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Patients with myelomeningocele and kyphosis managed with an ACM plate

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SUMMARY. Kyphosis, as a sequel of myelomeningocele, is a malformation that may result in many problems including ulcers; limited use of the arms for support purposes, and reduced pulmonary function, among others. Treatment is complex and demanding. Sharrad first described a technique for the surgical management of these patients in 1968. Since then many techniques have been described but none has been accepted as the treatment of choice for this disorder. In 1998 we started treating a group of patients by using an implant designed by Dr. Alfredo Cardoso Monterrubio, the ACM plate. This paper presents the initial report of a 15-patient group he treated for an average of 2.9 years with the Alfredo Cardoso Monterrubio (ACM) plate.

Key words: myelomeningocele, kyphosis, implant, children.

RESUMEN. La cifosis como secuela de mielomeningocele es una deformidad que puede provocar múltiples problemas como son úlceras, limitación del paciente al utilizar sus brazos como punto de apoyo y disminución de la función pulmonar entre otros. Su tratamiento es complejo y demandante; en 1968 Sharrad describió por primera vez una técnica para el manejo quirúrgico de estos pacientes y desde entonces se han descrito múltiples técnicas, pero ninguna de ellas ha sido aceptada como el tratamiento de elección para este problema. Desde 1998 iniciamos el manejo de este grupo de pacientes mediante el uso de un implante diseñado por el Dr. Alfredo Cardoso y cuyo nombre es la placa ACM. En esta ocasión presentamos un reporte inicial de un grupo de 15 pacientes manejados durante un tiempo promedio de 2.9 años con la placa ACM.

Palabras clave: mielomeningocele, cifosis, implante, niños.

Introduction

Because of its natural history and the alterations it involves, myelomeningocele is a disorder often presenting with spine deformities such as scoliosis or kyphosis, especially in patients with myelomeningocele in the lower thoracic or upper lumbar spine. The incidence of kyphosis in patients with myelomeningocele is around 12 to 20 percent.¹

The kyphotic deformity results from dysraphia. This disorder causes ventral rotation of extensor muscles, which, together with others such as the iliopsoas muscle, result in a deformity

due to the absence of an opposing force on the posterior region. Thoracic lordosis is secondarily developed out of the need to achieve trunk control and balance in the sitting position.²

The above malformations lead to a series of alterations such as respiratory distress due to the pressure that the abdominal contents exert on the diaphragm, the impairment of kidney function and urinary diversion, recurring skin ulcers at the kyphotic apex level, and infections.² Furthermore, the proper function of the ventricle-peritoneal shunt may be altered. The patient's activity may also be limited, as the upper limbs become an additional support for the chest due to the position that results from kyphosis.

This has prompted the need to find an appropriate treatment to correct this malformation. Treatment with braces is not appropriate for these patients. Since 1968, when Sharrad first described the osteotomy and vertebrectomy to correct the kyphosis in this group of patients,³ many techniques and modifications have been proposed for spinal instrumentation, in an attempt to reduce the high complication rate seen with the already available techniques.^{2,4,5}

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Some of the complications described include skin ulcers secondary to casts and braces, long-bone fractures, loosening of the osteosynthesis material, urinary tract infections, and surgical wound infections.

In our search for new techniques and implants to manage patients with myelomeningocele kyphosis we designed a new implant which we named the ACM plate (*Figures 1A and 1B*), and which we started using in 1998 at the Shriners Hospital in Mexico.

The purpose of this paper is to report the use of the ACM plate to manage these patients.

Material and methods

Between November 1998 and March 2002, we performed vertebrectomies and used ACM plates for fixation in 18 patients with myelomeningocele and kyphosis at the Shriners Hospital in Mexico. Our series included 18 patients. Information about 15 (9 females and 6 males) of these 18 patients was taken from their case histories, X-ray films and interviews with 4 of them.

The mean age in this group of patients was 6 years (2.9 years to 8.6 years) and the mean follow up was 2.9 years (1.5 to 5.9 years). (See *Table 1*).

Surgical technique: The surgical procedure is preceded by a preoperative assessment by the plastic surgeon to determine the need for procedures to be performed prior or simultaneous to plate placement. This is because usually the skin of these patients on this body area is very thin and has undergone prior surgeries to close the myelomeningocele defect or due to previous ulcers.



Figure 1A .



Figure 1B .

Figures 1A and 1B. AP and lateral views of the ACM plate

Surgery is performed under general anesthesia with a posterior longitudinal approach at the midline level on the kyphotic region. A careful lateral dissection is performed to avoid cutting the remaining dural sac exposed by the dysraphia. After that, the fibrosis holding the remaining anchored sac is released. This sac, which is distal to the kyphosis apex, is dissected and lifted in a cranial direction thus exposing the posterior wall of the vertebrae involved in the malformation.

The apical vertebra is located and resected from the posterior region by means of curettage from the center to the periphery (this causes less bleeding). Next, the tract to insert the plate on the vertebral bodies distal to the vertebrectomy area is prepared by cutting with a curved chisel at the center of the upper plane of the distal vertebra resected (with fluoroscopic control) and then the ACM plate is inserted. Once the plate is in place, the proximal portion is used as a lever arm for reduction and it is fixated on the proximal vertebral bodies of the vertebrectomy with cancellous bone screws. An autologous graft made from the resected vertebrae is put in place and the incision is closed by planes (*Figures 2A and 2B*).

The mean operative time was 62 minutes (0:50 – 1:10) and the mean blood loss was about 515 ml (100-1,200 ml).

Once the surgery is completed, the patient is transferred to the recovery room to recover from anesthesia. Then he/she is taken to the corresponding ward for assessment of the skin at the surgical site, and to manufacture a thoracolumbar corset in hyperextension.

Results

Preoperatively the mean preoperative kyphosis was 89.33° ($40 - 119^\circ$) measured on the lateral film with the patient in a sitting position.

After surgery, a mean kyphosis of 21.93° ($-3^\circ - 54^\circ$) was seen with a mean correction of 67.4° accounting for 75.45% of correction.

At the last follow-up, the mean deformity was 62.90° ($30-97^\circ$) accounting for a mean correction loss of 40.97° . Four patients maintained a correction $\geq 50\%$ of the malformation. Two patients had an increased deformity compared to the preoperative malformation. One of them was due to improper distal plate placement on the kyphosis apex and the other case was associated with a loosened proximal plate screw and a kyphosis proximal to the plate.

It was necessary to remove the ACM plate in 4 patients. In one of them it had been improperly placed; two other patients developed an ulcer and infection; and in the fourth case, we tried to place the plate while we were rotating the flap, which resulted in flap necrosis and infection.

The 4 patients we were able to interview, and who were asked for their opinion about the procedure, stated they were satisfied with their surgery because their posture while sitting and their functionality improved as they did not have to use their upper limbs for support anymore (*Figures 3A, B and 4A, B*).

Table 1. Information on Patients Included in this study
Follow-up of patients with an ACM plate.

Record Number	Sex	Age	Weight (kg)	Preop. Angle	Postop. Angle	Last Control Angle	Operative Time (hrs)	Estimated Blood Loss (ml)	Follow-up Time
26694	F	4 y 5 m	9.6	83	35	84	01:10	280	5.9 years
18828	F	7 y 6 m	21.7	40	6	Plate Removed	01:05	500	2 years
23134	F	8 y 6 m	27.9	89	50	33	01:10	550	5.9 years
20164	F	8 y 2 m	23.7	63	8	34	01:05	1000	1.9 years
28554	M	7 y 6 m	22.6	88	26	Plate Removed	01:00	700	0
33777	M	2 y 9 m	9	110	28	70	01:10	200	3.5 years
22414	F	5 y 4 m	13.4	119	54	Plate Removed	03:25	300	0
34390	F	8 y 5 m	21	60	15	30	01:00	600	3.2 years
31609	F	6 y 2 m	21	90	22	62	01:00	100	2.3 years
35173	M	6 y 3 m	20	115	2	55	00:50	750	2.3 years
33880	M	3 y 6 m	11.9	107	14	Plate Removed	01:05	300	5 months
35753	F	5 y	13.2	83	26	75	00:50	400	1.5 years
35644	M	4 y 2 m	10.8	114	26	62	01:50	1200	1.9 years
30409	M	4 y 3 m	29.5	114	30	97	01:00	400	2.8 years
18111	F	7 y 5 m	26	65	-3	90	01:05	450	1.6 years
Average	9 F 6 M	6 y	16.4	89.33	21.93	-	01:02	514.33	2.9 years

Follow-up time = means the plate was removed during the hospital stay during which it was placed.

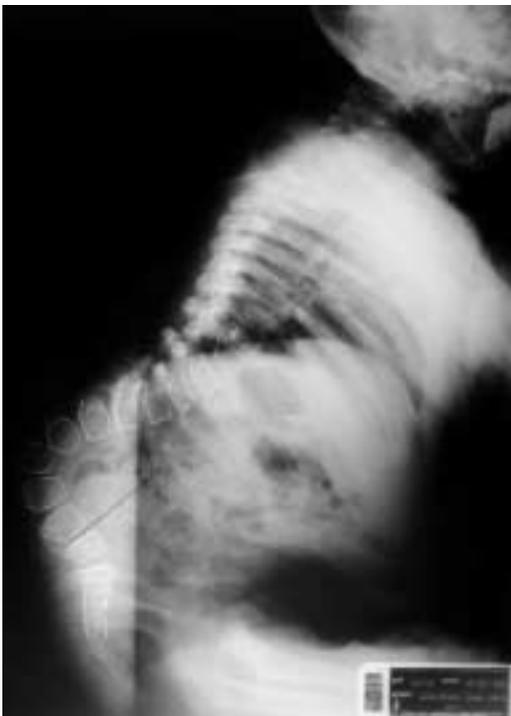


Figure 2A.



Figure 2B.

Figures 2 (A). Preoperative X-ray of a patient with a 115° kyphosis. **(B)** Postoperative X-ray with an 8° kyphosis.

Eleven of 15 patients (73.3%) developed some kind of complications associated with the management protocol followed.

Five patients (33.3%) developed some kind of infection in the back; 3 (20%) of them had a surgical wound infection during the hospitalization itself; and 2 patients (13.3%) had an infection during the follow-up period, associated to the pressure points and resulting from the braces used. One

of these patients was managed on an outpatient basis. In 3 (20%) of the patients with an infection the plate had to be removed.

Four patients (26.6%) showed signs of plate loosening. In one of them the plate had to be removed as it also showed signs of infection. In two patients the most proximal plate screw loosened but this situation required no further treatment.



Figure 3A.



Figure 3B.

Figures 3 (A). Imaging 5 years after surgery. (B) Last control X-ray 5 years after surgery.



Figure 4A.

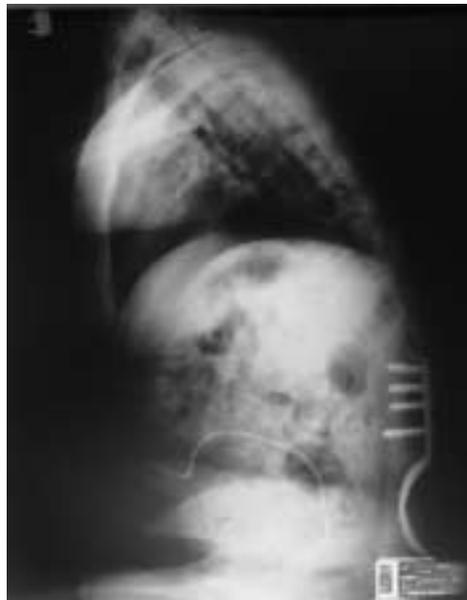


Figure 4B.

Figures 4 (A). A patient 2.3 years after surgery. (B) Control X-ray 2.3 years after surgery.

Six patients developed kyphosis proximal to the plate. One of them developed kyphosis because of improper plate placement, as described above.

There was one case of CSF leak in addition to wound infection that warranted removal of the plate.

Discussion

Managing a myelomeningocele kyphosis deformity is very demanding because of the large number of complica-

tions that occur starting at the preoperative period (quality of the skin, ulcers, other simultaneous malformations or medical problems), which may even be a contraindication for surgery. Complications may also occur during the post-operative period.

At present, we continue to look for a proper method to manage the kyphosis deformity in this group of patients, in order to reduce the complication rate. Several techniques and modifications have been described. Heydemann and Gillespie² and Torode and Godette⁶ have described several

modifications to the Luque instrumentation system while John V. Banta⁷ described the combination of anterior and posterior fusion to manage the malformation, among many others. In general, nearly everyone coincides in resecting one or several vertebrae at the malformation apex level or the vertebrae immediately adjacent to it. However, the most appropriate instrumentation and fusion technique is yet to be defined.

As regards the ACM plate, in the group of patients we assessed, the spine area covered by the plate maintained an adequate correction.

The rate of kyphosis proximal to the plate was 40%. This could be improved by expanding the fixation more proximally.

Seventy-five percent of ulcers developed at the surgical site because of the pressure points caused by the braces, while 40% of infections occurred at the ulcer level described above. Modifying the braces may improve the outcome.

The nutritional status of the patients who presented with this problem is poor in most cases. This increases the risk of complications such as impaired healing, poor skin quality, and increased risk of surgical site infection in addition to chronic urinary tract infections.

The ACM plate may be an option to manage patients with sequelae of myelomeningocele and secondary kyphosis.

The group of patients eligible for this choice of treatment may be defined as those with myelomeningocele and kyphosis at a neurological level of T12 and above and a body weight >20 kg. This choice of treatment is an alternative for patients during their growth period. By using short spine instrumentation, a broad segment of the spine will be able to continue to develop and grow normally,

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