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Original article

Kyphosis after dorsal spine surgery with and without sparing the posterior ligament system

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SUMMARY. ***Material and methods.*** **A cohort analysis was conducted on 74 patients who underwent instrumentation fusion of the spine with a dorsal approach. Spines were operated regardless of etiology, age or gender of patients. Patients were randomized into 2 groups, 37 to a group. One group had the spine posterior ligament system (PLS) spared. The other group did not. Both were followed up for an average 30 months. The variable at issue was the development of kyphosis on the cephalic end of the instrumentation as an X-ray complication during the postoperative period. Statistical analysis was done by simple frequencies and inferred statistics using Mann-Whitney´s "U" and Fisher's testing kyphosis and their postoperative grading.** ***Results.*** **The median age of patients was 13.5 years (ranging between 9 and 28 years). Females prevailed by 65%; prevailing etiologies were idiopathic scoliosis (62.2%) and Scheuermann disease (14.8%). The group having their spine posterior ligament system spared had a lower incidence of postoperative kyphosis (p < 0.001) and less loss of correction in kyphosis degrees (p = 0.037).** ***Conclusion.*** **Sparing the spine posterior ligament system in patients under posterior instrumentation showed a lower incidence of postoperative kyphosis of the instrumentation cephalic end compared to patients who had not their ligament system spared.**

Key words: spine, kyphosis.

RESUMEN. ***Material y métodos.*** **Se realizó un estudio de cohortes analítico de 74 pacientes intervenidos quirúrgicamente con instrumentación vía dorsal de la columna de cualquier etiología, edad y sexo; dividido en dos grupos de 37. Uno en el que se les preservó el sistema ligamentario (PSL) de la columna y otro al que no se les preservó; ambos con un seguimiento promedio de 30 meses. La variable de interés fue el desarrollo de cifosis en el extremo cefálico de la instrumentación como complicación radiológica en el postoperatorio, el análisis estadístico se realizó mediante frecuencias simples y estadística inferencial mediante la prueba "U" de Mann-Whitney y exacta de Fisher para la presencia del cifos y su gradación en el postoperatorio.** ***Resultados:*** **La mediana de la edad de los pacientes fue de 13.5 años (rango de 9 a 28), predominó el sexo femenino con 65%, las etiologías predominantes fueron la escoliosis idiopática con el 62.2% y la enfermedad de Scheuermann con 14.8%. El grupo con preservación del sistema ligamentario posterior de la columna presentó una menor incidencia de cifosis postquirúrgica (p < 0.001) y menor pérdida de corrección en grados del mismo (p = 0.037).** ***Conclusión:*** **La preservación del sistema ligamentario posterior de la columna en pacientes bajo instrumentación posterior tuvieron una menor incidencia de cifosis postquirúrgica en el extremo cefálico de la misma en comparación con aquellos pacientes en quienes no se preservó este sistema ligamentario.**

Palabras clave: columna, cifosis.

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Introduction

One of the possible complications of using metal implants in a dorsal approach to correct some vertebral spine deformity is the development of a kyphotic deviation of the instrumentation cephalic end or "swan neck" (*Figure 1*).[1,4,5,8-10] The development of a kyphotic deformity of the instrumentation cephalic end was studied by Guy A. Lee,

R. Betz et al.[4] in patients after surgery for idiopathic scoliosis. They determined a kyphosis prevalence of 46% in 69 patients studied and suggested this complication may be due to poor surgery planning in selecting the fusion area. They submit that the solution is a new surgery to expand the fusion area towards the cephalic end.

When describing the surgical technique involving a dorsal approach of the spine, traditional texts mention the resection of the epispinal ligament, the interspinal ligament and even the spinous process. Authors justify this by claiming it increases the fusion area and it is possible to get a bone graft. Approaching the midline is also considered because it results in less blood loss, since this approach involves avascular elements, greater spine flexibility and consequently, better correction is achieved. Finally, the physiology of these structures is thoroughly known. It consists of limited flexion motion, if dorsal arthrodesis is achieved, assuming the fusion mass and the presence of the instrumentation will act to limit flexion (even prevent it), and thus replace the dorsal ligament system functions.[2,3,6,7]

However, resection of the ligament system and spinous processes leaves two areas having different biomechanics without some sort of union. The area involved becomes rigid by the presence of implants and the vertebral fusion while the area adjoining the surgical intervention maintains its anatomical integrity and normal mobility.

Furthermore, because of the resection of the ligament system and spinous process, other inconveniences arise such as eliminating the possibility to access the epidural space necessary to perform anesthesia or diagnostic procedures in the future and produce an other than normal contour of the back when the depression of the midline is lost due to the presence of the spinous processes.

We, therefore, feel it was important to conduct this study to watch the development of kyphotic deformities on the instrumentation cephalic end by comparing both preservation techniques or otherwise of the spine posterior ligament system (*Figure 2*).

Material and methods

A cohort study was conducted at the Spine Deformity Service of the "Victorio de la Fuente Narváez" Orthopedics Hospital of IMSS (Spanish acronym for Mexican Social Security Institute). The study used a non probabilistic sampling of consecutive cases including patients eligible for surgery with a posterior approach to correct the spine deformity regardless of etiology, instrumentation used, and patient age and gender.

Based on this, patients were divided into 2 groups: Group A with patients where the spine posterior ligament system was resected. They had been operated before 1999 and Group B, where patients had their ligament system spared having been operated beginning 1999 with a surgical technique involving a traditional approach of skin and subcutaneous cell tissue, where two longitudinal incisions were made: one to the right and the other to the left. Each incision was 3-5 mm from the vortex of the spinous process. This was done to spare the ligament system between spinous processes. Through these incisions parallel to the midline, one can approach the lateral surface of the spinous processes. From there, it is possible to continue dissecting subperiosteally in a conventional fashion. The lumbodorsal fascia is incised in the lumbar region while the incision of the chest region is made over the trapeze muscle. Subperiosteal dissection is done to the transverse processes for a basically joint and transverse arthrodesis. Here, the instrumentation is placed more laterally than with a conventional technique.

Figure 1. Lateral postoperative X-ray of the instrumentation cephalic end showing a kyphotic deformity.

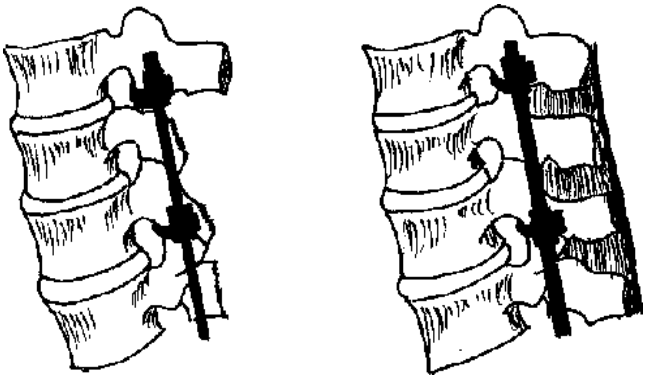

Figure 2. Schematic showing the technique involving resection of the ligament system and the technique sparing of the ligament system.

After completing the procedure, the wound is rebuilt by suturing the right side and the left side to the midline separately and at the end, the subcutaneous cell tissue and skin in the usual manner.

X-ray measurements pre- and postoperatively were performed looking for kyphosis on the instrumentation cephalic end through the Cobb method on the lateral projection of the surgically managed spine for both groups with a follow up of no less than 24 months. In accordance with Guy A. Lee and R. Betz et al.4 a curvature of at least 5 degrees was considered as a kyphotic deformity. In each case we recorded the cephalic level reached by the instrumentation, the type of implants used, and the kyphosis limits.

In each group, a total of 37 patients were subjected to a complete X-ray work up.

Descriptive statistics was done by simple frequencies and measurements of central trends and dispersion for the study variables. Inferred statistics was also applied to learn the difference between groups, using the Fisher's exact test for the kyphosis variable and the gender. The chi^2 test was used for etiology and the type of instrumentation; and Mann-Whitney's "U" test was used for age and pre- and postoperative degrees of kyphosis.

Results

The mean age of patients with ligament system spared was 13 years (9 to 28 years) while in patients with no ligament system spared it was 14 years (7 to 27 years) with $p = 0.879$. The group where the ligament system was spared was made by 27% males and 73% females, while the group with no ligament system spared was 43% males and 57% females respectively ($p = 0.223$). The prevailing etiology in the group with ligament system spared was idiopathic scoliosis (70%) followed by Scheuermann disease (16.2%), neuromuscular scoliosis (8.1%), neurofribromatosis and congenital scoliosis (2.1%). On the other hand, the group of patients without their ligament system spared had idiopathic scoliosis (62.2%), Scheuermann disease (13.5%), neuromuscular scoliosis (10.8%), spine tumor (5.4%), post-traumatic scoliosis (2.7%), and neurofibromatosis (5.4%) with $p = 0.576$.

The type of instrumentation used in patients with ligament system spared included Luque bars (54%) and Harrington rods (46%). In patients where the ligament system was not spared Luque bars (70.9%) and Harrington rods (21.5%) were used. The TSRH (5.4%) and USS (2.7%) systems were also used ($p < 0.001$). Predominant fusion levels were C7 to T5 (range C3 to L2). Preoperative kyphos in patients having their ligament system spared was 17° (meadian) and 10-75° (quartile 25-75) while in patients with no ligament system, it was 20° ranging from 12 to 26.5° ($p = 0.974$). Postoperative kyphos in patients with ligament system were 20° (median) ranging between 11.5 to 30° (quartile 25-75) and for patients with no ligament system, 25° ranging between 17 and 39° with a significant difference ($p = 0.037$ and an average 30 month follow up.

Figure 3. Lateral X-ray with instrumentation where it was possible to examine the site with a dye since the interspinal pathway is free.

Finally, there were 7 (18.9%) patients with ligament system developing kyphosis of at least 5° and 24 (64.9%) patients with no ligament system spared. The difference was statistically significant ($p < 0.001$).

Discussion

Kyphotic deformities developing in the instrumentation cephalic end were studied by Guy A. Lee, R. Betz et al.[4] in patients after surgery for idiopathic scoliosis to determine the prevalence of kyphosis. These authors reported 46% of patients developing this complication (32 of 69 patients). None the less, these authors did not focus on studying the cause for such deformity and they dared to suggest that if the preoperative lateral X-ray shows a segmented kyphosis with more than 5° on the site selected for the more cephalic implant, fusion should be taken to a more cephalic level of the site determined.

Lowe and Kasten[5] studied the correction of kyphotic deformities due to Scheuermann disease using Cotrel-Dubousset instrumentation. They mentioned the development of the kyphotic deformity proximal to the instrumentation as one of the complications observed and recommended to spare the ligament system as an action to prevent such complication. However, in their paper, they

do not specify whether such action was performed in the patients they studied.

In our research, when the ligament system was not spared, the incidence of kyphosis proximal to the instrumentation was 64.9% or 24 of 37 cases. When we spared the ligament system, the incidence decreased since we saw it in only 7 of 37 patients. This is equivalent to 18.9% with highly significant differences. The results are not influenced by age, gender or etiology. No statistical differences were seen meaning both groups were homogenous and comparable to each other except for the kind of instrumentation which did show statistical differences. This was so because of the instrumentation used for the spine. In the 1980s we used Harrington rods and sublaminar wiring. After that, Luque smooth rods and wires. At present, we are using the Universal Spine System and TSRH. It is important that we conduct a new study in the future comparing the same kind of instrumentation to increase their internal validity.

We included patients of any etiology such as idiopathic scoliosis, neurofibromatosis scoliosis, Scheuermann disease, vertebral tumor, post-traumatic scoliosis, and congenital and neuromuscular scoliosis. We felt that regardless of the cause of the primary deformity, secondary kyphosis in the instrumentation cephalic end is caused by the actual surgical procedure since the area operated is left with no ligament union to the normal adjoining area.

The first impression in terms of the level reached by the instrumentation is to think that the higher (more cephalic) the levels the greater the possibility for kyphosis to develop as a result of absent costal arches. However, when comparing both groups, the opposite can be seen, namely in Group A the higher incidence of the deformity was found at the cephalic level and the instrumentation was placed preferably between T2 and T4 while in Group B with a lower development of kyphosis the instrumentation was more frequently placed at the T1-T3 level.

A fact that should not be underestimated is the preservation of an access pathway into the epidural space for future anesthetic and diagnostic procedures. Most patients who undergo surgical procedures to correct deformities are teenagers and many are females who in the future will become pregnant requiring anesthesia or analgesia in labor. Hence, unless the epidural space access is preserved, we are eliminating a significant possibility for diagnostic and anesthetic procedures. *(Figure 3)* Likewise, we should emphasize that symptoms in such kyphotic deformities are not painful to the patient.

Based on the results from this study, it is extremely important to preserve the dorsal ligament system and spinous process in patients who underwent a posterior surgical approach to the spine with metal implants for correction or stabilization, without undermining arthrodesis (more laterally) and with the reconstruction of the surgical wound in a more anatomical fashion so that the access to the peridural or subdural space in the future is preserved. Obviously, we must not overlook the need for a longer follow up on patients studied in this research to consolidate the information reported here.

Conclusion

Sparing the epispinal and interspinal ligaments and the spinous processes in a posterior approach with spine instrumentation, significantly contributes to decreasing the development of kyphotic deformities of the instrumentation cephalic end compared to patients where the ligament system was not spared.

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