THE ROD-SLEEVE METHOD FOR THE TREATMENT OF THE BURST FRACTURES IN THE THORACOLUMBAR SPINE

Ü. Domaniç*, İ. Esenkaya **, A. Hamzaoğlu *, M. A. Kaygusuz **

At the Istanbul University, Istanbul Faculty of Medicine, Orthopaedics and Traumatology Department, the Rod-Sleeve method was applied to 36 burst fractures in the thoracolumbar spine of 32 cases between October 1987 and January 1990. Our cases, (21 male, 11 female) the yloungest 13, the oldest 63, the average 29.7 years old; were followed up for at least I month and most for 26 months, with an average of 15 months. Kyphosis angle, local fracture angle, compression degree on the corpus vertebra, corpus vertebra and disc space height, posterior and lateral translation amount in plain graphics; spinal canal opening degrees and CT examinations of the cases are compared preoperative, postoperative and at the last follow-up. Because of the recovery level of neurologic and other findings, we came to the conclusion, that the Rod-sleeve method is effective in the treatment of burst fractures.

The treatment of the burst fractures let to big discussion for many years until that FRANCIS DENIS put forward the "three column spine concept". This theory of DENIS helped to the better understanding of the treatment of these fractures (4).

Today, it is known that the burst fractures need surgical treatment, because they are mechanically and neurologically instabil (4,5,7,13,16,21,24,27,32). It could be no neurologic symptom, but, because of two instability, the progressing of a neurologic symptom is a high probability (4). Therefore for the decompression of the pressure of narrowing of the neural canal, for the maximum raise of the reduced vertebra anterior height and for the prcvcntalion of the correction is need of stabilization. For this purpose many methods arc used: anterior decompression and fusion (2,3,7,30); anterior decompression; fusion and fixation with an internal fixing device (1,9,24,27); anterior decompression + fusion + posterior reduction and posterior stabilization (3); posterior reduction and posterior stabilization (3,6,7,8,16,19,23,25,26,28,29,33,34,35); postcrolatcral decompression and stabilization (17, 20,32); posterior indirect decompression stabilization and postcrolatcral fusion (Rod-Sleeve method) (10-16,21) are the main methods.

The Rod-Sleeve method aims decompression to the spines by using different pressures from posterior three points (without opening the mcdullar canal from the anterior or the posterior), reduction and stabilization of the fracture. This method is defined in 1979 by EDWARDS (10,13) (Figure 1).

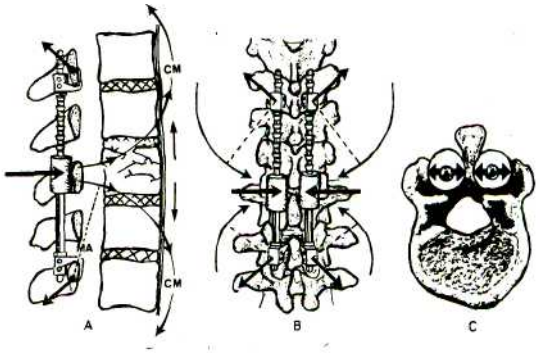

Figure 1. Rod-Sleeve biomechanics: (A) Sagittal plane. Sleeves generate corrective moments "CM" working through moments arms "MA" about the hooks to effect simultaneous hiperextension and distraction; (B) Coronal plane. Medially directed forces from the sleeves on the slightly bowed rods combine with the laterally directed forces from the hooks to correct medial-lateral translation and scoliosis and to enhance rotational stability; (C) Sleeves wedge between the facets and spinous processes.

In this report, we will present the results, which we obtained from the treatment with the Rod-Sleeve method in burst fractures.

MATERIALS AND METHOD

Material: At the Istanbul University, Istanbul facully of Medicine, Orthopaedics and Traumatology Department, 36 burst fractures in the thoracolumbar

* Istanbul University, Istanbul Faculty of Medicine, Orthopaedics and Traumatology Department, Associate Professor

** Istanbul University, Istanbul Faculty of Medicine, Orthopaedies and Traumatology Department, Senior Residentem-Alexandcr Zickcnhuis 's-Hcrtogcnbosch, the Netherlands.

spine of 32 cases, between October 1987 and January 1990 were our material.

Method: In our cases, the Rod-Sleeve method was applied for the reduction and stabilization of the fracture, and decompression of the medullar canal. This method is applied to the cases with fractures, which are between T5-L4 and not older than four weeks.

FINDINGS AND RESULTS

Findings: There were 21 male and 11 female patients who ranged in age from 13 to 63 years, with a mean age of 29.7 years old. Our cases were followcd-up for at least 1 month and most for 26 months, with an average of 15 months.

Due to the topographic distribution of the fractures, we have seen that 31 fractures (86%) of 36 were between T11-L2. The distribution was as follows:

T_{11}	2 cases
T_{12}	3 cases
T_{12}-L_1	1 case
L_1	16 cases
L_1-L_2	1 case
L_2	5 cases
L_2-L_3	1 case
L_3	2 cases
L_3-L_4	1 case

As seen at above, in four cases, we had burst fractures in two levels. Besides, six compression fractures were seen in six cases.

The distribution of these 36 burst fractures according to their sub types is as follows:

Type A :	9 cases (25 %)
Type B :	22 cases (61 %)
Type C :	1 case (2.8 %)
Type D :	2 cases (5.6 %)
Type E :	2 cases 5.6 %)

The neurological evaluations of our cases at the first application to our clinic according to the Frankcl classification was as follows: A(3 cases); B(1 case); C(8 cases); D(5 cases); E(15 cases).

Operation was done on 19 cases (59.4 %) in the first week after trauma, in 5 cases (15.6 %) in the second week, in 8 cases (25 %) between the 2nd 4th weeks (average 9.7 days).

Fusion is applied to the segments between hooks in at least 4, at most 7, average 4.7 vertebrae.

Cases were evaluated comparatively preoperative, postoperative and at the last follow-up date with local kyphosis angle, local fracture angle, scoliosis angle, the translation rate to the posterior and lateral, the height loss in the corpus vertebra, and the disc distance in plain graphics and narrowing or widening of the spinal canals in CT scans.

According to this:

-Local kyphosis angle measurements are as follows (Table 1):

	Minimum (°)	Maximum (°)	Average (°)
Preoperative	4	44	19.3
Postoperative	0	24	5.3
Last follow-up	1	34	14.4

-Local fracture angle measurements are as follows (Table 2):

	Minimum (°)	Maximum (°)	Average (°)
Preoperative	4	35	19.9
Postoperative	0	22	6.4
Last follow-up	0	28	10.0

-Corpus vertebra and disc distance measurements in our cases expressed as percentages are as follows (Table 3):

	Minimum (°)	Maximum (°)	Average (°)
Preoperative	30	92	59.8
Postoperative	71	100	92.1
Last follow-up	33	100	80.8

As seen in Table 3, in the last follow-up date, there has been a decrease of 11% in the acquired height.

-In our cases, the decreasing quantities (percentage of compression) in the anterior side of the corpus vertebra, that has injured, are as follows (Table 4):

	Minimum (°)	Maximum (°)	Average (°)
Preoperative	5	70	40.8
Postoperative	0	32	9.1
Last follow-up	0	67	18.6

-In our cases, percentage of posterior displacement are as follows (Table 5):

	Minimum (°)	Maximum (°)	Average (°)
Preoperative	3	21	9.9
Postoperative	0	10	1.8
Last follow-up	0	12	3.5

-In our cases, the mcdullar canal anteropostcrior opening percentage recognized in prc and postoperative in CT scans are as follows (Table 6):

	Minimum (°)	Maximum (°)	Average (°)
Preoperative	5	70	48.6
Postoperative	31	86	69.6

-The neurologic evaluations (pre and postoperative) of our cases according to the Frankcl classification are as follows (Table 7):

		Postoperative					
		A	B	C	D	E	Total
Preoperative	A		1		1	1	3
	B				1		1
	C				2	6	8
	D					5	5
	E					15	15
	Total	-	1	-	4	27	32

-As seen in Table 7; 1 of the 3 patients in Frankel A grade improved to B, 1 of them to D, and the other to E. 2 cases of the 8 patients in Frankel C grade improved to D, and the other 6 patients to E, posloperatively.

The complications we have seen in our cases are as follows (Table 8):

Table 8:

Superficial infection	:2
Deep infection	:4
Urinary tract infection	:4
Decubitus	:2
Lower hook dislodgement	:5
Upper hook dislodgement	:2
Fracture of lamina and lower hook displacement	:4

In all the cases that have been specified by hook dislodgement, "C" shaped standard hooks were used. No dislodgcmcnts occured when anatomic hooks with "L" shappd were used. In the cases with hook dislodgement and displacement, the degree of loss of correction was excessive (There were average 14.4 degrees in the local kyphosis angle and 19.6 per cent in corpus vertebra +disc space height as loss of correction).

DISCUSSION

Today it is understood that what DENIS (4) put forward with the three column spine theory and what is made up of posterior longitudinal ligament, posterior anulus fibrosus, and the posterior half of the vertebra corpus, the third column which was also the middle one, had a very important role in the stability of the spine. The importance of the key elements of stability were defined by HOLDSWORTH (22), posterior ligament complex is made up of intraspinous and supraspinous ligaments, capsule, and ligamentum flavum, almost switched to the middle column. It was known that the space which fitted the middle column was fractured in burst fractures (31,32). But when DENIS expressed the importance of the middle column in the vertebral stability, the confusion in the treatment of burst fractures decreased. Today we certainly know that in a burst fracture even if there isn't any neurologic deficit, kyphosis can occur in the late period, related to mechanical instability becomes a problem. For this reason, in a burst fracture with no neurologic deficit, it is not reasonable to avoid surgical treatment just because of absence of neurologic deficit (4,5,7,16,32).If there is neurologic deficit, there's no doubt about decomprcssivc treatment (1,3,9,16,24,27,30). Viewed from this point, we sec that some authors use expressions like " the treatment of unstabil burst fractures" (32,35) and we have difficulty in understanding that. Because a burst fracture is cither neurologic or mechanical unstabil in which cases there is already neurologic deficit or when the anterior and middle column is only fractured, it is mechanically unslabil. From the point of forming a neurologic deficit or at least severe kyphosis, it carries a potential risk (4). But it may be possible to accept a burst fracture which occured with pure axial loading mechanism, if there is less than 50% loss of one anterior vertebral height, canal area more than 60 %, and it comes no neurological deficit and avoid surgical intervention (33,35,36).

Even though the method depends on the experience of the operation the method should provide the necessary obligations to get the results. The most important aims must be: the decompression of the mcdullar

canal, the restoration of the narrowed disc space and the anterior height of the vertebra which faced a compression more than 50%, and stabilization and maintenance of the correction. The decompression of the medullar canal can be formed in many ways. As this can be done by the anterior intervention (1,2,3,7,9,24,27,30), it can also be provided by posterolatcral(17,20,32) or indirectly by the posterior intervention (10,11,12,13,14,15,16,21). Certainly with anterior intervention a very effective decompression can be made. But following this, it is clear that to make a graft for stabilization will not be enough and an implant is needed. For this reason, authors like BLACK and associates (1), DUNN (9), KANEDA and associates (24), and KOSTUIK (27) developed stabilization materials, which are named after themselves, and applied them. As GARFIN and associates (20), MCAFEE and associates (32), and FLESH and associates (17) defend posterior stabilization method following postcrolatcral decompression can be more benign application than anterior decompression and stabilization. We think, it is possible to get an effective decompression with this application in the cases, where anterior decompression can not be applied.

EDWARDS and associates (10,11,12,13,14,15) suggested the indirect decompression of the mcdullar canal, the reduction and stabilization of the fracture, without opening the mcdullar canal and getting enough stabilization with a pair of Harrington rods. When we applied this method to 32 cases with burst fractures, we got satisfying results. In 36 burst fractures in the 32 cases, the prcopcrativc kyphosis angle average 19.3 degree (range, 4-44 degree) fell down to 5.3 degree (range, 0-24 degree). Prcopcrativc and postoperative, in the cases, where CT scans studies be made, average 21% (from 48.6% to 69.6 %) mcdullar canal decompression is found. In other words, in all of 17 cases with neurologic deficit, acording to the Frankcl classification there was a certain healing in neurologic functions, at least one grade.

We believe that plaster cast is necessary for preventing the correction, which is obtained in the postoperative period, at least 3 months. The external immobilization wilh corset is not sufficient. We have got this result from our experiences.

We mean, that it is better to combine this method with postcrolatcral decompression, if anterior decompression can't be done, because of too narrowing of the mcdullar canal or the cases, which arc included to Frankel A or B due to their neurologic functions.

We believe, that the decompression degree in the mcdullar canal with the Rod-Slccve method depends on the applying technique and not so much on the time, which is passing from trauma to the operation, EDWARDS (11), and EDWARDS and LEVINE (13) emphasized the time. If the time from trauma to the operation is more than 3 weeks, there is no doubt, that the chance for the healing of the fracture will be less.

REFERENCES

1 . Black, R.C., Gardner, V.O/., Armstrong, G.W.D., O'Ncil, J., and George, M.S.: A Contoured Anterior Spinal Fixation Plate. Clin. Orthop., 227: 135-142,1988.

2 . Bohlman, H.H., and Eismont.F.J.: Surgical Techniques of Anterior Decompression and Fusion for Spinal Cord Injuries. Clin. Orthop., 154:57-67,1981.

3 . Bradford, D.S., Akbamia, B.A., Winter, R.B., and Seljcskog, E.L.: Surgical Stabilization of fracture and Fracture Dislocations of the Thoracic Spine. Spine, 2:185-196,1977.

4 . Denis,F.: The Three Column Spine and Its Significance in the Classification of Acute Thoracolumbar Spinal Injuries. Spine, 8:817-831,1983.

5 . Denis, F., Armstrong, G.W.D., Searls,K., and Matta,L.: Acute Thoracolumbar Burst Fractures in the Absence of Neurologic Deficit: A Comparison Between Operative and Nonoperative Treatment. Clin.Orthop., 189:142-149,1984.

6 . Denis,F., Winter.R.B., and LonstcinJ.E.: CD Superiority in the treatment of fracture dislocations of the thoracic and lumbar spine. 1989,6th International Congress on Cotrel-Dubousset Instrumentation (Posters/abstracts), ll,Sauramps Medical, 1989.

7 . DcWald, R.L.: Burst Fractres of the Thoracic and Lumbar Spine. Clin.Orthop.,189:150-161,1984.

8 . Dick,W.: The "Fixatuer Interne" as a Versatile Implant for Spine Surgery. Spine, 12:882-900,1987.

9 . Dunn,H.K.: Anterior Spine Stabilization and Decompression for Thoracolumbar Inujuries. Orthop.Clin.North Am., 17:113-119,1986.

10 . Edwards, C.C.: The spinal rod-sleeve: Its rationale and use in thoracic and lumbar injuries. J.Bone Joint Surg., Orthop. Trans., 6:11-12,1982.

11 . Edwards, C.C.: Rod-sleeve construct. Spinal Reconstruction Using a Modular System: Surgical Manual, 30-32, Spinal Research Foundation, Baltimore, Sept.,1988.

12 . Edwards, C.C., Griffith, P., Levine.A.M., and Do-Silva, J.B.: Early clinical results using the spinal rod-sleeve method for treating thoracic and lumbar injuries. J.Bone Joint Surg., Orthop.Trans., 6:345-346,1982.

13. Edwards C.C., and Lcvine, A.M.: Early Rod-Sleeve Stabilization of the Injured Thoracic and Lumbar Spine. Orthop.Clin.North Am., 17:121-145-1986.

14 . Edwards, C.C., Levine A.M., Murphy, J.C., and DeSilvaJ.B.: New Techniques in Spine Stabilization. A Scientific Exhibit presented at the 49 th Annual Meeting, American Academy of Orthopaedic Surgeons, New Orleans, Jan., 1982.

15. Edwards, C.C., Levine A.M., Simmons S.C., and Joly, J.M.: Bridging sleeve fixation of the unstable spine with absent or fractured lamina. J.Bone Joint Surg., Orthop.Trans., 10:450,1986

16 . Escnkaya, I.: Torakolombcr Omurga Kinklarimn Cerrahi Tedavisinde Rod-Sleeve YSntcmi. Uzfnanhk Tczi, 1.0.Istanbul Tip Faktiltesi Ortopcdi ve Travmatoloji Anabilim Dali, Istanbul, 1989.

17. Flesh,J.R., Lcidcr.L.L., Erickson, D.L., Chou, S.N., and Bradford, D.S.: Harrington Instrumentation and Spine Fusion for Unstable Fractures and Fracture-Dislocations of the Thoracic and Lumbar Spine. J.Bone Joint Surg., 59-A: 143-153,1977.

18. Frankel, H.L., Hancock, D.O., Hyslop, C, Melzak,J., Michaelis.L.S., Ungar.G.H., Vcrnon, J.D.S., and Walsh, J.J.: The value of postural reduction in the initial management of closed injuries of spine with paraplegia and tctraplcgia. Paraplegia, 7:179-192, 1969.

19. Games, R.W., Breedlove, R.F., and Munson, G.: Stabilization of Thoracic and Thoracolumbar Fracture-Dislocations with Harrington Rods and Sublaminar Wires. Clin. Orthop., 189:195-203,1984.

20. Garfin, S.R., Mowcry, C.A., Gucrra, J.Jr., and Marshall, L.F. Confirmation of the Posterolatcral Technique to Decompress and Fuse Thoracolumbar Spine Burst Fractures. Spine, 10:218-223,1985.

21. Hamzaoglu, A., Akalm,Y., Domanic, U., Antamur,A., Esenkaya,İ.: Torakolombcr bolgenin anstabil kinklarimn cerrahi tedaisinde Rod-Sleeve yontemi. Acta Orthop.Trauma. Turcica, 22(3):79-84,1988.

22. Holdsworth, F.W.: Fractures, dislocations, and fracture-dislocations of the spine. J.Bone Joint Surg., 45-B: 6-20,1963.

23. Jacobs, R.R. Dahners, L.E. Gcrtzbein, S.D., Nordwall, A., and Mathys,R.: A locking hook-spinal rod: Current status of development. Paraplegia, 21: 197-200,1983.

24 . Kaneda, K-, Abumi, K., and Fujiya, M.: Burst Fractures with Neurologic Deficits of the Thoracolumbar-Lumbar Spine: Results of Anterior Decompression and Stabilization with Anterior Instrumentation. Spine, 9: 788-795,1984.

25. Keene, J.S.: Thoracolumbar Fractures in Winter Sports. Clin. Orthop., 216:39-49,1987.

26. Keene, J.S. Wackwitz.D.L., Drummond.D.S., and Breed, A.L.: Compression-Distraction Instrumentation of Unstable Thoracolumbar Fractures: Anatomic Results Obtained with Each Type of Injury and Method of Inhstrumentation. Spine, 11:895-902,1986.

27 . Kostuik, J.P.: Anterior Fixation for Burst Fractures of the Thoracic and Lumbar Spine with or without Neurological Involvement.Spine, 13: 286-293,1988.

28 . Luque, E.R., Cassis.N., and Ramircz-Wiclla, G.: Segmcntal Spinal Instrumentation in the Treatment of Fractures of the Thoracolumbar Spine. Spine, 7: 312-317,1982.

29. Magerly, F.P.: Stabilization of the Lower Thoracic and Lumbar Spine with External Skeletal Fixation. Clin.Orthop., 189: 125-141,1984.

30. McAfee,P.C., Bohlman, H.H., and Yuan.H.A.: Anterior Decompression of Traumatic Thoracolumbar Fractures with Incomplete Neurological Deficit using a Retropcritoneal Approach. J.Bone Joint Surg., 67-A:89-104,1985.

31 . McAfee,P.C., Yuan.H.A., Fredrickson,B.E., and Lubicky.J.P.: The Value of Computed Tomography in Thoracolumbar Fractures. J.Bone Joint Surg., 65-A:461-472,1983.

32. McAfec,P.C, Yuan-H.A., and Lasda.N.A.: The Unstable Burst Fracture, Spine, 7:365-373,1982.

33. McEvoy, R.D., and Bradford, D.S.: The Management of Burst Fractures of the Thoracic and Lumbar Spine: Experience in 53 patients Spine, 10: 631-637,1985.

34. Roy-Camille, R., Saillant, G., and Mazel, Ch.: Plating of Thoracic, Thoracolumbar, and Lumbar Injuries with Pedicle Screw Plates. Orthop. Clin.Nonh Am., 17:147-159,1986.

35 . Sullivan, J.A.: Sublaminar Wiring of Harrington Distraction Rods for Unstable Thoracolumbar Spine Fractures. Clin.Orlhop., 189: 178-185,1984.

36. Weinstein, J.N., Collalto, P.,and Lehmann, T.R.: Thoracolumbar "Burst" Fractures Treated Conservatively: A Long Term Follow-up. Spine, 13:33-38, 1988.