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THE SPINAL FUSION, OUR TECHNIQUE AND ITS EVALUATION

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This report presents our technique of spinal fusion with which we have practised for more than 20 years (developed by E.S.) and the results achieved with it. No originality is claimed, but we have failed to find it mentioned in the literature available to us.

Two techniques with its variations are employed, for the fusion of the posterior elements of the spine. One consists of the splitting of the spinous process and introduction of a graft (*Albee, Gibson*) or the use of the laminae and the base of the spinous process for grafting (*Young, Henry & Geist, Dobrotworski* a. o.) and the second, introduced by *Hibbs* and further developed and modified by others (*Ghormley, Peter, Steindler, Overton*), consists of denuding the laminae, using the local bone as graft-material and excision of the articular processes. To the denudation of the articular processes internal fixations have been added (*Hadra, Fett, Wilson* a. o).

The great effort put into a good fusion-technique is understandable, if one studies the results, which give figures of failures in solid fusions from 4.3 per cent in Scoliosis (*Cobb*) to 60 per cent in Spondylolysthesis (*Hammond*).

OUR TECHNIQUE

We use the standard supine position, preparing the skin with soap and alcohol and infiltrating the muscles and subcutaneous tissue with a solution of Novocain—(0.25 per cent) with Adrenalin sol., (8 drops of 1/1000 to 100 cc of fluid), in order to render the field bloodless.

Special care is attached to the subperiosteal exposure of the spinous processes. Each process is exposed separately from both sides, the area

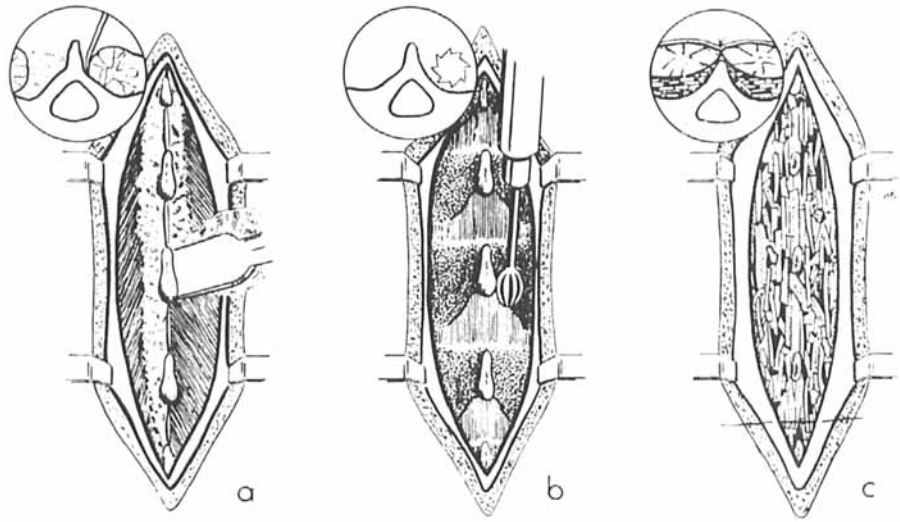

Fig. 1 a–c.

packed with a pad soaked in the same solution mentioned above for infiltration. In this way as many processes are exposed as necessary for the planned fusion. In the next step, the separated exposures are connected and again the area is solidly packed (Fig. 1a). Here, care is also taken to remain in the subperiosteal plane. Then with a 4 cm broad chisel the muscles are pushed to the side, as far as over the articular processes. This is done by starting a semicircular movement from the base of the laminae towards the articular process. This is the only phase of the procedure where bleeding can occur and can be secured by tight packing with soaked pads (Fig. 1a). If the fascia of the erector trunci muscles is very tight it is incised freely at the 4 corners of the exposure. This step is mostly necessary in the lumbosacral region.

The denudation of the laminae as far as the articular joints is the next step in the procedure. This step, which in very skilled hands takes quite a time, can, with the help of a ball burr, be done in less than a few minutes. The burrs are available in different sizes, so that it can be fitted to the width of the laminae. One starts at one end of the field, and moving the burr down takes the cortical bone off till spongy bone is visible. The bone dust remains in the place and the area denuded is lightly packed with soaked sponges. This movement goes down over the area on both sides of the spinous processes (Fig. 1b). When the surgeon is satisfied with the result , the spinous processes are cut off at their bases. In this way the area of spongy bone is enlarged. It is wise, to leave

this step till the end, in order to control the movement of the burr better. No hammering and chiseling is done and this step has as yet never caused changes in the general condition of the patient. No joints are exposed.

As bone graft we prefer autogenous spongy bone, taken from the posterior iliac spine and ilium at the same time of the fusion procedure, or from the anterior iliac crest, 10 days before. If this is not sufficient, we add boiled bone from the bank (Fig. 1c).

In the cervical spine, we leave the spinous processes intact, wiring them in addition to the graft. In one case of fract. dislocation at D_{12} we used an additional plate.

In Scolioses we place the patient in the corrected position in plaster with a great window in the back; in all other cases our patients are without plasters even after the operation, until they can be put on their feet, 8–12 weeks after operation. We generally use a Sandwich-Bed for the post-operative period.

During the past years, 68 spinal fusions have been carried out by the senior members of the department. Of these 68 patients, two died as a result of the operation. They will be reported in detail, but have been excluded from this survey.

The aetiology and region of fusion are shown in Table 1.

TABLE 1
Aetiology and Region.

Aetiology region	TB	Fracture	Scoliosis	Instability	Spondylolisthesis	Total
Cervical				3		3
Dorsal	8	3	2	1		14
Dorsolumbar ...	10	6	10			26
Lumbar	1	2		1	1	5
Lumbosacral ...	4	2		6	6	18
Total	23	13	12	11	7	66

Number of fused vertebrae is presented in Table 2.

A total of 342 intervertebral spaces were fused. As was expected, the longest fusions were done at the dorsal and dorso-lumbar areas and the shortest ones in the cervical and the lumbo-sacral regions. The most extensive fusions were performed in some of the tuberculous cases and of course in scolioses (Table 3).

TABLE 2
Number of Fused Vertebrae and Region.

Number of Vertebrae ...	2	3	4	5	6	7	8	9	10	11	12	13	Total
Cervical		3											3
Dorsal				4	3	3		2	2				14
Dorsolumbar			3	3	3	1	3	4		5	2	2	26
Lumbar	1	1	2	1									5
Lumbosacral	1	9	5	1	1	1							18
Patients	2	13	10	9	7	5	3	6	2	5	2	2	66
Intervertebral spaces	2	26	30	36	35	30	21	48	18	50	22	24	342

TABLE 3
Number of Fused Vertebrae and Aetiology.

Number of Vertebrae ...	2	3	4	5	6	7	8	9	10	11	12	13	Total
T.B.			3	3	5	3	2	5	2				23
Fracture		1	4	6	1		1						13
Scoliosis						1		1	1	5	2	2	12
Instability	1	8			1	1							11
Spondylolisthesis	1	4	2										7
Patients	2	13	9	9	7	5	3	6	3	5	2	2	66

We included in our studies patients with at least a two years follow-up period. The average follow-up was 6.4 years (Table 4).

TABLE 4
Years of Follow-Up.

Years	2	3	4	5	6	7	8	9	10	11	12	Average	6.4
Patients	4	2	10	7	6	6	3	3	5	10	10	Total	66

There have been in this series 7 postoperative infections. Of these 4 infections occurred after autogenous graft material and 3 after homogenous bone material. Of these 7 infections, 5 healed after discharging some of the bone material. In two patients surgical revision was necessary in order to clean the infected areas. 5 of these infections occurred in tuberculous patients.

The roentgenological control of the fused area (Table 6) was done by bendings-film and if necessary, by tomographic technique. 63 fusions

were soundly healed, while 3 demonstrated pseudarthroses (described later in detail).

TABLE 5
Postoperative Infections.

	Autografts	Homografts	Patients total
	Infected	Infected	
T.B.	2	3	23
Fracture	0	0	13
Scoliosis	0	0	12
Instability	0	0	11
Spondylolisthesis	2	0	7
			66

TABLE 6
Roentgenological Results of Fusions.

	Solid	Pseudarthrosis	Total
Fusions	63	3	66
%	95.5%	4.5%	100%

A personal follow-up was made on 54 out of 66 patients. We divided these patients in 4 groups:

1. Very good: no pains, normal daily activities, no clinical findings.
2. Good: occasionally pains in the back, normal daily activities, no clinical findings.
3. Fair: frequent pains in the back, limited daily activities, but still no clinical findings.
4. Poor: constant pains in the back, extremely limited daily activities, positive clinical findings.

According to this classification, we had one poor and three fair results (Table 7).

TABLE 7
Clinical Results of Fusions.

	Very good	Good	Fair	Poor	Total
Clinical Results	32	18	3	1	54
%	92.6%		7,4%		100%

In the following we present details of the fair and poor results, as well as the two deaths:

1. Z.W., 30 year old male, suffering for many years from tuberculosis of the 12. dorsal and 1. and second lumbar vertebra. A large paravertebral abscess, bulging on both sides of the spine and a gibbus with an angulation of 70 per cent were present. In 1950 a spinal fusion was performed. In 1953 a double-sided costo-transversectomy was done and a big cold abscess evacuated. After subsidence of the process a second spinal fusion was performed in 1955, extending from D10–L3. The fusion remained ununited. The patient is walking with a brace and a spastic gait. He does not work ("poor result").

2. R.W., 31 year old female, suffering for several months from pains in the back due to tuberculosis of 12. dorsal till 2. lumbar vertebra. A fusion from D11–L3 was done in 1957. The patient felt well for 3 years, then started to complain about pains in the back; an X-ray examination demonstrated a pseudarthrosis at the level of 1. lumbar vertebra. Repair of the pseudarthrosis was advised but not accepted by the patient ("Fair results").

3. N.B., 29 year old male, a professional dancer, complained about pains in the lower back. A spondylolisthesis was found. In 1955 an H-graft was done. A year later he returned to his work. Two years later he complained again of pain and an x-ray control demonstrated a pseudarthrosis of the graft. 1958 a bone was added to the operated area and solid union was achieved. He returned to his profession. ("Fair result").

4. A.N. An 11 year old boy was run over by a car, and suffered a fracture-dislocation of the level of the 11. and 12. dorsal vertebra. A complete paraplegia was the consequence. His spine remained unstable and a fusion from D9–L1 was done. Repeated control examinations demonstrated the fused area to be solidly united. The patient complained over some years about constant pains in the back. It is doubtful, if the fusion is the cause of these pains. ("Fair result").

We had two surgical deaths:

1. X.I., an 8 year old boy suffered from tuberculosis of the dorsal spine. A spinal fusion was planned. During the first steps of the operation, the patient stopped breathing. An open cardiac massage was done, but the patient did not recover. Death due to cardiac arrest resulted.

2. M.Z.A., 25 year old female suffered from tuberculosis of L3–L4. A spinal fusion was done from L2–S1. She died on the 17th postoperative day due to anuria. Cause: mismatched blood transfusion.

SUMMARY

1. The accepted technique of spinal fusion consists of the denudation of the cortical bone from the posterior elements, including the joints, by means of a hammer and chisel, requiring a considerable period of time. The advantage of our method is that this step is done with an

electric burr within a few minutes and with no trauma, thus strikingly reducing the danger of spinal shock developing as a result of the prolonged hammering. The joints are not fused.

2. We have operated on 66 patients with an average of six years follow-up. On average five intervertebral spaces were fused.

3. Beside fusion for scoliosis, the postoperative care was performed on a turning frame without plaster fixation.

4. With this technique we achieved clinically 92.6 per cent good and 7.4 per cent fair and poor results.

5. Roentgenologically we had 95.5 per cent solid fusions, and 4.5 per cent pseudarthroses.

RESUME

1. La technique de fusion vertébrale acceptée consiste à une dénudation de l'os cortical des éléments postérieurs, y compris les articulations, au moyen d'un marteau et d'un ciseau, intervention qui demande un laps de temps considérable. L'avantage de notre méthode c'est de pouvoir accomplir ce processus avec une foreuse électrique dans l'espace de quelques minutes et sans trauma, en réduisant par conséquent beaucoup le danger de choc vertébral par suite de la frappe prolongée du marteau. Les articulations ne sont pas fusionnées.

2. Nous avons opéré 66 malades qui ont été suivis pendant une période moyenne de six ans. En moyenne cinq espaces intervertébraux ont été fusionnés.

3. A côté de la fusion pour scoliose, des soins post-opératoires ont été donnés sur un cadre tournant sans fixation dans le plâtre.

4. Avec cette technique, nous avons obtenu dans 92,6 pour cent des cas des résultats cliniquement bons et dans 7,4 pour cent des cas des résultats moyens et mauvais.

5. Radiographiquement, nous avons eu des fusions solides dans 95,5 pour cent des cas et des pseudarthroses dans 4,5 pour cent.

ZUSAMMENFASSUNG

1. Die gebräuchliche Technik der Wirbelverschmelzung besteht in der Entblössung des kortikalen Knochens der rückwärtigen Bestandteile einschliesslich der Gelenke mittels Hammer und Meissel, ein Vorgehen das viel Zeit erfordert. Der Vorteil unserer Methode ist, dass dieser Schritt mit einem elektrischen Zäpfchenbohrer in wenigen Minuten und ohne Trauma ausgeführt wird. Dadurch wird die Gefahr

des spinalen Schockes, der sich infolge des zu langen Hammerns entwickeln kann, deutlich herabgesetzt. Die Gelenke werden nicht verschmolzen.

2. Wir haben 66 Patienten mit einer durchschnittlich sechsjährigen Beobachtungszeit operiert. Durchschnittlich wurden fünf Zwischenwirbelräume verschmolzen.

3. Abgesehen von der Verschmelzung wegen Skoliose, wurde die postoperative Pflege auf einem Drehrahmen ohne Gipsfeststellung durchgeführt.

4. Mit dieser Technik erhielten wir klinisch 92,6 Prozent gute und 7.4 Prozent mittelmässige und schlechte Ergebnisse.

5. Röntgenologisch hatten wir 95.5 Prozent solide Verschmelzungen und 4.5 Prozent Pseudarthrosen.

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