



SCHEUERMANN' S KYPHOSIS

SCHEUERMANN KİFOZU

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SUMMARY:

Scheuermann's kyphosis is a spinal deformity associated with an increase in thoracic kyphosis due to the growth spurt that occurs in the prepubertal and adolescent periods. Hyperkyphosis, hyperlordosis, apparent gibbosity in forward bending, hamstring stiffness or contracture and pain are the general characteristics of the disease. It is a progressive and symptomatic deformity. A treatment decision in Scheuermann's kyphosis depends on the severity of the deformity, the age of the patient, and the accompanying symptoms. According to evidence-based studies, physical therapy alone is unable to correct the deformity. There is no consensus on the indications for surgical treatment of the disease. There is an ongoing debate whether treatment of the deformity in the absence of neurological deterioration is cosmetic or vital. The aim of this review study is to increase the understanding of Scheuermann's kyphosis by contributing our experience while considering data from the literature, and to suggest an ideal treatment algorithm.

Key-words: Scheuermann's Disease, kyphosis, corset, surgical treatment

Level of evidence: Review article, Level V

ÖZET:

Scheuermann kifoza, puberte öncesi gelişen ve adölesan dönemdeki büyüme patlaması ile daha da belirginleşerek torakal kifozda artış ile seyreden bir omurga deformitesidir. Hastalık, genellikle normal torakal kifozda ve lomber lordozda artış, öne eğilme ile daha da belirginleşen kamburluk, hamstringlerde gerginlik veya kontraktür ve genellikle ağrı ile seyreder. Deformite ilerleyicidir ve hastalığın seyri sırasında semptomatik bir hal alır. Scheuermann kifozunda tedavi kararı deformitenin şiddetine, hastanın yaşına ve eşlik eden semptomlara göre verilir. Scheuermann kifoza olan hastalarda tek başına fizik tedavi uygulamanın deformitenin düzelmesi yönünde bir etkisi olduğu yapılan çalışmalarda gösterilememiştir. Hastalığın cerrahi tedavisi ile ilgili endikasyonlar açısından ise tam bir görüş birliği yoktur. Deformiteye bağlı nörolojik statüde bozulmanın yokluğunda Scheuermann kifozunun tedavisinin kozmetik bir cerrahi mi yoksa yaşamsal bir tedavi mi olacağı konusundaki süregelen tartışma da halen devam etmektedir. Bu derleme çalışmasının amacı, Scheuermann kifozunun tedavisi ile ilgili güncel literatür bilgileri ışığında kendi klinik tecrübelerimizi de aktararak hastalığın daha iyi anlaşılmasını sağlamak ve ideal bir tedavi algoritması oluşumuna katkıda bulunmaktır.

Anahtar kelimeler: Scheuermann Hastalığı, kifoz, korse, cerrahi tedavi

Kanıt düzeyi: Derleme, Düzey V

INTRODUCTION:

Scheuermann's kyphosis is a spinal deformity associated with an increase in thoracic kyphosis due to the growth spurt that occurs in the prepubertal and adolescent periods². Scheuermann's kyphosis generally emerges with the appearance of normal thoracic kyphosis in the period of puberty, and is usually diagnosed late as families often attribute this deformity to posture disorder²⁴. The rate of incidence of this disease varies between 0.5% and 8% in different sources in the literature. It has been reported that the incidence rate is higher in the male population⁶. Due to differences in the criteria for study inclusion, there have been varied rates of incidence between the genders published. While there have been studies that have reported the same rate of incidence for both genders, other studies have reported an increased incidence rate in males.

ETIOLOGY:

Scheuermann suggested that the reason for kyphosis was apophysial osteonecrosis of vertebral bodies, in his paper first defining the disease³³. Bick and Copel reported that apophysial osteonecrosis is found outside of the real cartilage physis and so has no effect on the longitudinal growth of vertebrae, and therefore they stated that Scheuermann's suggestion was wrong⁸. In 1930, Schmorl stated that increased pressure in the vertebral anterior depended on reduction of the intervertebral disc distance due to herniation of the disc content to the vertebral body in vertebra wedging, and irregularities of endochondral ossification in the vertebral end-plates³⁴. Schmorl nodules are seen in vertebrae outside of the kyphosis area of patients with

Scheuermann's kyphosis, and they are also randomly detected in thorax.

X-rays of a normal population²⁹. In recent years, endochondral ossification irregularities in vertebral end-plates, a decrease in the collagen amount and an increase in the mucopolysaccharide amount have been detected in histopathological examinations performed on vertebrae of patients with Scheuermann's kyphosis. These publications support the suggestion that endochondral ossification irregularities in the vertebral end-plates caused by a collagen accumulation defect are responsible for the etiology of Scheuermann's kyphosis⁷. This situation can result in wedging in the vertebral body and an increase in kyphosis angle.

In the etiology of Scheuermann's kyphosis, it has been accepted that genetic, hormonal, and mechanical factors can have effects⁵. Halal et al. examined the patterns of genetic transmission in five families with a high incidence rate of Scheuermann's kyphosis¹⁴, and showed the presence of an autosomal dominant transmission pattern^{14,18}.

Ascani et al. observed that patients with Scheuermann's kyphosis were taller than average, their skeletal ages were ahead of their calendar ages, and there was an increase in their growth hormone levels⁴.

The place of mechanical factors in the etiology of Scheuermann's kyphosis is controversial. In the literature, there are studies reporting that repetitive heavy physical activities done at an early age can cause changes in the skeletal structure and increase deformity. These articles report that deformity caused by heavy physical

activity is related to thoracolumbar and lumbar Scheuermann's kyphosis³⁵.

Bradford suggested that juvenile osteoporosis was responsible for the development of Scheuermann's kyphosis¹⁰. In a study carried out by Gilsanz et al. using computerized tomography, they found no significant difference in terms of vertebral osteoporosis between patients exposed to trauma and patients with Scheuermann's kyphosis¹⁶. Although a cause-and-effect relationship has not been proven, Scheuermann's kyphosis is commonly associated with inflammatory diseases, neuromuscular diseases, hormonal pathologies, dural cysts, spondylolysis, Perthes disease, polio, and hypovitaminosis (avitaminosis)⁵. Moreover, mild and moderate forms of scoliosis can be observed in 30% of patients with Scheuermann's kyphosis².

NATURAL COURSE:

The natural course of Scheuermann's kyphosis can vary due to the age of the patient and the severity of the deformity. It is a progressive and symptomatic deformity. Murray et al. published the long-term results of the natural course of patients with Scheuermann's kyphosis who received no treatment²⁷.

Although rapid progression is known to occur in deformity during puberty, it is not known whether this progression continues after the completion of bone development. It has been argued that thoracic curvatures over 80° and thoracolumbar curvatures over 55° show progression after the completion of bone development²⁴.

Ponte et al. reported that curvatures of more than 45° showed further progression in puberty and continued to progress after 30 years.³⁰ In many articles, it has been reported that untreated curvatures of more than 45° showed further progression in adulthood, caused pain, were associated with an increased risk of cardiopulmonary failure development, and that patients were not comfortable about their physical appearance^{9,37}. Sorensen stated that back pain developed at a rate of 50% in adolescence, and this rate regressed to 25% in adulthood³⁶.

The incidence of spondylolysis and spondylolisthesis in patients with Scheuermann's kyphosis is higher than the normal population²⁸. The incidence of spondylolysis in these patients is 50%, and this increase is thought to be due to the exposure of the pars interarticularis to increased pressure based on lumbar hyperlordosis²⁸.

The mean follow-up period and kyphosis angle of the 67 disease cases were 32 years and 71°, respectively. Although there were back pain complaints in 61% of the patients (15% of the control group), it was found that this pain did not significantly affect their social lives when compared to the control group. As a result, Murray reported that patients adapted to this condition, and concluded that Scheuermann's kyphosis follows a benign course and surgical treatment should only be applied after a very thorough evaluation²⁷.

Detailed neurological examination of patients with Scheuermann's kyphosis should be performed. Although neurological findings are quite rare, cord compression due to reasons such as thoracic discopathy, dural cysts, or extreme deformity can be observed²⁷. It has been stated

that the development of cardiopulmonary failure is quite rare. Murray et al. found that the incidence of restrictive pulmonary diseases increased for curvatures of more than 100°²⁷.

CLASSIFICATION:

Although Scheuermann's kyphosis was initially defined as a disease that only affected the thoracic vertebrae, it was subsequently detected that can also affect the thoracolumbar and lumbar regions². There are two forms of Scheuermann's kyphosis: the commonly seen thoracic type, where the peak point is between T7–9, and the thoracolumbar type, where the peak point is between T10–12⁵. Hyperkyphosis, hyperlordosis, apparent gibbosity in forward bending, hamstring stiffness or contracture and pain are the general characteristics of the disease². Although pain is one of the most commonly seen symptoms, its severity increases with sitting, standing for a long time and heavy physical activity. Although pain generally decreases with the cessation of bone growth, severe back pain is commonly seen in adults with advanced deformities and untreated Scheuermann's kyphosis¹⁵.

CLINIC:

Scheuermann's kyphosis begins at an average of ten years of age, in the period before puberty. There are no cases in the literature where radiological findings of Scheuermann's kyphosis were detected before the age of ten. Sorensen defined the criteria to be used in the radiological diagnosis of Scheuermann's kyphosis as anterior wedging of more than 5° in three or more consecutive vertebrae at the peak point of curvature³⁶. Accompanying radiological findings are vertebral end-plate irregularities,

contraction of the intervertebral disc distance and Schmorl nodules. A flexion test is useful for distinction from postural kyphosis. When the neck is in extension, kyphosis becomes clearer during front flexion in Scheuermann's kyphosis, while the kyphosis recovers after this test with postural kyphosis.

On physical examination, compensatory cervical and lumbar hyperlordosis is observed in patients with Scheuermann's kyphosis. Tension in the hamstrings is generally detected in a physical examination due to an increased pelvic tilt caused by lumbar hyperlordosis.

TREATMENT:

Conservative treatment:

A decision regarding treatment of Scheuermann's kyphosis is made according to the severity of the deformity, the age of the patient and the accompanying symptoms (pain, paraparesis)². Patients who do not have complete bone growth, have a kyphosis angle under 50° and have no finding of progression in deformity should be followed up by taking standing lateral X-rays at 4–6 month intervals and their progress should be recorded^{1,15}. There is no need for follow-up in patients who have complete bone growth¹.

Although physiotherapy has been suggested in the early periods of the disease, this serves no function other than increasing muscle tone and recovering posture. Although it has been shown that postural exercises are useful for the removal of pain and curvatures due to postural kyphosis, studies have not shown that physiotherapy alone has any effect on the recovery of deformity in patients with Scheuermann's kyphosis². Exercise, corset treatment or plastering have been suggested as complements

to more aggressive treatments⁵. The aim of physiotherapy is to provide flexibility, recovery of lumbar hyperlordosis, and to strengthen the extensor muscles of the vertebrae. If tension in the hamstrings and pectoral muscles is detected during physiotherapy, exercises for these should be planned. Weiss et al. published the long-term results of 351 patients who had Scheuermann's kyphosis with pain and were followed up with physiotherapy. In this study, a 16–32% decline in the pain levels of the patients were detected after physiotherapy²³.

In cases where the kyphotic curvature (kyphosis angle) is over 50° or for patients where a progression of deformity is detected in regular follow-up, other treatment methods should be considered. Corset treatment is an effective method that can be used for patients whose kyphosis angle is less than 75° and who have not completed bone growth¹⁹.

It should be ensured that the kyphotic deformity is flexible and the patient has sufficient growth potential (at least one year) before corset treatment³. In patients with completed bone growth, there is no place for corset treatment because the curvature does not change the progression course or prevent the development of symptoms². In thoracic Scheuermann's kyphosis, the most commonly seen Scheuermann's kyphosis, use of TLSO corsets cannot provide sufficient force to correct curvature, due to the presence of the peak point of curvature at T8 or higher levels¹.

In patients with thoracic Scheuermann's kyphosis, a Milwaukee corset is used in treatment. Good results have been reported with the use of Milwaukee corsets for flexible curvatures with an angle of more than 60°. Successful results

have not been obtained using a corset for cases with greater degrees of curvature, with more than 10° of vertebral wedging and in patients with completed skeletal development¹. The Milwaukee corset applies corrective forces to the thoracic spine from three points and helps to provide a negative sagittal balance⁴¹. Evidence in the literature regarding corset treatment is provided by studies that are retroactive, have different work criteria, and no control groups. Despite all these deficiencies, a corset is often used in the treatment of Scheuermann's kyphosis, and better results are reported for properly-selected patients.

A significant correction of deformity has been observed after corset use for an average of 12–18 months full time (22 hours per day), with subsequent use for an average of 18 months part time (12 hours per day)^{26,32}. During treatment, the corset can be gradually adjusted for further correction of deformity. It has been shown that allowing patients to exercise for 2–4 hours per day without the corset does not cause progression in curvature and increased adaptation to the corset⁴⁰.

Bradford et al. showed 49% and 35% correction in early thoracic kyphosis and lumbar kyphosis, respectively, for patients using a Milwaukee corset full time for an average of 14 months, followed by part-time use for an average of 18 months⁹. Although some loss of correction in the long-term results was observed, the correction of kyphosis angle was shown to be 69% for the patients after treatment. No good results were obtained with corset treatment for patients whose kyphosis angle was greater than 75°, who had more than 10° of wedging in the vertebral body, and who had completed bone growth. Sachs et al. published the long-term

results of 120 Scheuermann's kyphosis patients who were treated with Milwaukee corsets and then followed up for at least five years³². In this study, the average age of the patients was 12 years and 5 months at the beginning of the treatment, and 16 years and 1 month at the end of the treatment. Decline was detected in 76 patients (69%) in terms of the kyphosis angle at the end of the corset treatment and at the last follow-up. Progression of the kyphosis angle was detected in 24 patients, and no change was observed in ten patients.

Surgical treatment was applied to seven patients who showed progression of the kyphosis angle. At the beginning of the treatment, corset treatment failed for 30% of the patients with a kyphosis angle of more than 75°, and spinal fusion was applied³².

Although it was shown that a Milwaukee corset prevented progression of the deformity and provided correction of the kyphosis angle, low patient adaptation to full-time corset use has been reported. Therefore, modified Boston and modified Milwaukee corsets were also used for treatment due to the low adaptation of patients to the Milwaukee corset, and successful results were obtained¹⁷.

Montgomery et al. published the results of a study on 39 patients with Scheuermann's kyphosis who used a modified Milwaukee corset. The kyphosis angle, which was 62° before the treatments, declined to 41° after full-time corset use for 18 months. 18 months after the cessation of corset use, 15° correction loss was detected on follow-up. It was shown that vertebral wedging regressed from 7.9° to 6.8°²⁶.

Gutowski and Renshaw reported that 27% curvature correction could be obtained using a Boston corset for kyphotic curvatures of less than 70°, with high patient adaptation (Boston corset 61%, Milwaukee corset 29%)¹⁷.

Although good results have been reported with hypertension plasters, they are not preferred, as they cause skin problems, limit physical activity and require frequent changing¹⁵.

In evaluating our clinical experience and the literature, we consider that corset treatment should be used for patients who have not completed skeletal development and have a flexible kyphotic curvature. Patients Should be instructed to do stretching exercises each day for two hours without the corset, in order to maintain their flexibility.

Surgical Treatment:

There is no consensus regarding the indications for surgical treatment of Scheuermann's kyphosis. Decisions as to the surgical indications and which surgical method is appropriate have shown changes over the years. Initially, while surgical treatment was suggested for painful deformities, opinions have emerged recently regarding surgery for patients experiencing pain who have not responded to conservative treatment⁴¹.

Surgical treatment is suggested for adolescents with a kyphosis angle of more than 70° and patients with progression of deformity despite corset treatment, persistent back pain, or a cosmetically unacceptable deformity²⁵.

Moreover, Tribus stated that surgical treatment should be considered for Scheuermann's kyphosis

patients when pain, progression of deformity, neurological disorders, cardiopulmonary disorders and cosmetic problems emerge. The only certain indication of surgery is the development of neurological deficit³⁸. Lowe has suggested that a lateral hyperextension X-ray of the patient should be evaluated when considering the surgical treatment to be applied²⁵. If the kyphosis angle does not regress to less than 50° in hyperextension, the application of combined antero-posterior surgery is suggested, while if the kyphosis angle regresses to a degree less than 50°, only posterior instrumentation and fusion is suggested. Speck and Chopin stated that posterior instrumentation gave successful results in the patients who had not completed bone growth, but that combined antero-posterior surgery was required for the patients who had completed bone growth³⁷.

Anterior release can be applied by open thoracotomy, a thoracoabdominal approach, or thoracoscopy. The need for anterior release decreases after pedicular screw correction, and even advanced deformities can be successfully treated with posterior instrumentation¹. Moreover, it has been reported that complications such as hemothorax, pneumothorax, pleural effusion, infection of the wound site and paraplegia have occurred in patients who received antero-posterior fusion for Scheuermann's kyphosis²³.

In most Scheuermann's kyphosis patients, successful results have been reported after only posterior instrumentation and fusion. Also, studies have suggested that the application of anterior release can be useful to provide sufficient flexibility of rigid deformities with more than 100°. Lee et al. published the two-year follow-up results of posterior instrumentation and combined antero-posterior surgery, and

reported that better correction was provided using posterior instrumentation, and fewer complications developed²⁰.

If posterior instrumentation alone is applied in rigid deformities, it has been suggested that Ponte or Smith-Peterson osteotomies should be applied at the peak point of kyphosis¹.

The decision to use pedicular screws or hybrid systems in the instrumentation is made by the surgeon. In a study on this issue performed in our clinic, 30 patients with Scheuermann's Kyphosis were divided into two groups, and 15 patients received posterior fusion using a hybrid system (laminar grapple and pedicular screw) while 15 patients received posterior fusion using only pedicular screws¹¹.

In the group that received the hybrid system, the average kyphosis angle was 78° before surgery, 45° after surgery, and 57.4° at the last follow-up. For the second group, the average thoracic kyphosis value of the patients instrumented with pedicular screws decreased from 80° to 41.7° in the early period after surgery, and was measured as 45.5° at the last follow-up. When the two groups were compared, the results of the second group were better than the first group in terms of the protection of the deformity correction rates in the early period after surgery, and it was emphasized that the patients in the hybrid group should be tracked to monitor correction loss. In another study carried out in our clinic, the results of 16 patients with Scheuermann's kyphosis who received posterior instrumentation and fusion using pedicular screws were published³⁹. The average kyphosis angle of the patients was 80.4° before surgery, and this regressed to 42.4° after surgery.

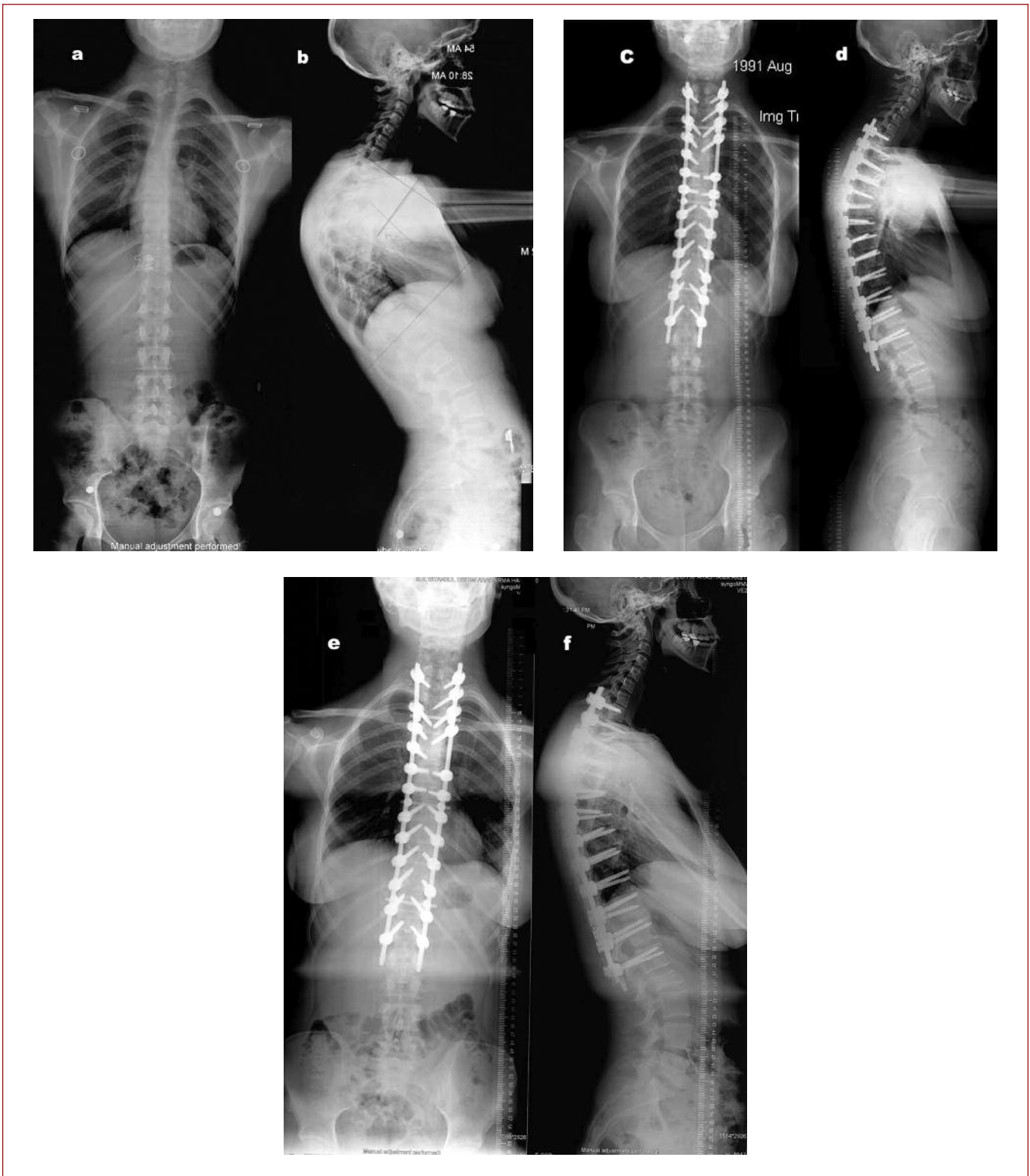


Figure-1. a. Antero-posterior and b. lateral X-rays of an 18-year-old female patient before surgery, c. Antero-posterior and d. lateral X-rays of the same patient after surgery, e. antero-posterior and f. lateral X-rays at last follow-up

In the last follow-ups, the average kyphosis angle was found to be 45.7°, and the correction rate was reported to be 43.3% (Figure- 1,2,3)³⁹.

The aim of surgical treatment in Scheuermann's kyphosis is to raise the thoracic kyphosis angle as close as possible to the limit of the normal thoracic kyphosis angle (40–50°). Excessive correction of deformity can lead to neurological complications, sagittal alignment disorder and proximal junction kyphosis. In the literature, complications such as neurological deficit development, infection, pseudoarthrosis, implant failure, gastrointestinal obstruction, correction loss, hemothorax and pneumothorax have been reported after Scheuermann's kyphosis surgery⁴¹.

Lowe and Kasten suggested that a correction that did not exceed 50% of the kyphosis angle was required before surgical treatment, and reported that sagittal alignment was disrupted after surgery for cases where the kyphosis angle was less than 40°, which could lead to junction kyphosis²². In the literature, rates of junction kyphosis development of 68% were reported for surgery of Scheuermann's kyphosis performed with a Luque system¹³. The choice of the fusion levels during surgery is important in order to prevent complications that can develop after surgery. The proximal point of fusion should extend to the proximal end of the vertebra that is used for measurement of the kyphotic deformity. There is no consensus on which distal vertebra fusion should extend to. The general view is that fusion is required to extend distally of the lordotic disc in order to prevent junction kyphosis²². In some articles, it has been reported that fusion should be extended to the second lordotic disc³¹, L1⁵, or distal to the sagittal stable vertebra¹². However, no association has been

found between pain reduction and deformity correction rate⁴¹.

CONCLUSION:

The treatment decision in Scheuermann's kyphosis is made according to the severity of the deformity, the age of the patient, and the accompanying symptoms. Patients who have not completed bone growth, have a kyphosis angle under 50° and have no findings of deformity progression should be followed up by taking standing lateral X-rays at 4–6 month intervals, and their progress should be recorded. It has been suggested that surgical treatment should be considered for adolescents with a kyphosis angle of more than 70°, for patients with progression of deformity despite corset treatment, in the presence of persistent back pain, and for patients with cosmetically unacceptable deformities and cardiopulmonary disorders due to kyphosis. Taking these data into account, the discussion about whether the treatment of Scheuermann's kyphosis in the absence of disruption in neurological status is a cosmetic surgery or a vital treatment seems to be carried forwards by spinal sciences, and further research on this subject can be expected.

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