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Cotrel-Dubousset Instrumentation for the fixation of thoracic and lumbar vertebral fractures (110 cases)

(Torasik ve lumbar vertebra fraktürlerinin fixasyonu için Cotrel-Dubousset enstrümantasyonu)

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Nice Üniversite Hastanesi, Ortopedi ve Travmatoloji Departmanında Ekim 1978 ile 1991 sonu arasında 700 torakolomber kırık tedavi edilmiştir. Hastaların üçte ikisi konservatif olarak tedavi edilmiştir. Bu ya fonksiyonel yöntemle ya da Boehler yöntemiyle yapılmıştır. Kalan üçte bir hasta, 232 vaka, cerrahi tedavi görmüştür. İlk 122 vakada üst seviyelerde Harrington rodları, aşağı seviyelerde Roy-Camille plakları kullanılmıştır. 110 tanesi ise CD enstrümentasyonu ile tedavi edilmişlerdir. Cerrahi stratejimiz hastanın ilk müracaatındaki nörolojik durumuna göre belirlenmektedir. Nörolojik defisitli tüm hastalara cerrahi tedavi uygulamaktayız. Acil veya gecikmeli cerrahinin nörolojik iyileşme açısından benzerlik göstermesi nedeniyle %90 vakada gecikmeli cerrahi uygulamaktayız. Cerrahi girişim posterior yaklaşımla yapılmaktadır. Nörolojik komplikasyonlu vakalarda geniş bir laminektomi uygulamaktayız. Anterior girişim 8 ila 15 gün sonra yapılmaktadır. Nörolojik defisitli vakalarda endikasyonlar kırığın tipine bağlıdır (Dennis sınıflaması). Kompresyon kırıklarında cerrahi nadiren endikedir (genç hasta, multipl torakal seviyede, kifoz 15 derecenin üzerinde ise). Burst kırıklarında, saece spinal kanalda daralma %30'un üzerinde ise cerrahi uyguluyoruz. Fleksiyon-distraksiyon kırıkları konservatif olarak tedavi edilmektedir. Kırıklı çıkıklarda, nörolojik duruma bakılmaksızın cerrahi gerekmektedir. Genel fonksiyonel sonuç olarak, 110 vakamızın 85'inde mükemmel bir sonuç söz konusudur. Bir yıldan sonra implantın çıkarılması sadece lomber seviyede spinal mobilite açısından belirgin bir iyileşme sağlamaktadır.

Anahtar kelimeler: *İnternal fiksasyon, Kırıklar, Vertebralar, CD-İnstrumantasyonu*

Cotrel-Dubousset İnstrumentation for the fixation of thoracic and lumbar vertebral fractures (110 cases)

Seven hundred fractures of the thoracolubar spine were treated in the Department of Orthopedics and Traumatology of the Universitary Hospital, Nice, France, between October 1978 and the end of 1991. Posterior fixation was performed in one third of patients and was achieved using Cotrel-Dubousset instrumentation in the 110 most recent cases. surgical technique is discussed; analysis of results showed that the outcome was very favorable in 85% of cases.

Key words: *Internal fixation, fractures, spine, Cotrel-Dubousset instrumentation.*

The management of vertebar injuries has been radically modified by the introduction some thirty years ago of internal fixation devices initially intended for the treatment of scoliosis. Thus, use of Harrington rods and subsequently Luque rods provided the means for achieving immediate and Roy-Camille (20, 21) subsequently developed an original method for treating fractures by specialized departments for approximately 15 years. Our experience is based on the study of 700 fractures treated in our department over the last ten years. Table 1 summarizes the causes of these fractures.

Traffic accidents *	40.50%
Falls (accidental falls at home, attempted suicide..)	35%
Sports accidents **	24.50%

* Motorcycle injuries=70% ** Hang gliding >wing hang gliding > climbing >horse-riding >ULM >bicycling

Table 1: Aetiology

Therapeutic indications

In approximately two thirds of our patients, a conservative method was used, i.e.

- either the functional method, including bed rest on a hard surface for 21 days then ambulation with a stayed twill corset for two months and (static) rehabilitation based on teaching lumbar spine locking techniques.

- Or the Boehler method (7, 19), of which all three components must be used:

-Reduction in traction nd lordosis without general anesthesia on a Cotrel frame, controlled clinicall and radiographically;

-Immobilization by a tightly fiiting plaster corset resting on the sternum and pubic bone, with a large anterior window, combined with cedvical support by means of a collar if teh fracture involves a higg vertebral level; after 45 days the plaster cast is replaced by a plastic corset; total duration of immobilization

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sholud always be at least four months.

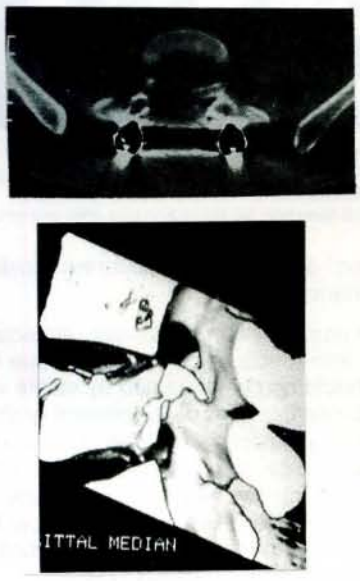
-Static physiotherapy during wear of the braces with early ambulation. Physical therapy should becontinued throughout the period of immobilization. We use thes method only after resumption of intestinal function, and careful clinical monitoring is needed during the first few days because of the possible development of gastric dilatation which requires prompt removal of the cast.

The remaining third of our patient, i.e., 232 subjects, underwent surgical treatment. In the first 122 cases, immobilization was achieved using Harrington rods at the dorsal level and Roy Camille screw-plates at lower levels (3,4, 8). The 110 following patients were treated by Cotrel-Dubousset instrumentation (5,10); the first patient in this group was treated in April 1986. Our surgical stategy haschanged considerably since we started using this new instrumentation; it is based on the patient's neurological status at admisson.

In patients with neurological compromise

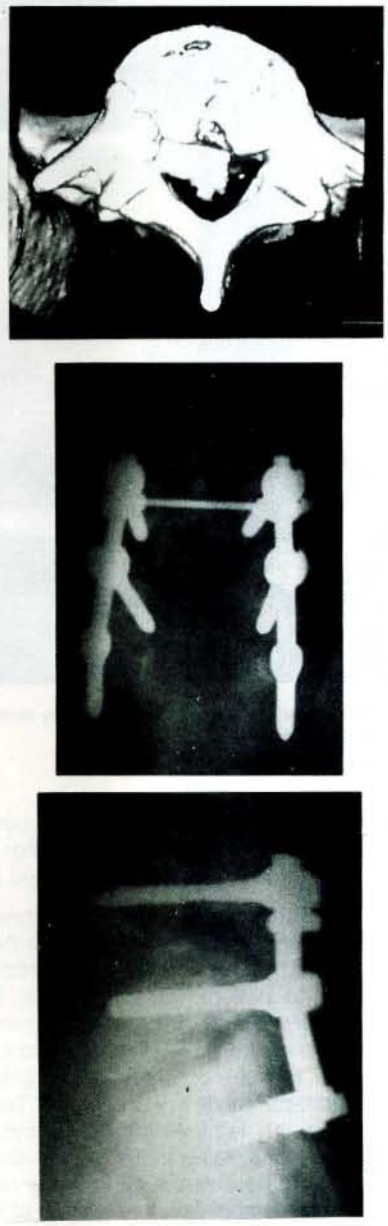
We perform surgery in all patients with neurological deficit since we agree with most authors that only early reduction and stabilization of bone damage provides optimal conditions for neurological recovery. In 90% of these cases, we perform surgery on a delayed time.

- In patients with complete paraplegia (Frankel A) documented by evidence of severe spinal cord injury, there is no hope of recovery unless clinical cssessment of initial spinal cord damage was in error. The rist of death is high especially in patients with thoracic spinal fractures or multiple injuries. Consequently, we belive that intensive care ir necessary for 24 or 48 hours.

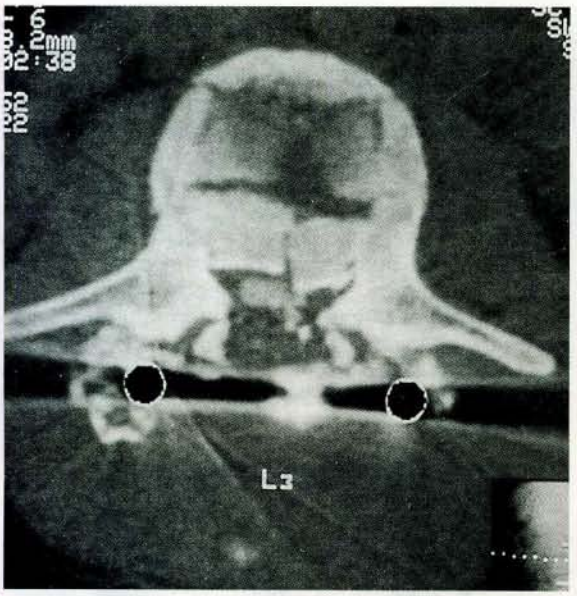


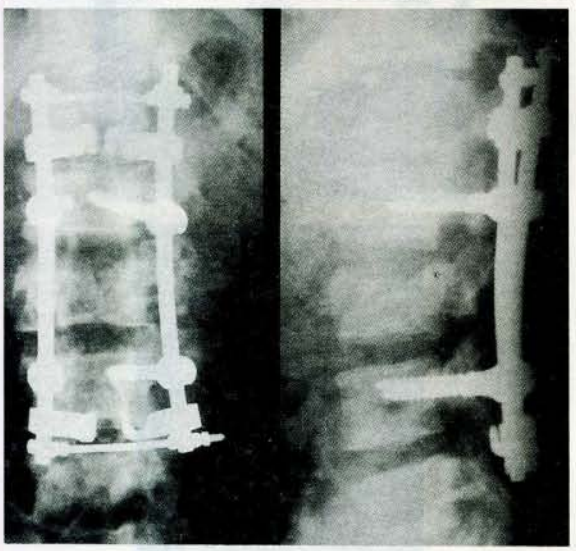
Figur 1: a) Hand gliding injury. 25 year old patient. Cauda equina syndrome. Large fragment in the canal visible on the 3D reconstruction. b) removal of the fragment by unilateral laminectompy and internal fixation. c) Postoperative CT scan showing an air bubble where the fragment was located. Full clinical recovery.

- In patients with incomplete impairment, "postural" reduction is performed at admission; however, when we operated these patients on on emergency basis, we observed cases of lifethreatening bleeding from the perispinal venous plexuses and vertebral cancellous bone. This bleeding made it impossible to consistently remove spinal canal compromise as completely as we would have wished to. In our experience, technical conditions are optimal only during elective spinal surgery performed in a fully staffed operating room by a well-experienced team. In patients with Burst fractures, we perform surgery 24 to 49 hours after admission; reduction of Dislocations involves less bleeding and are conducted at reduction and open fixation of these lesions at admission of the patient.

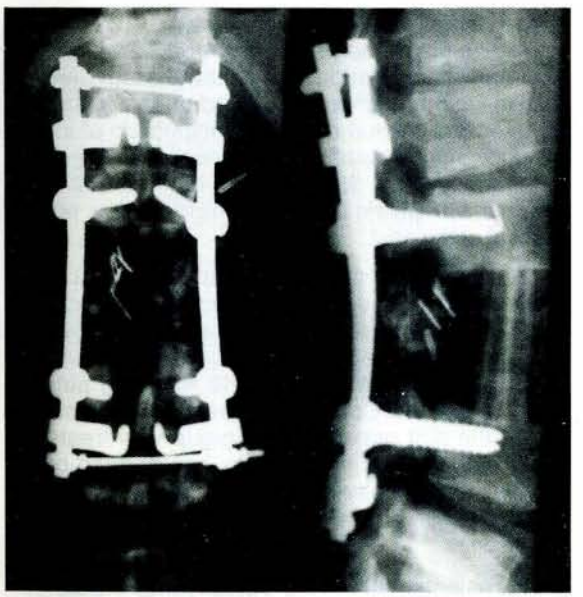


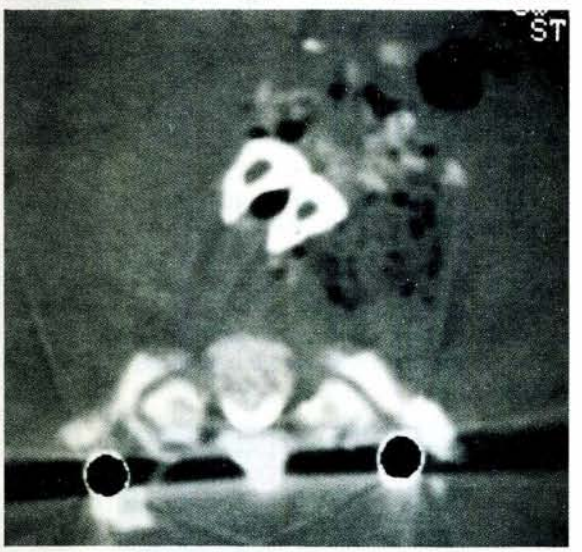
Figur 2 a: 25 year old male. Motor vehicle injury. Nerve root deficits





Figur 2 b: Initial posterior stage to clear the canal by laminectomy. Decompression was inadequate (postoperative CT scan)





Figur 2 c: Second stage, through the anterior approach removal of fragments impinging on the canal. Fibular graft. Decompression was complete (myeloscan). Full recovery. No correction loss after one year

Analysis of our 122 first patients (4) showed that neurological recovery was similar whether surgery was performed on an emergency or delayed time.

We achieve the surgicalprocedure through the posterior approach: in these patients with neurological complications, we perform a wide laminectomy, which allows us to explore tthe spinal canal, to suture or patch any dural steath wounds, to remove bone fragments detached from the laminae, and to displace anteriorly or remove con;oneay fnaglehkb wpicp have displaced backwards into the canal. To achieve this, we extend the laminectomy by removing the transverse processes, facet joints, and pedicles; this allows the canal to be cleared without any risk to the spinal cord. At the lumbar level, retraction of the dural sheath is possible and facilitates posterior decompression. CT scans and sagittal ; preoperative "reconstruction" studiesenable accurate localization of bone fragments (Fig.1).

These posterior laminectomies, especially when extended, add to the spinal instability due to the injury and should be compensated by stable internal fixation ond insertion of a posterolateral graft made of cortical and cancellous autologous or mixed bone. this graft should be larger that in patients who do not undergo laminectomy, although in this latter situation also, grafting is necessary (3); more recently, transpedicular injections have been used, according to the technique descibed by Daniaux (11).

Postoperative CT scan studies (table 2), combined with nyelography in doubtful cases, allow assesment of the exent of spinal canal compromise; in the event of persistent stenosis due to a residual bone or

disk fragment, a subsequent anterior decompression procedure is necessary (Fig. 2).

We have very stringent requirements concerning relief of spinal canal compromise (we consirder that spinal canal stenosis greater than 30% is unacceptable) in order to ensure that the spinal canal can easily accomate the spinal cord. We use the same requirements in patients with complete neurological involvement (Frankle A), because an ongoing study has shown us that the most consistent factor associated with the development of post-traumatic syringomyelia (3 to 5% of cases) is persistent spinal cord compression.

The anterior procedure is performed 8 to 15 days later. For injuries involving T1 thouhg T10, right thoracotomy is used since vascular ligations are easiest with this approach. Thoracophrenolombotomy or the left subpleuro-retroperitoneal approach is used for TXI, TXII or L1.

The anterior step allows removal of bone fragments responsible for spinal cord compression and insertion of an intercorporeal graft. A fibular graft is inserted between the endplates of the two intact vertebrae above and below the plane of injury; alternatively, a tricortical iliac graft is simply impacted in the fractured vertebral body This " neurological" indication for anterior surgery currently accounts for onl about 2% of our patients at the thoraco-lumbar junction. In patients without neurological compromise : indications depend on the type of fracture (Denis's classification) (12,13).

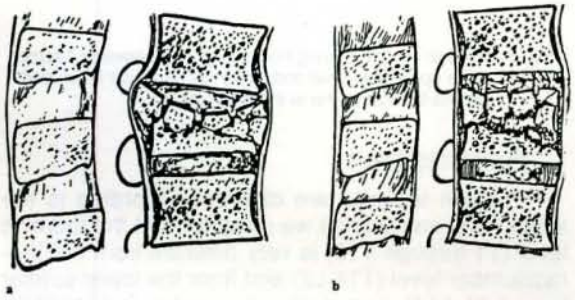


Fig. 3 a: Denis type B burst fracture with a postero-superior fragment measuring less than 30% of the spinal canal diameter.
b: the intact posterio-superior ligament allows decompression of the canal through a ligamentotaxis effect during conservative treatment in lordosis.

1.Compression fractures

When the decrease in vertebral body heigt doesnot exceed 33%, the functional method is used. boehler's method is indicated only when the loss in heigth is 50% or more; it should be kept in mind that this method is effective only for thoracolumbar injuries (7,19).

Surgery is very rarely indicated in compression fractures. Surgical treatment is needed only in younger patients with fractures of several thoracic vertebrae and vertebral kyphosis exceeding 15°; some authors (In 2) believe that these lesions carry a risk of progressive kyphosis; in our opinion, development of this complication suggested in fact that a burst fracture was misdiagnosed at admission because a CT scan study was not performed, orthat this compressi-on-fracture is cssociated to a posterior ligamentous complex disruption, cllearly shown on the M.R.I.

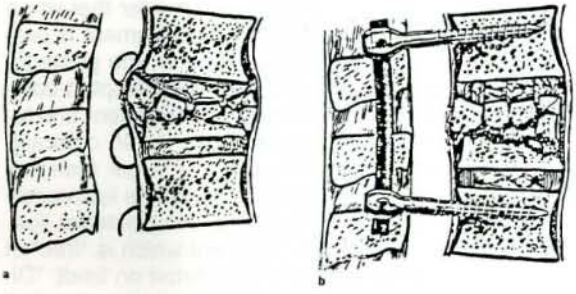


Fig. 4 a: Denis Type B burst fracture with a postero-superior fragment measuring 30 to 50% of the spinal canal diameter.
b:The postero-superior ligaments is partially torn and a spinal device is required to achieve reduction (and healing in the correct position)

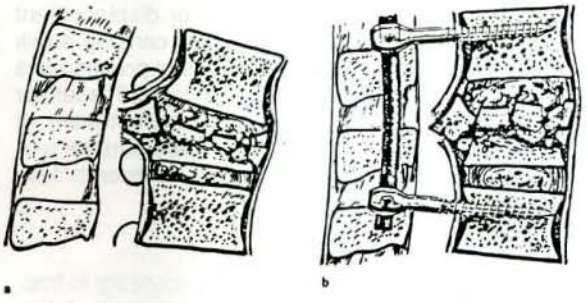


Fig. 5 a: Denis type B burst fracture with a postero-superior fragment measuring more than 50% of the spinal canal diameter and completely rotated on itself.
b: the posterior vertebral ligament is completely torn and distraction is ineffective in achieving reduction. A direct approach of the fragments is required.

2. Burs fractures

This is the type of injury for which the surgical strategy is most difficult to define, as shown by the conflicting recommendations found in the literature (1,16,20,23). In our opinion, the presence of a fractu-

re line involving the middle column does not necessarily require a surgical stabilization (12). When posterior displacement of the postero-superior fragment is less than 30% of the diameter of the spinal canal, we believe, together with Willen (23), that the posterior vertebral ligament is intact and can act as a bowstring to reduce the fragment by a "ligamentotoxis effect". In this situation, conservative treatment can be expected to achieve healing (Fig. 3).

We perform surgery only when spinal canal narrowing due to posterior displacement of the posterosuperior fragment exceeds 30%; in most of these patients, vertebral kyphosis exceeds 15° at the thoracolumbar level. Decompression relies exclucively on distraction on the CD screws we concider that when the diameter of the posterosuperior fragment is less than 50% of the spinal canal diameter, the posterior vertebral ligament is streched but not disrupted contrast, when the diameter of the bone fragment and leads to a good fracture healing (fig. 4). In contrast, when the diameter of the fragment is larger than half the diameter of the spinal canal, comlplete ligamentous disruption islikely; in this case, the posterior ligament has no action on the fragment which is "free" in the spinal canal and sometimes rotated on itself. "Direct" decompression by laminectomy is then needed as described above for "neurological" patients.

3. Flexion-distraction injuries

Flexion-distraction injuries are treated conservatively by a plaster cast or brace when the fracture line involves only bone, as in the classical Chance fracture; surgical treatment is performed in patients with damage to the disks and ligaments or with multiple injuries; in this case, stable internal fixation allows efficient nursing care and exxedites rehabilitation.

For some time, we have been aware that these flexion-distraction fractures can be associated with significant disk damage and posterior displacement of a disk fragment in the spinal canal, carrying a risk of postsurgical neurological loss; careful preoperative and postoperative investigation using CT scan or myelography is necessary and demaonstration of disk damage should lead to a secondary anterior procedure for removal of the disk and intercorporeal fusion (2 cases in our series).

4. Fracture dislocations

Surgical treatment is obbiously necessary in fracture-dislocations, irrespective of neurological status. It is vorth pointing out that we recently observed two cases of lumbar fracture-dislocation with no mawor-neurological loss; becuse displacement was substantial, we first performed gradual reduction by continuous traction using transfemoral pins in order to improve spinal canal alignment before the surgical procedure which we carried out 48 hours later.

Apart from obvious cases of joint dislocation, the diagnosis of "fracture-dislocation" is not always easy. A case in point is that of predominanty ligamentous injuries with spontaneous reduction after the accident. Disruption of the anterior column can be suspected on the lateral roentgenogram only by identification of a small triangular anterior fragment, as in inverted cervical tear drop fractures. The posterior disk and ligament lesions, which are clearly visible during surgry through the posterior approach, escape detection on conventional roenthgenograms and even CT scan studies MRI is more sensitive for visualizing disk and ligament disruption and the decision and to perform posterior surgery consequently relies on thisinvestigation. Disk and ligament injuries, which are responsible for " potential instability", are well known since the SOFCOT report (16) in case of dislocation of the "shear type", they require surgical "segmentae" fixation to avoid the development of progressive kyphosis. This "short segment" fixation is performed using pedicle screws inserted in the onll vertebrae adjacent to the plane of injury; in this case, compression is performed.

Fig. 6: Thoracic construct using hooks pediculotransverse "clamp" at the uppermost level and "relay" by pedicular hook, and lamino-laminar clamp at the lower end.

Fixation technics

Fixation technics are different according to the spinal level involved as we consider that the thoracic level (T1 through T10) is very different from the thoracolumbar level (T11-L2) and from the lower lumbar level (L3,L4,L5), from both a biomechanical standpoint [14] and a pathological standpoint.

Exect for T1, thoracic vertebrae have small pedicler (pedile width is equal to or greater than 5 mm only from T10 downwards), making the use of pedicular screws hazardous or ineffective (2). At this level, we prefer to use hooks which can be inserted in the pedicles, laminae or transverse processes. By inserting two hooks in the same vertebra, one in the pedicle and the other in the the transverse process, it is possible to create a pediculo-tranverse clamp capable of effectively withstanding tensile stresses hich are significant at this level and were one of the main causes of failure of fixations performed using Harrington instrumentation. If the size or strength of the transverse process sem inadequate, there should be no reluctance in using thoracic laminar hooks (5,9)

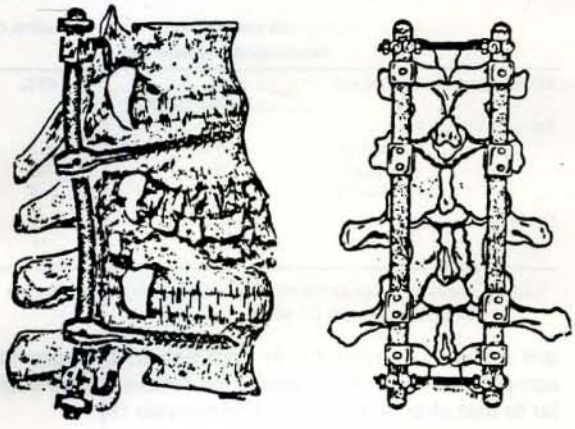


Fig. 7: "Intermediate" construct for injuries of the thoracolumbar junction. Two vertebrae above the lesion and one below are incorporated using a "clamp" with a pedicular screw and an "offset" hook above or below the lamina.

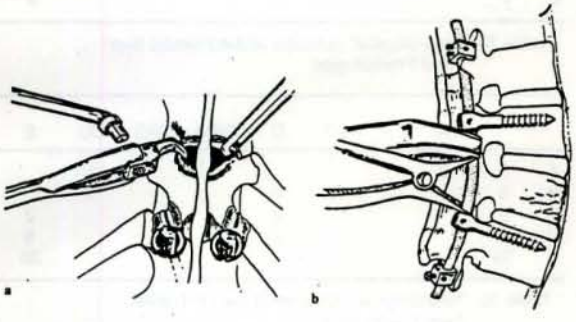


Fig 8 a: Extension using a nibbler to achieve maximum "lateralization" of the hook.
b: reduction by moderate distraction

inserted in the vertebra immediately above the vertebra is fixed by a pedicular hook.

At this hevel, loss of mobility due to internal fixation has no adverse functional consiquences, and long segment fixation can therefore be used (Fig. 6).

We incorporate two or three vertebrae above and two below the injury by inserting hooks in the pedicle and transverse process or lamina at each end of the segment and intermediary hooks in the pedicles above the injury and in the laminae below the injury. In over 50% of thoracic spinal fractures, there is damage to several vertebrae, especially to the neural arches, and long segment fixation is therefore warranted (5,9). Distraction allows a subsequent help to reduce the displacements.

At the thoracolumbar jinction (T11, L2)

We used a variety of fixation devices in our first 49 patient, who were managed at the begining of the study perior. We first used long segment fixations similar to those which had give us satisfactory results at tne thoracic level. Subsequently, we attepted to use shorter fixations but with this technipue e observed 4 cases of dislocation of the construct with substantial losses in reduction. We then turned to pedicular screws with long segment fixation but, as reported by other authors (17,18), the screws ocasionally broke at each end of the fixation (especially when screw diameter was 5 mm). Pedicular screw brakage, which occurs mainly in the vertebra at the upper end of the segment, is due to the sudden difference in rigidity between the non- instrumented spine segment above the fixation and the very rigid fixation achieved using these pedicular systems. This experience led us to us what we call "intermediate" fixation involving insertion of a screw and hook above and below the injury (Fig. 7). The screw is intended to withstand compression stresses, whereas the hook withstands tensile stresses, the transverse devive (D.T.T.) avoiding any rotationel displacement. At the upper end of the fixation the screw is inserted in the vertebra immediately above the injured vertebra and the laminar hook ("thoracic" or "offset" hook) is inserted in the second vertebra above the fracture.

The technique of insertion of the hooks involves partial section of the spinous process of the vertebra lying above the plane of insertion, followed by section of the ligamentum flavum, first along the midline, then transversally after insertion of a protective spatula along its deep surface; the opening thus created is widened on either side using a "Kirmission bone ronger" to remove the medial portion of the superior articular process().

The fixation thus obtained exhibits gradually decreasing rigidityon the two vertebrae above the fracture. At the lower end of the fixation a single vertebra is incorporated by insertion of a screw and sublaminar hook, which is of "offset" type nine times out of ten; the vertebra involved is the first or second lumabr vertebra, since the height of the neural arch at both these levels is sufficient to allow dual implantation.

The hook is inserted by means of the usual technique after detachment of the ligamentum flavum using a rugine and partial resection of the lateral and

Fig. 9: Lumbar construct. A pedicular screw is inserted on either side of the injury. Pretransverse hook at the upper end, sublaminar hook at the lower end on the same vertebra can be added

lower portions ot the lamina using a Kirmission ronger. Because of this lateralization, the two hooks naturally align with the pedicular screws and exhibit no tendency towards overriding.

The screws that we currently use are open tulip screws which allow very easy introduction of the rod. The rod should be bent to ensure restoration of the physiological lordosis which ranges from 0° to 10° at this level.

In burst fractures, distraction is applied between the two hooks However, care should be taken not to use excessive distraction, which may cause spinal kyphosis or bend the pedicular screws through an "anterior hinge" effect due to the fact that the anterior vertebral ligament is nearly always intact.

At the lumbar spinel level, from the outset we used short segment fixatino since it is obviously desirable to preserve the hargest number of mobile disks at this level. We use pedicular screws directed anteriorly, medially, and downwards for L4 and L5.

For some time we have been reinforcing this 1ixation by a pretransverse hook inserted above the transverse process at the upper end of the fixation and by a sublaminar hook inserted according to the technique described above for the thoracolumbar wunction at the lower end of the fixation (Fig. 9). Use of the lower hook at L5, however, in not routine since the lamina tends to be horizontal.

As a result of its special design, the pretransverse pocess; it is intended to withstand flexion stresses during forced movements by acting like the straps of a harness; thus, this hook does not participate in a pediculo-transverse clamp placed under tension as is the case at the thoracic spine (after exposure of the transverse process, a pretransverse rugine is used on its superior and anterior aspect and the hook is inserted anterior to the transverse process using a pusher).

At this level, restoration of the physiological lspina curvature is even more importantn than at higher levels and requires appropriate bending of the rods in lordosis. Restoratiaon of physiological lordosis ensures that the gravity line coincides with the posterior wall of the vertebral body.

The technical difficulty of introducing bent rods in the screws can be ovecome by the use of first moderately bent rods whose curvature is increased "in situ" after they have been fixed to the secres by the use of bending irons.

Results are analyzed in our 100 first patients who were followed up for more thansix months. We will successively consider neurological results, results in terms of stability (documented radiologically), and overall function.

Neurological results

They are summarized in Table 3.
These results confirm the classical view that thoracic fractures carry a high risk of neurological compromise (Table 3a) and that "complete" lesions at this level are severe (Frankel A); in contrast, in the rare incomplete lesions the potential for recovery was similar to that seen at the other spinal levels (9).

	18 patients with neurological impairement	23 without
Mean spinal canal stenosis	52% (postoperative: 27.8%)	41%
Spinal canal contour		
Horseshoe	16	7
Half circle	0	12
Miscellaneous	2	4
Facet joint damage Yes	16	12
No	2	11

Table 2: Burst fractures of the thoraco-lumbar spine. Preoperative and postoperative CT scan

		A	B	C	D	SRM	SRS	DC	E
A	5	4						1	
B	3			1	2				
C									
D									
E	9								9

Table 3a: "Neurological" outcome at the thoracic level. Final Frankel type

		A	B	C	D	SRM	SRS	DC	E
A	7	6						1	
B	5			2	2			1	
C	5			1	2				2
D	8				2				6
E	38								38

Table 3b: "Neurological" outcome at the TH-L level. Final Frankel type

		A	B	C	D	SRM	SRS	DC	E
A									
B	1				1				
C	2								2
D	2								2
SRM	2						1		1
SRS									
E	13								13

Table 3c: "Neurological" outcome at the lumbar spine Final Frankel type

We perpormed detailed analysis of the patients with burst fractures (53 out of the 63 thoracolumbar injuries (Table 3b) treated by CD instrumentation). In these patients we studied the correlation between

- the percentage of spinal canal stenosis
- the contour of the damaged canal
- the presence of damage to the neural arch
- and the presence of neurological complications (Table 2).

Results showed greater statistical significance for parameters 2 and 3 than for the percentage of spinal canal stenosis (52% in patients with neurological loss, 41% in patients with no neurolgical compromise; these findings are consistent with those of other

studies (22). It should be pointed out that "decompression" was achieved in 17 out of 18 patients through the posterior approach alone (Table 2).

Sixteen of the 20 patients who had surgery for lumbar fractures (Table 3c) had a Denis Type II lesion (burst fracture); the relationship between spinal canal stenosis was 61% in patients with neurological loss and 36% in patients without neurological loss; however, the number of patients with neurological compromise was small (18). At this spinal level, recovery was more common and more substantial and improvements sometimes continued over ttttwo years. In conlusinon, surgical treatment, which was carried out through the posterior approach alone in 90% of cases, ensured reduction, decompression, and stabilization of disk, ligament and bone lesions; concomitantly, improvement or stabilization of neurological compromise was consistently achieved.

Results on spine stability

These results should be analyzed separately at each spinal level (Table 4).

Regional kyphosis	Postoperative	at Follow up	Loss
Thoracic injuries: 17 cases	10°	12,2	2,5
Thoracolumbar injuries			
1st construct: 49	-2°	7,5	9,5
Intermediate construct: 14	-3°	2,7	5,7
Lumbar injuries: 20	-13°	-5	8

Table 4: Stability outcome

At the thoracic level, correction loss was minimal (2°5); this is tue to the strength of the long, multivertebrae fixations used and to insertion of a posterior graft that readily fused along the transverse processes and laminae; we recorded only one case of dislocation of the instrumentation after excessively long fixation with no "relay" in a patient with multiple thoracic and thorcolumbar vertebral fractuer.

At the thoracolumbar level, no cases of screw breakage were recorded after adoption of the new fixation technique; furthermore, correction loss was only 5°7, which is quite acceptable, and immediate postoperative restoration of the physiological angulation was achieved in nearly every case (note that a complementary anterior procedure was performed in only 2 (or 3) patient in this group); the largest correction losses were seen after extended laminectomy and, above all, inadequate posterolateral grafting with poor visibility of the of the graft on delayed films. Two of the four patients with a poor outcome after the first type of fixation had a repeat surgical procedure tthrough a thoracophrenolombotomy which allowed application of a distractor to achieve intercorporeal reduction, followed by insertion of an iliac graft and of an AO type plate screwed into the vertebral bodies (2). The largest correction loses were seen at the lumbar mean loss was 8° and in the two worst cases, loss was 20° and 30° respectively. These larger correction losses were due to a number of factors significant comminution was common, reduction mainly involved the disk, and high-quality posterolateral grafts are difficult to achieve at this level. To patients had a secondary anterior procedure to correct the angulation and allow stable fusion. We therefore currently recommend a secondary anterior procedure aimed at improving "stability" results in low lumbar burst fractures; neural arch damage, rduction in the "disk" more than in the body, on the film in lordosis, denoting an anterior empty space which causes stress on the instrumentation and carries a risk of dislocation of the fixation(*).

Complications

Apart from the 8 partial instrumentation dislocations mentioned with the earliest fixation techniques used and four cases of screw breakage after long segment fixation with 5mm screws, we recorded one CSF fistula developed on a traumatic sutured dural sheath wound which closed spontaneously, one case of S1 paresis with recovery within three months, and, above all, 8 cases of sepsis following lon and difficult procedures at the beginning of our study period before open tulip screws were available; in two cases, removal of the fixation was required, after 15 days and 7 months respectively; both these patients required a secondary anterior procedure for reduction and stabilization to correct post-traumatic kyphosis(2).

Overall functional outcome

85 of the 110 patients had an excellent outcome and were able to resume work and even sports (6). The absence of postoperative immobilization by a brace is especially beneficial in patients sustained "thoracic" fractures who nearly always have lesions of the chest wall, as well as in patients sustaining spinal cord damage in whom nursing is substantially facilitated. External support are used only in patients who have multiple vertebral fractures or exhibit poor compliance. Postoperative resolution ofquick obtained is rapid and allows active physical therapy in a pool or early rehabilitation room in order to minimize muscle wasting. Among the 25 other patients, 6 had a repeat surgical procedure for ealy removal of the instrumentation (4 cases of infection including severse sepsis in two cases) or a complementary anterior procedure (2 patients with neurological loss); most of these patients were treated at the beginning of our study period, at a time when we had not yet developed the specific fixations we now use or our current technique of careful dainage of the operative site.

In conclusion, in our opinion use of CD instrumentation to treat thoracic and lumbar vertebral fractures promtly very satisfactory results after a single surgical procedure. Although this procedure is longer and more demanding than the insertion of screw-plates, in most instances it allows to achieve fixation of sufficient stregth fixation to obviate the need for a second anterior step which carries additional risks.

The cost of CD instrumentation is high but should be weighed against the shorter legth of the hospital stay, the absence of postoperative bracing, and the decreace en residual disability (15).

Resumption of work varies with the occupation

and ranges from 4 months to one year; maney of our patients had been injured during a recreational such as hang gliding or skiing and were able to resume the same activity once their fractures had healed.

Removal of the instrumentation one year after insertion provides a significant improvement in spinal mobility only at the lumbar level; at the other spinal levels, the instrumentation causes litthle reduction of segmental mobility.

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