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Research Article

Surgical Approach in Patients with Scoliosis "*De Novo*"

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Abstract

Surgical treatment for adult scoliosis which is resistant to non-invasive treatments is a challenge for surgeons; in fact, it is a delicate and demanding surgery.

The greater knowledge of the surgeon, along with modern day instrumentation, has allowed and still allows to offer patients, even elderly ones, a safer, less demanding surgery with less time in surgery and shorter hospital stays than in the past and with higher success rates.

International scientific literature in the comparison between patients who are seriously ill with these pathologies shows clearly greater advantages in patients who have been operated on compared to those who have not been operated on.

Surgery should be reserved for those cases in which the specific cause of pain has been identified and when all conservative treatments have failed. The reason for surgery is not to prevent the rapid aggravation of the deformity like in adolescent idiopathic scoliosis (in adults with a curve that is greater than 30° the aggravation is around 1 - 3° annually) but to treat the pain.

Great importance is given to the choice of the arthrodesis area and the restoration of the physiological curves on the sagittal plane [1].

The lumbosacral joint should be "spared" if there are no documented structural changes of the lumbosacral passage.

Some authors have emphasized the validity of the treatment of rigid deformities of the adult with multiple anterior and/or posterior osteotomies (in the same operation or in two operations within a short time of each other) even if this technique is undoubtedly very demanding for the patient.

For arthrodesis of the sacrum the circumferential fusion increases the percentage of fusion and correction.

If the patient needs fusion of the sacrum, it is necessary to select the most appropriate technique and the most suitable approach [2].

Alternatively, it is necessary to consider an anterior and posterior approach to avoid pseudarthrosis and loss of fixation.

Whichever technique is used, it is fundamental to respect the balance of the lumbosacral hinge (Flat Back syndrome).

Scoliosis surgery in adults and the elderly is a difficult and demanding surgery that has a high rate of risk and of complications.

The study was carried out on 106 scoliosis patients aged between 60 and 85 treated in our operating unit from 2011 to 2015 with a maximum follow-up of six years and a minimum of three years. The study yielded good results in 87% of cases.

Keywords: *Surgical Approach; Scoliosis*

Introdution

Degenerative diseases are the ones that most frequently make the spine diseased. The spine is a mechanical system on which variously distributed loads weigh daily, which in turn determine its physiological aging. For this reason there is a greater percentage of people in later life who suffer from the symptoms resulting from the degeneration of the various vertebral components, but not all human beings in advanced age (over 65) suffer from the aforementioned symptoms. This is because, as is known, there are risk factors. There is in fact a genetic predisposition, which is associated with environmental factors, such as type of work, type of sport, diet, smoking, lifestyle and conformation of the spine [3].

The first component that becomes diseased is the intervertebral disc.

The spine is a biological machine endowed with stability and it is a kinematic chain that transfers the biomechanical forces into coordinated functional activities. It is also a conduct for peripheral nerve tissues.

The spinal column is a mobile bone formation that extends dorsally and longitudinally with respect to the body, originating near the base of the skull and reaching and forming, part of the pelvis. It is the result of the alternating overlapping of bone and fibro-cartilaginous disc elements, tightly connected to each other by ligaments, and held up by strong muscle-tendon bundles.

It represents the supporting and joining axis of the body's girdles, and is a very complex organ, not only for how it is made, but also for the structures present inside and next to the vertebral canal, that is, the spinal cord and nerve roots. It is generally straight and symmetrical when seen on a frontal plane, while on a sagittal plane it physiologically assumes four nominal curves: the kyphosis (thoracic and sacro-coccygeal), which cause a dorsal convexity, and lordosis (in the cervical and lumbar tracts), which instead determine a convexity in front of the column.

These curves give the spine the qualities of elasticity and mobility, as well as resistance, which are essential for spatial movements.

The lumbar spine forms the flexible caudal part of an axial structure that supports the weight of the head, upper limbs and internal organs. The sacrum forms the base of the spine and articulates with the sacroiliac joints in the pelvis. It can support heavy loads and withstand gravitational movements while maintaining lordosis in a neutral posture. Unlike the dorsal tract, it has considerable mobility on the coronal and sagittal planes.

The vertebral bone is a specialized structure for transferring loads. The parallel lamellas of the highly vascularised spongy bone and made of trabeculae, are oriented according to biomechanical stresses. The spongy tissue is encapsulated in a shell of cortical bone. The lumbar vertebrae are bigger as they get further down precisely because they have to bear greater loads. The intervertebral disc is composed of an external fibrous ring and an internal pulpy nucleus. The outer portion of the annulus is rich in nociceptive and proprioceptive nerve endings. The inner portion of the ring contains the nucleus and protects it during compression [4]. The pulpous nucleus of a healthy intervertebral disc makes up two thirds of the surface area and supports 70% of compressive loads. The nucleus is made of proteoglycan macromolecules that can soak up to 250% of their weight in water. Until the third decade of life the gel inside the pulpy nucleus contains 90% of water, while in the fourth decade that number is already reduced to 65%. The nourishment of the fibrous ring and the pulpy nucleus depends on the diffusion of water from the vertebral plates while only a third receive nourishment from the capillaries of the epidural space. Repeated eccentric and torsional loads and daily microtraumas cause interruptions of the fibers of the annulus, with possible separation from the plate with a further damaging effect, resulting in a reduction in nourishment and consequent dehydration.

Following a discopathy, the hypertrophy of the facet joints is determined with bone thickening and reaction with formation of osteophytes and narrowing of the central canal and neuroforamis. Thickening of the yellow ligaments and disc herniations can be observed, which contribute to the further reduction of the anteroposterior diameter of the canal with neural compression. Faced with

this degenerative condition, the spine puts compensations and neuro-chemical variations in place. Some of these can be a cause of pain, functional disabilities and change of normal neuro-physiology. Some compensation mechanisms are benign, others can become harmful. Spinal pain is multifactorial, secondary to structural changes, biomechanical alterations with loss of stability, biochemical changes, and medical alterations with psycho-social influences. All this determines the difficulty of treatment [5].

There is talk of chronic low back pain when the pain persists beyond three months. In fact the healing of connective tissues, when they are the pre-eminent cause of pain, generally occurs in a period of time between four and twelve weeks, while the anatomical disease instability condition vertebral mechanics persists.

Degenerative scoliosis is an asymmetric degeneration that leads to an asymmetrical load with a progression of degeneration and deformity.

The destruction of the disks, of the interapophyseal joints and of the articular capsules generally leads to a condition of instability on the coronal and sagittal planes.

In sequence:

- Instability on the coronal and sagittal planes.
- Deformity in scoliosis and kyphosis.

Adult scoliosis is a spinal deformity in mature skeletal age with a Cobb angle greater than 10°, which is generally associated with a high degree of disability, greater than in idiopathic forms.

This shows how in adults there is no systematic correlation between the extent of the curve and the pain.

It is a common, progressive, debilitating disease.

This pathological condition generally becomes the cause of severe and disabling symptoms, capable of severely reducing the quality of life of those affected, and a need has been felt for a precise classification of the disease.

Instability is followed by central and/or lateral stenosis, and the deformity is followed by progression, also related to an altered metabolic condition of the bone.

This data corresponds to the appearance of symptoms such as lumbar spine pain, neurogenic claudication, in severe cases neurological deficits and change in appearance [6].

Moderate pain, as well as neurological symptoms, may benefit from a combined non-surgical treatment, while increasing, disabling pain that does not respond to common therapies associated with spinal claudication and curve progression has a surgical indication.

It is characterized by pain, curve progression, deformity, secondary stenosis of the vertebral canal and radiculopathies; the nerve roots are compressed on the concave side or on the convex side.

It is a chronic, significant, disease that can be substantially improved with surgery, and the realignment of rotational subluxation contributes to decompression of the nerve root, and results in relief of leg pain [4,7].

A physiological sagittal plane is essential for normal functioning of the spine, with cervical, thoracic and lumbar curves well balanced to allow an efficient absorption of energy and minimize muscular work to maintain an upright posture.

Materials and Methods

The objectives of scoliosis surgery include restoring sagittal and coronal balance, relieving pain and improving quality of life.

The objectives of the surgery are therefore:

- Balanced correction on the coronal plane (the appearance is less worrying than the pain).
- Correction on the sagittal plane: nothing is worse than a "flatback" which needs revision surgery.
- Obtaining a fusion (pseudoarthrosis can be observed more than a year later).

Surgery should be reserved for those cases where the specific cause of pain has been identified and when all conservative treatments have failed.

The reason for the surgery is not to prevent the rapid deterioration of the deformity like in adolescent idiopathic scoliosis (in the adult with curves greater than 30° the deterioration is around 1 - 3° per year) but that of treating the pain [8,9].

Surgical treatment of adult scoliosis is more difficult than adolescent scoliosis for various reasons:

- The patients are older (more pre/post operative complications).
- The presence of osteoporosis with less hold for the implants.
- The search for a fusion and sufficient stability often requires the instrumentation of several levels, even with a double approach.
- There are greater risks of stress fractures on the basis of osteoporosis in the area above the fusion especially in short instrumentation.
- The need to have to extend the fusion to the sacrum with a high rate of pseudoarthrosis, greater loss of lumbar lordosis (flat back) with possible alteration of movement.
- Excessive blood loss.
- Greater risk of infection.
- Higher rate of pseudoarthrosis.
- Continued pain after surgery.
- Greater neurological risks.
- Longer hospital stays.

Clinical tests are more important in order to study the characteristics of the pain:

- Localisation (convexity or concavity of the curve).
- When it appeared.
- Stable or progressive.
- Eventual reduction with conservative therapy.
- Characteristics (mechanical and/or radicular).

The choice of the arthrodesis area and the recovery of the physiological curves on the sagittal plane are of great importance.

The lumbosacral joint should be "spared" if there are no documented structural alterations of the lumbosacral passage. There may be a need for a combined posterior and lateral approach.

The circumferential fusion increases the percentage of fusion and correction for arthrodesis of the sacrum [10].

If the patient needs the fusion of the sacrum it is necessary to choose the most appropriate technique and the most suitable approach, such as iliac fixation.

Alternatively, an anterior and posterior approach is necessary to avoid pseudoarthrosis and loss of fixation.

Whichever technique is used, it is imperative to respect the "balance" of the lumbosacral hinge (Flat Back syndrome).

The posterior instrumented fusion acts well especially in the curves of medium severity, the patient can obtain a good sagittal and coronal balance; moreover, if it is not necessary to fuse to the sacrum it is beneficial for the patient, while if there are decompensated thoracic-lumbar or lumbar curves it may be necessary to fuse them to S1 or to the ileum.

Results and Discussion

Our case study includes 106 patients affected by scoliosis aged between 60 and 85 years old and treated in our unit from 2011 until 2015. It includes a retrospective analysis with a follow up of between three and six years. All of the patients suffered chronically with a severe limitation of quality of life and no benefit from non surgical treatment. For this reason and once appropriately informed about the meaning of the surgery, they underwent surgery after a complete pre-operative assessment of their general condition and therefore careful and detailed pre-operative planning [11].

Clinical study, x-ray, MRI and in some cases CT study of pedicles.

Scoliosis with a Cobb angle of up to 30 degrees which in 70% of cases was associated with an imbalance on the sagittal plane with spino-pelvic parameters altered to varying degrees.

In 80%, patients were ASA 2, in 20% they were ASA 3.

In 70% of cases the surgical approach was posterior using screws and sublaminar strips.

In the more elastic deformities a good correction was obtained with rebalancing on the coronal plane of about 80% and with acceptable pelvic parameters.

In the less elastic forms, a combined lateral XLIF approach was associated with the insertion of cages at one/two levels along with a posterior approach with Smith Petersen and/or Ponte osteotomies, screws and bars and sub-laminar strips. Patients were standing upright on the first or second day with discharge on the third/fourth or fifth.

Good results in 87% of cases.

Complications in 13% of cases:

- Mechanical (screws pulling out and/or rod breakage).
- Neurological (transitional).
- Two cases of the above vertebrae fractured with the need for further surgery three months after the initial surgery.
- Two cases of superficial wound infection.

G.A 13/01/57 Degenerative lumbar kypho-scoliosis

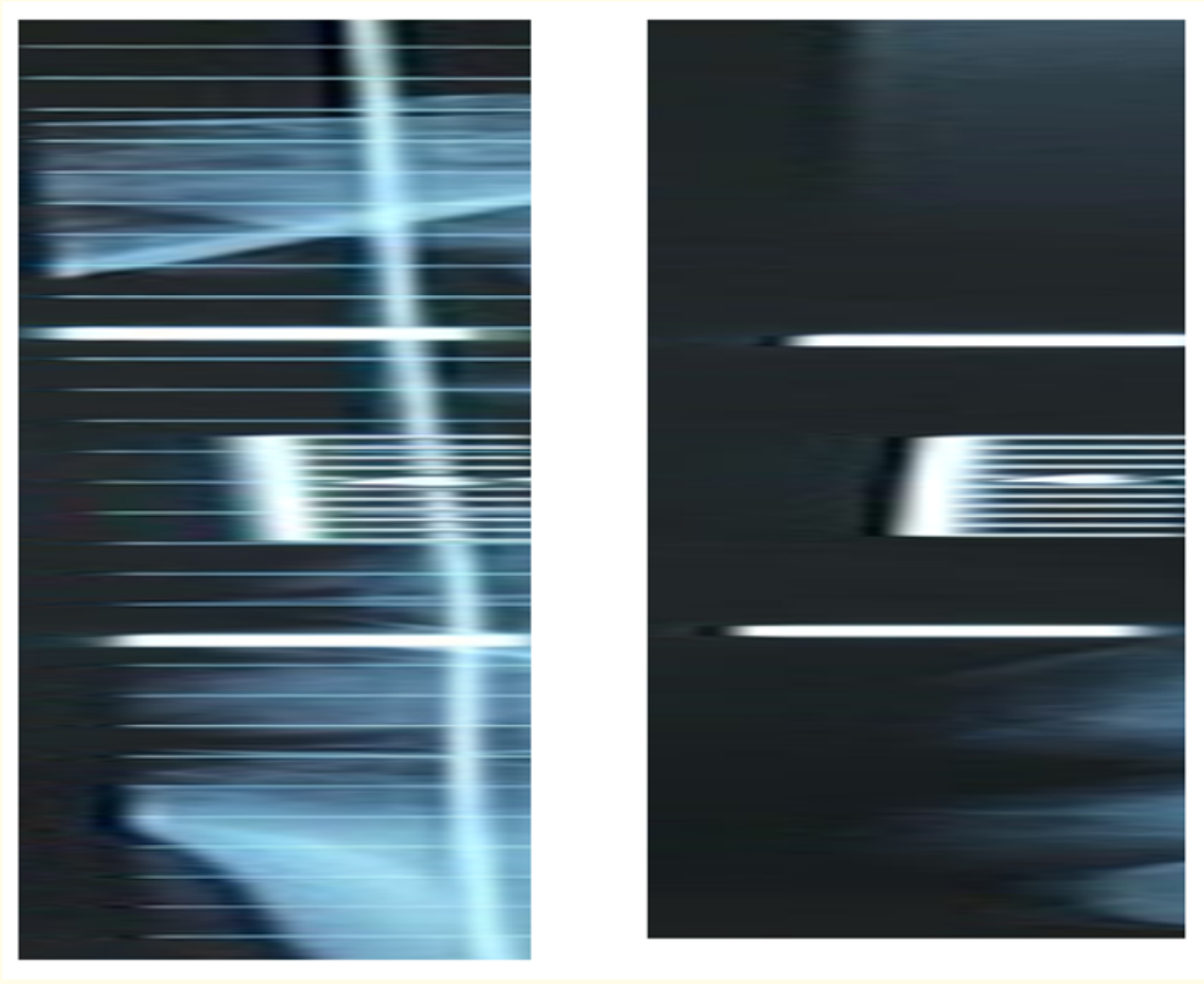

Figure 1A: *Pre-operative RX.*

Pre-operative:

Scoliosis = 38° Cobb

CSVL > 5cm

LL = 5°

KT = 0° Cobb

PI = 58°

PT = 47°

SS = 11°

Figure 1B: *Post-operative RX.Pre-operative:*

Post-operative:

Scoliosis = 5° Cobb

LL = 38°

KT = 25° Cobb

PI = 38°

PT = 19°

SS = 19°

M.T. 01/04/51 Degenerative scoliosis lumbar spine

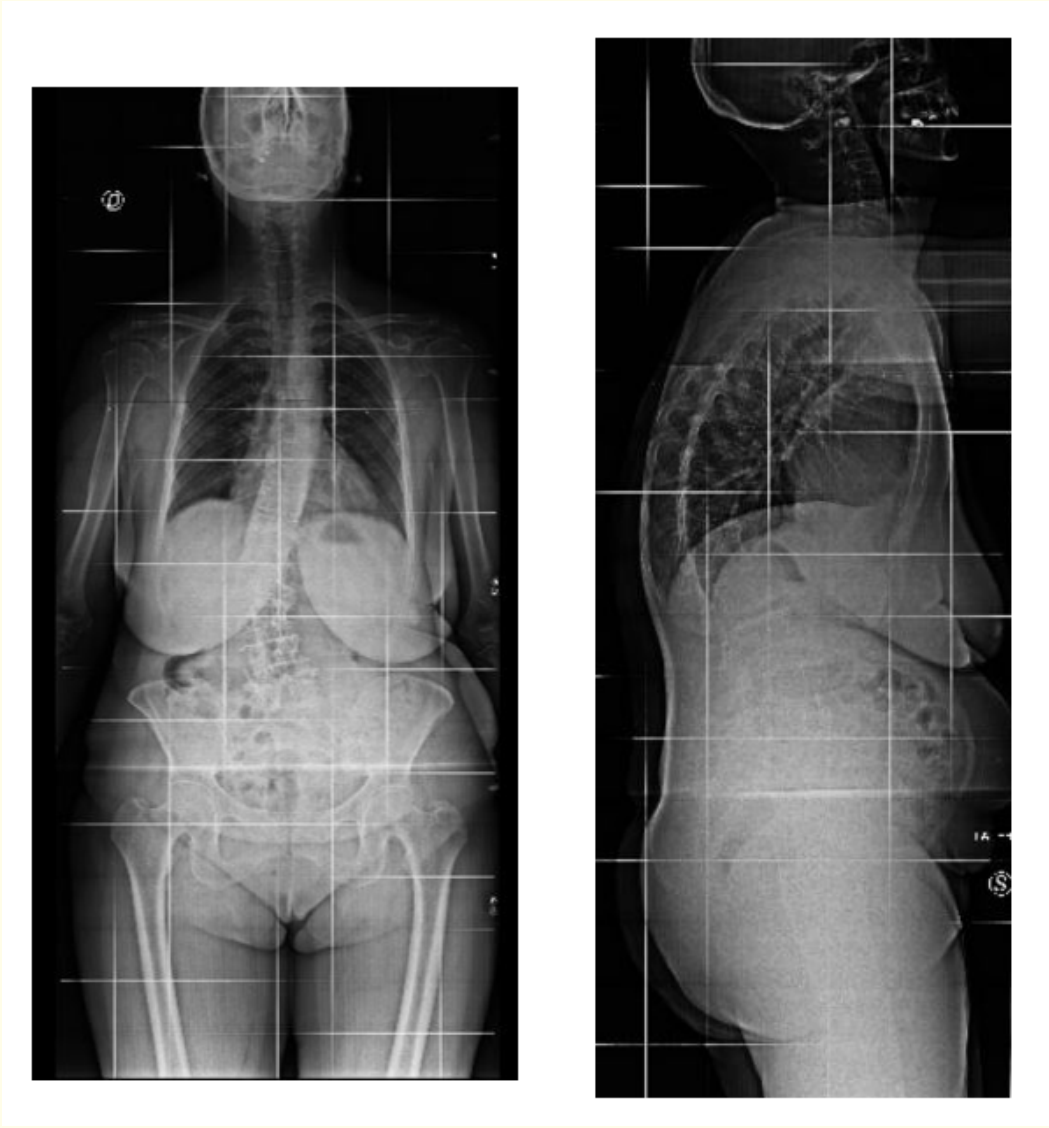

Figure 2A: *Pre-operative RX.Pre-operative:*

Pre-operative:

Scoliosis = 32° Cobb

CSVL > 5 cm

LL = 32°

KT = 52° Cobb

PI = 44°

PT = 34°

SS = 10°

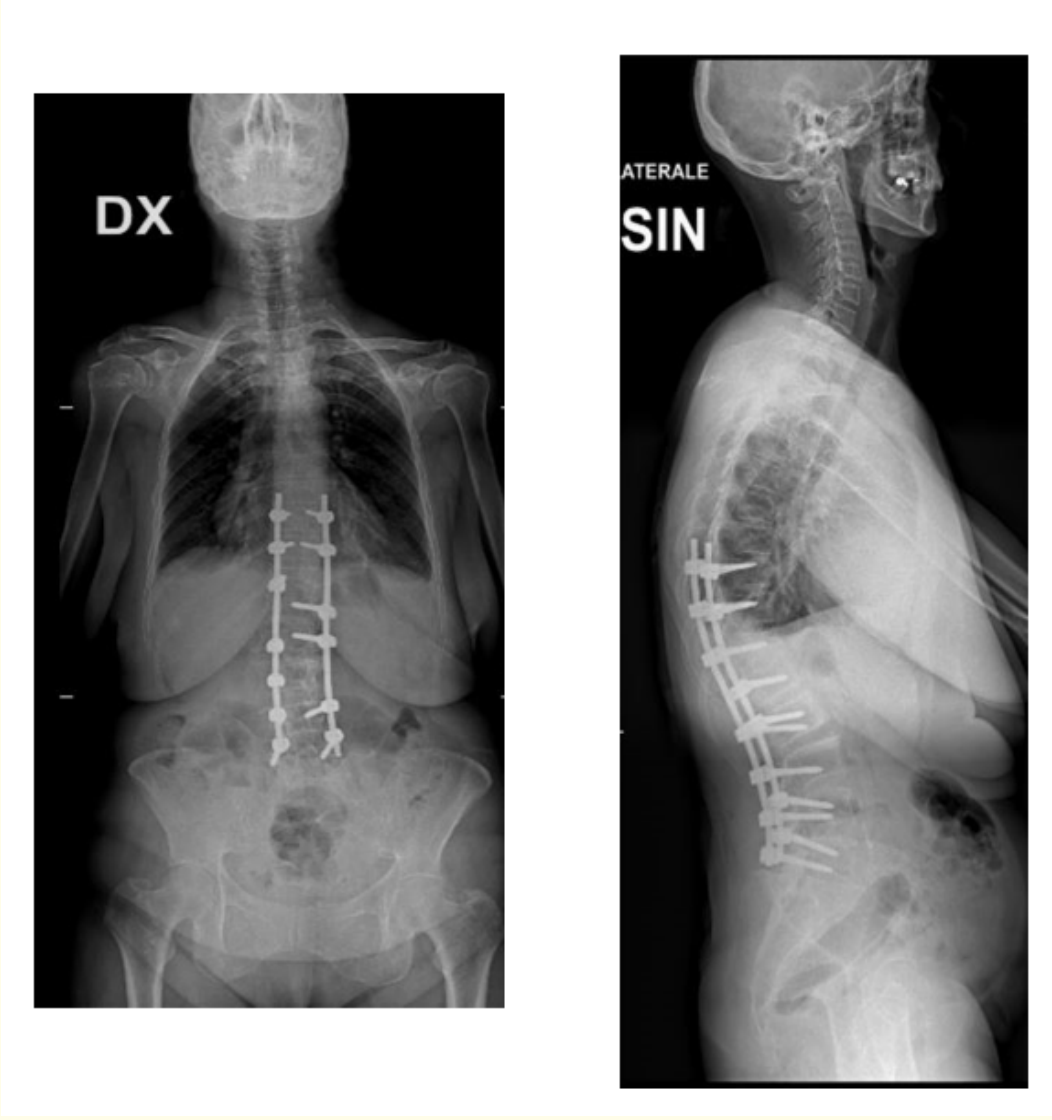

Figure 2B: *Post-operative RX Scoliosis = 32° Cobb*

Post-operative:

Scoliosis = 5° Cobb

CSVL < 5 cm

LL = 46°

KT = 47° Cobb

PI = 46°

PT = 20°

SS = 26°

M.G. 24/10/47 Degenerative adult scoliosis

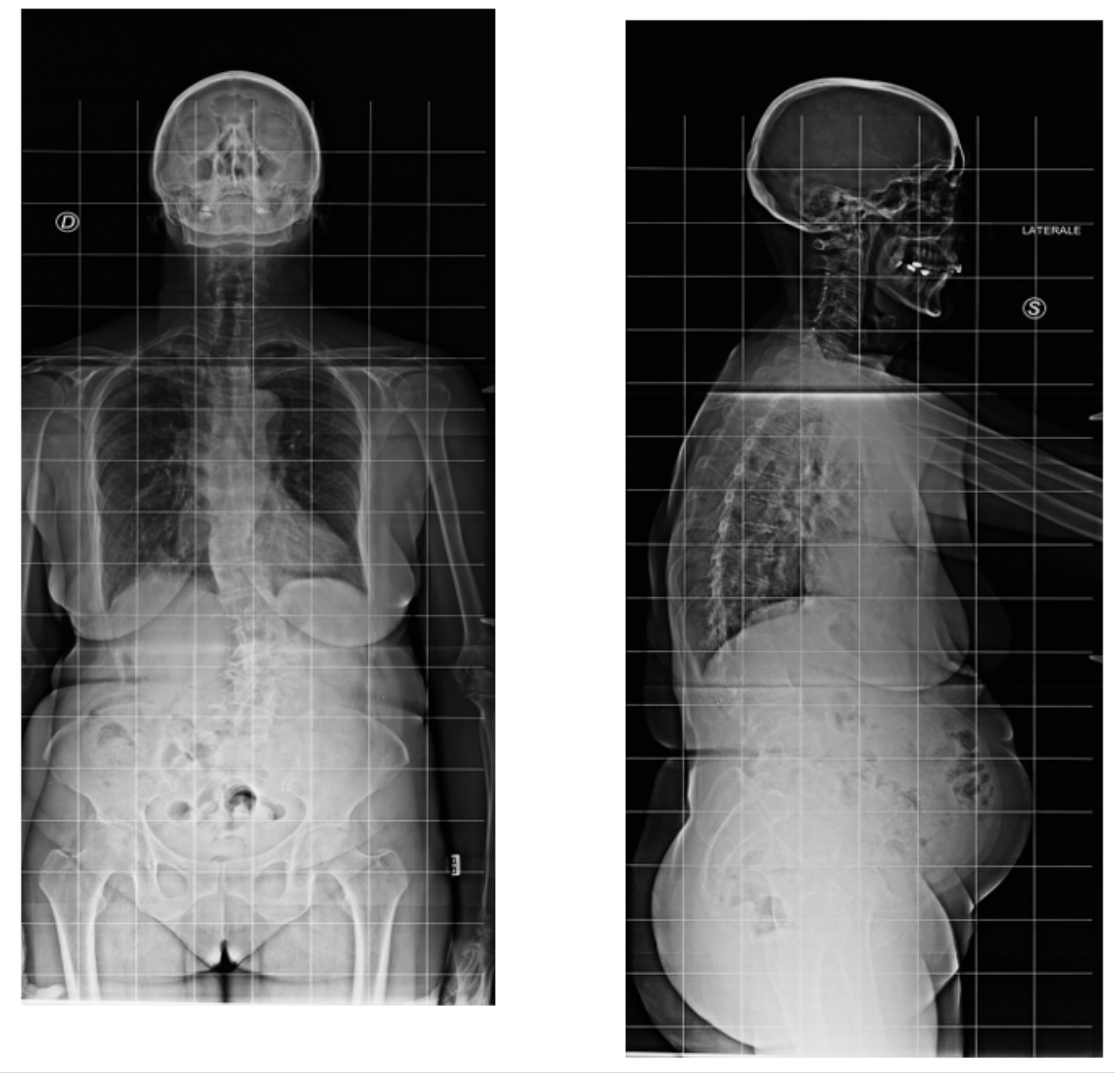

Figure 3A: *Pre-operative RX.Post-operative:*

Pre-operative:

Scoliosis = 28° Cobb

CSVL > 5 cm

LL = 36°

KT = 47° Cobb

PI = 40°

PT = 31°

SS = 9°

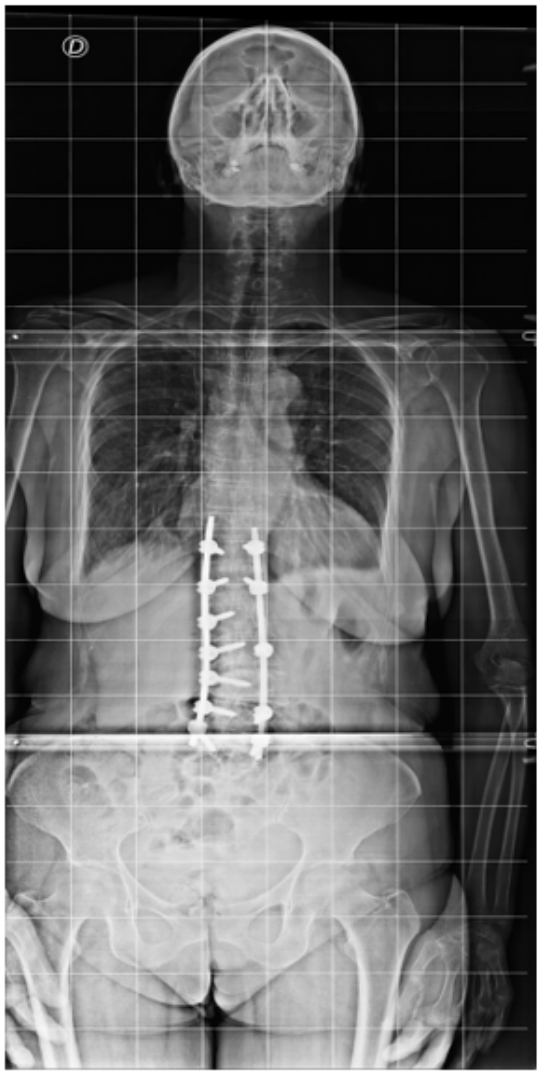

Figure 3B: *Post-operative RX.Post-operative:*

Post-operative:

Scoliosis = 9° Cobb

CSVL < 5cm

LL = 60°

KT = 38° Cobb

PI = 60°

PT = 18°

SS = 42°

P. MA. 07/04/45 Severe degenerative kypho-scoliosis of the adult

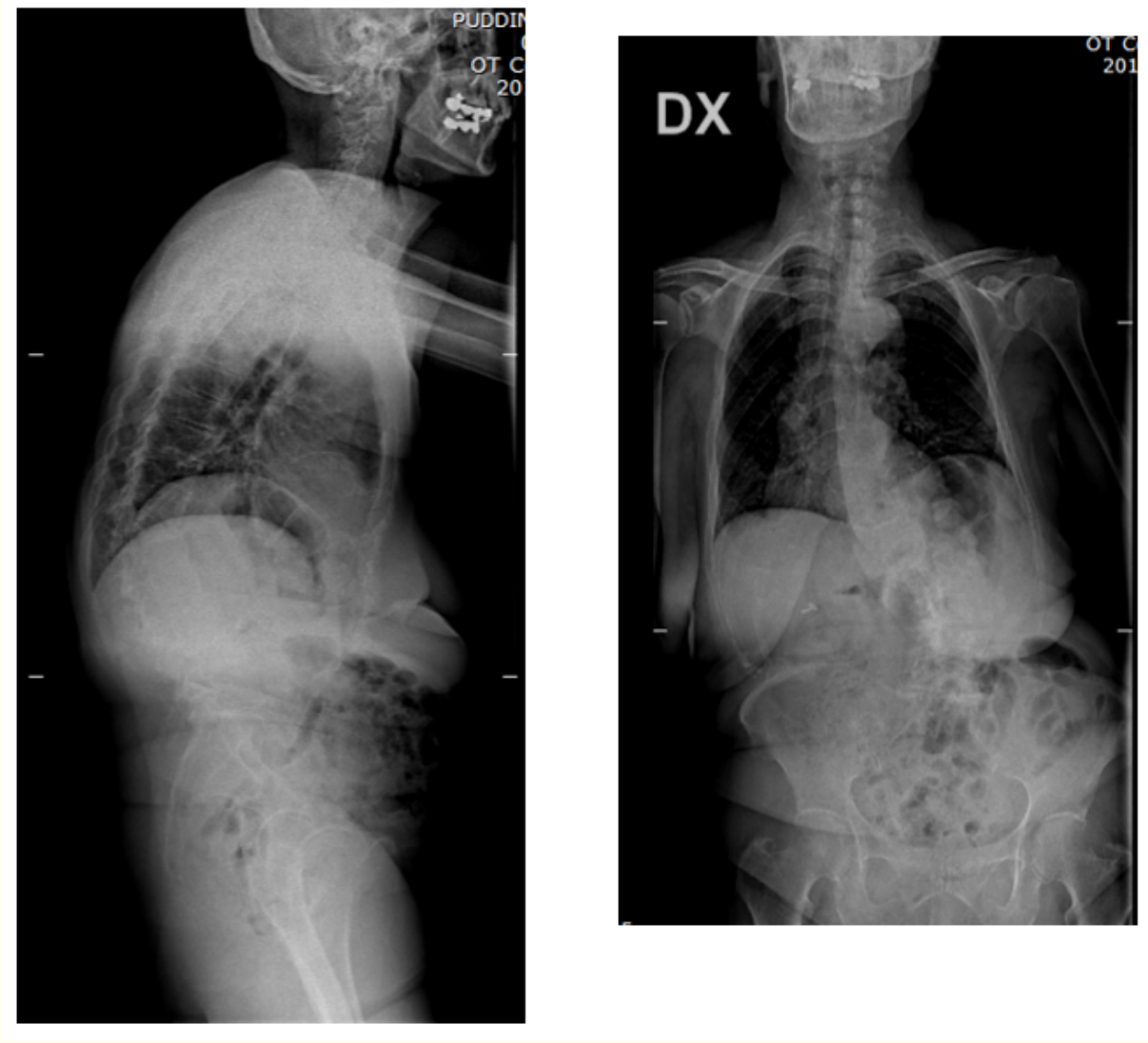

Figure 4A: *Pre-operative RX.Pre-operative:*

Pre-operative:

Scoliosis = 44° Cobb

CSVL > 5 cm

KT = 48° Cobb

PI = 45°

PT = 38°

SS = 13°

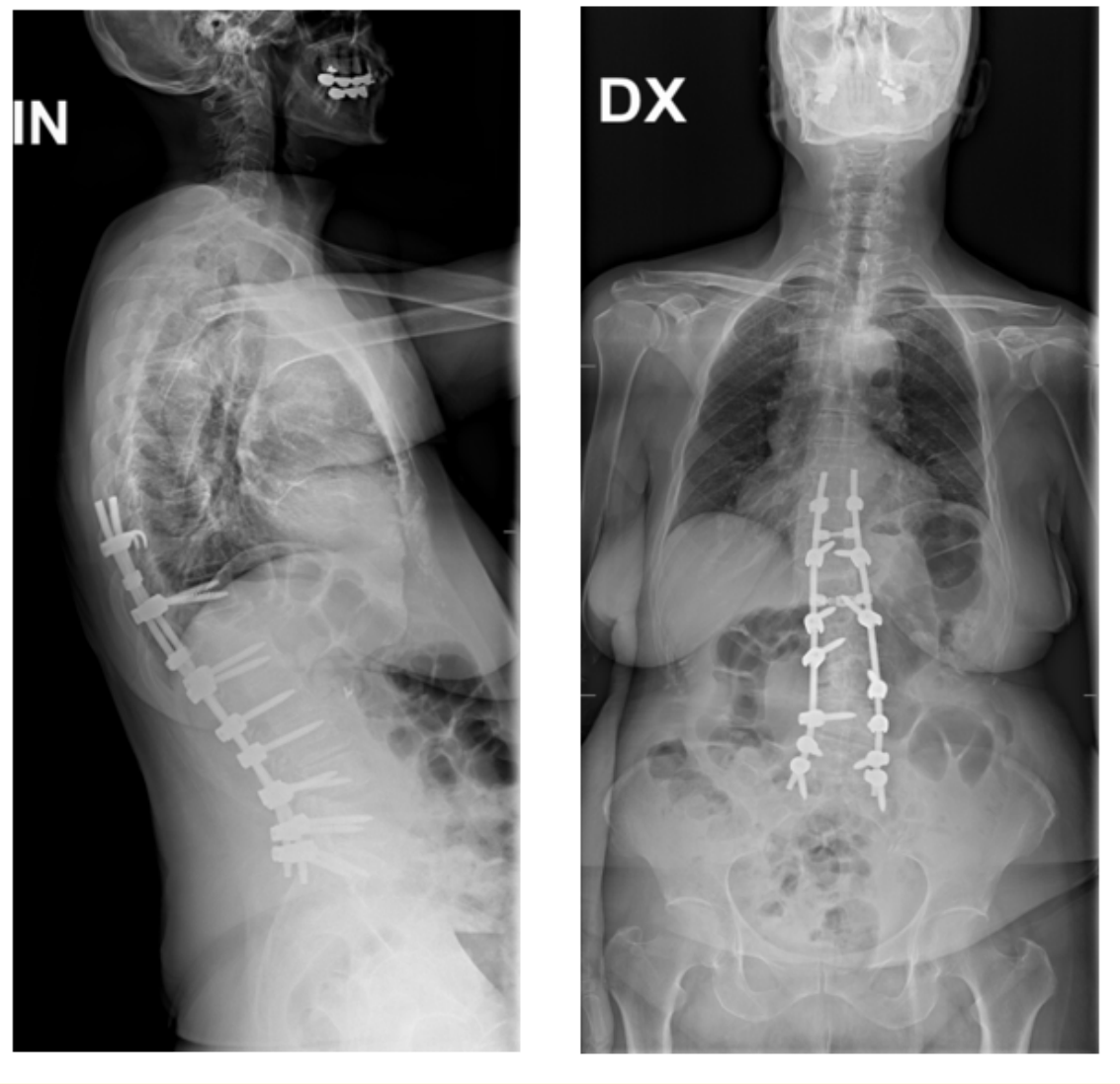

Figure 4B: *Post-operative RX.Post-operative:*

Scoliosis = 9° Cobb

CSVL < 5 cm

LL = 57°

KT = 48° Cobb

PI = 48°

PT = 18°

SS = 30°

T.R. 03/08/45 Degenerative adult scoliosis with severe alteration of lumbar lordosis

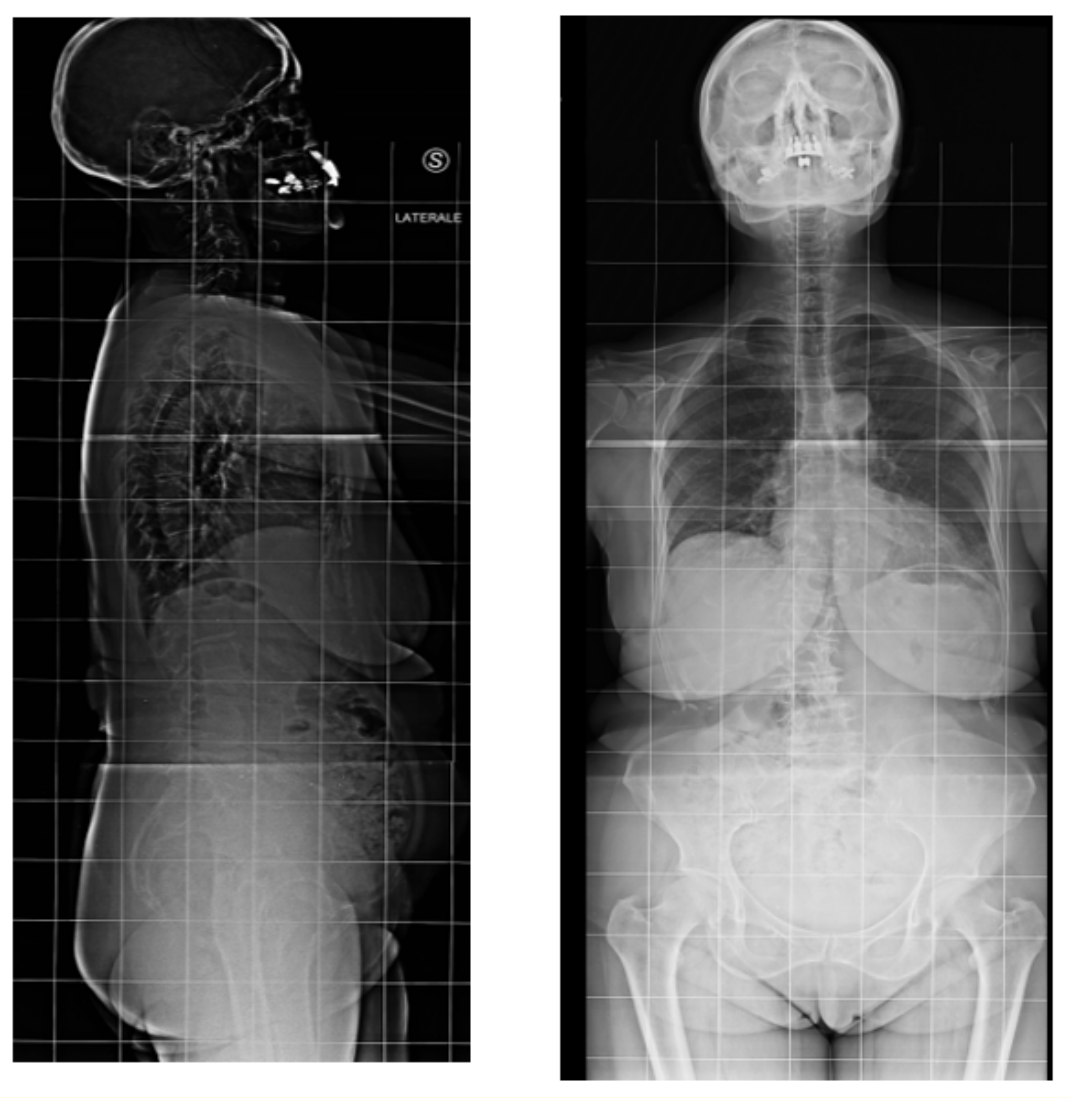

Figure 5A: *Pre-operative RX*

Pre-operative:

Scoliosis = 29° Cobb

CSVL < 5 cm

LL = 37°

KT = 24° Cobb

PI = 60°

PT = 25°

SS = 35°

Figure 5B: *Post-operative RX.Pre-operative:*

Post-operative:

Scoliosis = 12° Cobb

CSVL < 5 cm

LL = 64°

KT = 57° Cobb

PI = 60°

PT = 18°

SS = 42°

Conclusion

It is our opinion that the gold standard in scoliosis surgery is the posterior approach with instrumented arthrodesis using screws, with a diameter of 6.5/7.5mm in the lumbar tract and 6.5mm in the thoracic tract, and, in some cases, sublaminar strips.

Indirect compression in most cases.

Direct decompression is reserved for cases in which the MRI highlights tight stenosis.

In DDS we prefer to use screws plus an intersomatic fusion with a large decompression to obtain a better correction of the deformity in the selected cases. Intersomatic fusion can be performed with a minimally invasive lateral approach, transpsoas, with minimal blood loss and modest post-operative pain and with monitoring in selected cases.

The lateral access allows for the insertion of cages which are capable of occupying the entire intersomatic space after a complete discectomy with greater probability of obtaining an excellent fusion. The use of the cage is indicated in the most rigid deformities and it is possible to obtain an excellent correction on the coronal plane, while on the sagittal plane the correction is around 10% per level which can reach 30% with lordotic cages, which are better off fixed to the vertebral body with screws in order to avoid pull out. Where possible, we avoid PSOs in very rigid forms with severe sagittal imbalance even though they are not yet replaceable.

Scoliosis surgery in adults and the elderly is always a difficult and demanding surgery that presents a high percentage of risk and complications.

This is also because it is a relatively recently acquired disease that presents different peculiarities compared to adolescent scoliosis [12,13].

Scoliosis of the elderly is being seen much more frequently given that people live longer than before. It seriously reduces the quality of life.

It is necessary to evaluate the comorbidities of the patients and carefully study the best operative strategy both regarding the type of approach and the need to perform osteotomies as well as the use of the various means of synthesis.

It therefore involves a remarkable diagnostic, clinical and instrumental effort in order to achieve a more precise classification; careful planning and knowledge is essential, technique and experience can contain risks and complications, which, in our case study, are assessed in 13% of cases with an 87% success rate.

If these criteria are adhered to, there can be good results in a significant percentage of cases and the comparison with unoperated patients is certainly to the advantage of the operated ones.

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