to be operate under better conditions when that remains necessary.

And here, it is finished, Miss vertebra does not need more her brace!

She already left for other adventures...