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Posterior Spinal Fusion in the Management of Healed Post-Tubercular Kyphosis in Children

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Abstract : Post-tubercular kyphosis in children is not only a handicap cosmetically but is also functionally disabling. With progression in the deformity, there is a high risk to late-onset paraplegia. Here present our preliminary results in a prospective study of 20 cases of healed post-tubercular kyphosis in children treated with isolated posterior spinal fusion using irradiated allografts and autogenous cancellous grafts. All the patients had achieved healed post-tubercular kyphosis, based on clinical, radiological and hematological criteria, with the spine still at slight risk in only 2 patients radiologically. The mean age at operation was 7 years, with a mean follow-up of 4.2 years.

At most recent follow-up, 15 patients(75%)showed correction in the kyphosis, 4 patients(20%) showed no change, and 1 patient showed slight worsening in deformity.

The proposed mechanism for correction is selective anterior column growth through posterior fused mass leading to gradual self correction and remodeling.

In situ posterior spinal fusion is a simple, safe, easily reproducible, and less morbid surgical procedure with good results in young patients which may bring relief from long-term disability.

Introduction

There are many reports in the literature on the surgical protocol for active spinal tuberculosis (TB) (Albee 1911 ; Hibbs 1928 ; Bosworth 1953 ; Hodgson 1960)[1)5)3)6)], but these leave much scope for further studies on the management of the deformities after healing. Albee (1911) was the first to recommend posterior fusion for spinal tuberculosis but his fusion was primarily performed during the active stage of the disease, so collapse continued, and suitable cancellous allografts for good fusion were unavailable. In children, the incidence of the disease presenting in the first decade is nearly 50% in developing countries (Tuli 1995)[13)]. Recent protocols have recommended anterior, technically-demanding and complex, internal gibbus surgery (Yau et al. 1974)[15)], which is difficult to be performed at a small local clinic.

At our centre, we have pioneered a simple approach which could be performed at small local

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clinics in preselected cases. Here we report the first short-term analysis of our approach in children of isolated posterior spinal fusion after the disease has fully healed.

Material and Methods

Patients

The study was conducted from March 1998 to March 2003. 20 patients, 9 males and 11 females, between the ages of 3-11 years were prospectively entered into the study. Twelve patients had dorsal lesions, 6 had dorso-lumbar lesions and 2 had lumbar lesions.

The inclusion criteria used were :

1. Clinical, radiological and hematological documented healing ; Patients were treated with ambulatory short course chemotherapy regimen of 9 months duration as per the protocol laid down by Medical Research Council. Clinical healing was noted by elimination of pain and fever, and improvement in overall general condition. Radiologically healing was noted by spontaneous fusion of the involved vertebrae leading to formation of a fusion mass, and hematological healing was noted by normalization of the erythrocyte sedimentation rate after completion of the treatment.

2. Documented progression of kyphosis at serial follow up ; Patients were followed up at 3-month intervals after completion of the chemotherapy, and were managed by posterior spinal fusion surgery if they showed an increase of more than 10 degrees in 12 months.

3. Nil or<2 spine at risk signs (Rajsekaran 2001[9], Fig. 1)

4. No neurological deficit

Allografts

Freeze dried rib allografts were used ; double packed in polyethylene sleeves and exposed to 25kGy of gamma radiation. The freeze dried irradiated allografts were morsellized in the operation theatre prior to surgery using a bone cutter.

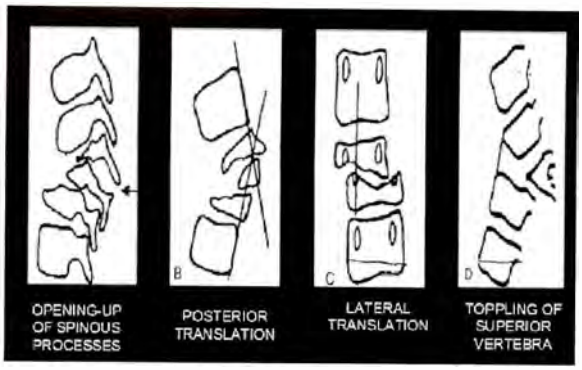

Fig. 1. Spine at risk signs (Rajasekaran 2001)

Surgery

Morcellised, irradiated allografts were used in all the patients. The morcellised allografts were mixed with autogenous cancellous iliac crest bone grafts.

Posterior midline exposure was done ; the incision was planned to include uninvolved single vertebral level above and below the healed segment. The spinous processes were carefully decorticated, and the recipient bed was prepared by careful decortication to the transverse process. In situ posterior fusion was done by implanting an adequate amount of allograft-autograft mixture onto the posterior spinal bed at one level above and at one level below the affected segment.

The patients were reassessed at 3-month intervals clinically and radiologically. The duration of hospitalization post-surgery was short. After removing the sutures, patients were ambulated in a protective part-time (during ambulation) total contact spinal brace for 1 year after surgery.

Results

At a mean follow-up of 4.2 years (range from 3.5 years to 5 years), all 20 patients showed solid

Table 1.

No.	Sex	Age (years)	Diagnosis (level of tuberculous lesion)	Pre-op Deformity (Angle in degrees)	Deformity at Final Follow-up (Angle in degrees)	Final Follow-up period (years)	Outcome	Result
1.	M	3	D4-D5	60	40	4	Solid Fusion	Good
2.	M	4	D12-L1	20	03	5	Solid Fusion	Good
3.	F	4.5	D7-D9	55	40	4.5	Solid Fusion	Good
4.	M	4.5	D7-D8	45	35	3.6	Solid Fusion	Good
5.	M	4.5	D12-L1	40	25	3.5	Solid Fusion	Good
6.	M	5	D7-D9	55	40	3.8	Solid Fusion	Good
7.	M	5.2	D8-D9	40	35	3.7	Solid Fusion	Good
8.	F	5.4	D11-L1	35	30	3.5	Solid Fusion	Good
9.	M	5.5	D9-D10	70	40	5	Solid Fusion	Good
10.	F	5.5	D7-D9	45	35	3.6	Solid Fusion	Good
11.	M	6	L2-L3	40	35	3.8	Solid Fusion	Good
12.	F	6	L3-L4	45	30	3.5	Solid Fusion	Good
13.	F	7	D8-D10	55	40	4.5	Solid Fusion	Good
14.	F	7	D7-D8	40	25	4.1	Solid Fusion	Good
15.	M	7.2	D12-L1	40	30	3.8	Solid Fusion	Good
16.	F	8	D4-D5	80	80	5	Solid Fusion	Fair
17.	F	9	D6-D7	75	75	4.5	Solid Fusion	Fair
18.	F	9.4	D9-D10	60	60	4.8	Solid Fusion	Fair
19.	F	9.5	D12-L1	55	55	4.2	Pseudoarthrosis at lower level	Fair
20.	F	11	D12-L1	25	30	4.1	Solid Fusion	Poor

posterior fusion, excellent graft incorporation and consolidation. Only 1 patient showed a break in the posterior fusion mass at the lower level suggestive of pseudoarthrosis. The fusion status was assessed by Computed Tomography aided by three dimensional reconstructions.

There was no graft related complication, and no infection.

15 patients showed correction in the deformity, four showed no change, and the other one showed deterioration with the K angle (Kyphotic angle ; Konstam angle) increased from 25 degrees to 30 degrees. (Table 1)

Illustrative example

A 5-year-old boy presented tuberculosis of the dorsal spine at the D7-D9 vertebral levels with a pre-operative deformity of 55 degrees (Fig. 2, 3). He was subjected to in situ posterior spinal fusion surgery. At 3.8 years later, the kyphosis deformity was corrected to near normal thoracic kyphosis (Fig. 4) of 40 degrees, and the three-dimensional reconstructed CT posteroanterior image showed excellent fusion (Fig. 5).

Discussion

Vertebral TB is the commonest form of skeletal TB constituting 50% of all cases of musculoskeletal TB reported, and the incidence of disease in the first decade of life is nearly 50% (Tuli 1995)[13]. The development of effective anti-tubercular chemotherapy has largely made spinal TB a medical disease, and the surgical focus has now

Fig. 2.
Preoperative clinical deformity (standing lateral view)

Fig. 3.
Preoperative lateral radiograph showing a D7-D9 tuberculos lesion ; healed with a kyphotic angle (Konstam) angle of 55 degrees

Fig. 4.
Follow-up postoperative lateral radiograph showing autocorrection of kyphosis to 40 degrees

Fig. 5.
Three-dimensional reconstructed posteroanterior CT scan showing solid posterior fusion

shifted onto the problem of progressive deformity, mainly kyphosis in healed cases in children (Rajsekaran 1989)[12]. In TB endemic countries more than 80% of patients have some degree of detectable kyphus (Rajsekaran 1989)[12].

The progression of the deformity occurs in 2 distinct phases : Phase I or the active phase includes the changes during the period of the activity of the disease and Phase II comprises changes in deformity after complete cure of the disease (Rajsekaran 1987)[11]. Children have an increased propensity towards developing a kyphotic deformity and a greater propensity toward progression during the active stage of the disease, with continued variable progression even after healing and growth completion. The reasons are :

1. Greater severity of the disease at presentation.

2. Greater flexibility of the spine in children.

3. Variable destruction in the growth plates interfering with future growth.

4. Suppressive unpredictable effect of mechanical forces of kyphosis on the growth of the anterior half of the fusion mass and adjacent healthy vertebrae. (Rajsekaran 2001)[9]. Nearly 39% show an aggravation in the deformity with growth (Rajsekaran 2002)[10]. In carefully selected patients, any surgical intervention which halts the progression of the deformity during the healed stage of the disease therefore has the potential to alter the biomechanics of the natural behavior of the kyphus.

Albee (1911)[1] and Hibbs (1928)[5] introduced posterior spinal fusion during the active stage of the disease, and Bosworth (1953)[3] carried out further work on this approach. The aims were to shorten the period of immobilization, provide inherent stability, and avoid recurrence and development of paraplegia. The pre anti-tubercular drug era saw a 20-50% increase in kyphosis despite surgical intervention. Though significant improvement was reported in the post chemotherapy era initially, posterior spinal fusion fell into disrepute subsequently because :

1. Eradication of the disease focus and

Fig. 6.
Sagittal MRI T2 ; image showing intact or variously destroyed anterior vertebral growth plates following D12-L2 spinal TB

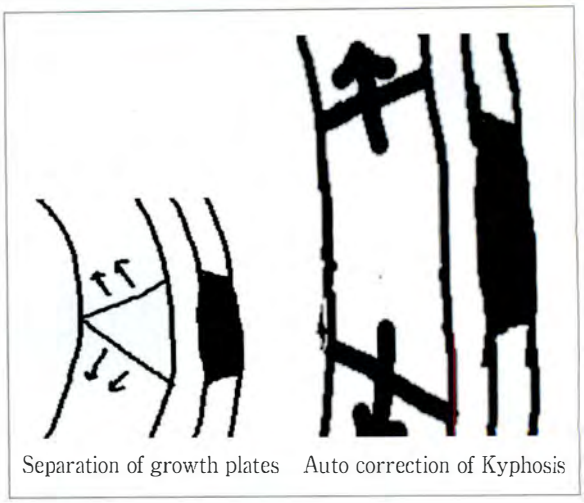

Fig. 7. Postulated mechanism for the correction of kyphosis
Schematic lateral diagram showing autocorrection of kyphosis with growth due to separation of growth plates anteriorly on a pivot of posterior spinal fusion

decompression in the spinal cord was not achieved.

2. Delayed healing and protracted course.

3. Increased incidence in mechanical instability and progressive collapse when involving 3 or more vertebrae (Tuli 1995)[13].

There is controversy in the literature regarding progression in the deformity after anterior decompression and arthrodesis. Some studies (Upadhyay 1994, Rajsekaran 1989, Hodgson and Stock 1960, Kemp 1973, and MRC 1982)[14][12][6][7][8] have reported good to excellent results, while some other studies (Bailey et al 1972)[2] have reported an increase in deformity >10 degrees in 42 of 100 children treated with anterior spinal decompression and fusion. Fountain et al (1975)[4] reported progression in the deformity which they proposed was likely due to :

1. Retardation in growth of the anterior vertebral ring epiphysis cephalad or caudad or both to fusion mass and

2. Overgrowth of posterior elements.

Also correction of established deformity is hazardous, technically difficult and with a high complication rate (Yau 1974)[15].

All the aforementioned studies were done in the active stage of the disease and in mixed populations, with various results with respect to progression in the deformity and fusion status. There is no report available in the literature on a surgical protocol for healed cases of spinal TB, specifically in children. The availability of indigenous irradiated allografts and large spectrum of healed spinal TB cases prompted us to undertake this study, which is the only study to date on how to manage healed post-tubercular kyphosis in children.

With this background in mind, all our 20 patients who were serially followed and adhering to our earlier described inclusion criteria achieved a 100% fusion status without any surgical complications following posterior spinal fusion. Seventy-five percent of our patients had a decrease in deformity (15 patients), and 20% remained unchanged (4 patients). Only 1 patient showed an increase in deformity. Overall a favourable result with respect to deformity correction was achieved in 95% of those 20 preselected cases.

The postulated mechanism of correction is growth of the anterior end plates (Fig. 6, 7) which are intact or variably destroyed vis a vis posteriorly fused mass leading to selective anterior column growth and gradual self correc-

tion of kyphosis. The posterior fused mass acted as a pivot on which the superior and inferior vertebral arm gradually moved apart with growth giving rise to autocorrection of the kyphotic deformity. These results were independent of the site of the lesion. The 4 patients who remained unchanged may have had complete destruction in the growth plate. Thus the addition of posterior fusion behaved like global fusion with the passage of time. The one patient who showed worsening in the kyphotic deformity was 11 years of age. This suggests that the beneficial effect with growth was lost in her because of having achieved the second growth spurt.

These early trends are encouraging and warrant further exploration. With a longer follow up and with more cases we may have to look for following possible sequeale :

1. Lordoscoliosis at or around the fusion mass.

2. Possibility of correction of anterior elements due to growth vis a vis surgical intervention.

3. Changes at one level above and below the fusion

4. Influence of the site of the tuberculous lesion.

Also we would like to clearly state that children with radiological spine at risk signs>2 or with a spinal instability score of more than 2 and involvement of more than 3 vertebrae would need radical anterior surgery.

Conclusion

Posterior spinal fusion with morcellised allografts and cancellous autografts is a classically simple, safe, easily reproducible procedure with reduced morbidity. It can be performed even at small outlying local clinics, and can give consistent good results in healed cases of spinal tuberculosis in children.

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