Scoliosis in growing rabbits induced with an extension splint

Mikko Poussa, Dietrich Schlenzka and Veijo Ritsilä

An external splint was applied to 49, 6-week-old rabbits to induce lordosis in the thoracolumbar junction. The splint was retained for 8 weeks, and the animals were killed after 6 months. Scoliosis developed in 23 rabbits during the splinting period. The deformity occurred above the thoracolumbar junction, and was more frequent in rabbits whose lordosis was sustained when the splint was removed after 8 weeks. The results support the view that sagittal changes are primarily or secondarily involved in the pathomechanics of scoliosis.

The Orthopedic Hospital of the Invalid Foundation, Tenholantie 10, SF-00280 Helsinki, Finland
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Scoliosis has been induced in growing animals by various methods. Michelsson (1965) produced scoliosis in young rabbits and pigs by severing the costotransversal ligament, and Hakkarainen (1981) induced scoliosis in very young rabbits by creating a "myostatic contracture" and a subsequent curvature concave to the shortened musculature. Michelsson (1965) claimed that lordosis was more common in the thoracic spine and kyphosis in the lumbar spine. In the studies of Hakkarainen (1981), an apparent kyphosis appeared at the apex of the scoliosis. In his many publications, Dickson (1984) has emphasized the importance of apical lordosis in the pathomechanics of scoliosis. In his animal model, however, apical asymmetric lordosis was created with nylon sutures and electrocoagulation.

We have studied the ability of an external splint to effect lordosis in the thoracolumbar spine of a growing rabbit and have sought to establish whether any deformity arises during the rapid growth period.

Materials and methods

Forty-nine, 6-week-old rabbits were fitted with an external dorsal splint to produce lordosis of the thoracolumbar spine. During the application of the splint, the animals were anesthetized with Hypnorm® (Philips, Duphar) 0.5 mL/kg; the splint was fixed with adhesive tape (Figure 1). Radiographs in AP and lateral projections were taken before and immediately after splitting; after 1, 2, 3, 4, 6, 8, and 12 weeks; and after 6 months, when the animals were killed. The splint was removed after 8 weeks. At radiography, the animals were under anesthesia with the splint left on. When necessary, the splint was exchanged, mostly because of growth changes or poor fitting. The angles of scoliosis and kyphosis-lordosis were measured according to the Cobb method.

Results

For technical reasons, 6 rabbits were excluded from the material. Of the 43 included, 23 developed scoliosis greater than 10°, with a mean of 47° and a maximum of 110°. In the 14 rabbits that had developed a thoracolumbar lordosis after 8 weeks, 12 had established scoliosis at 6 months. Of the 29 kyphotic rabbits, 11 developed scoliosis.

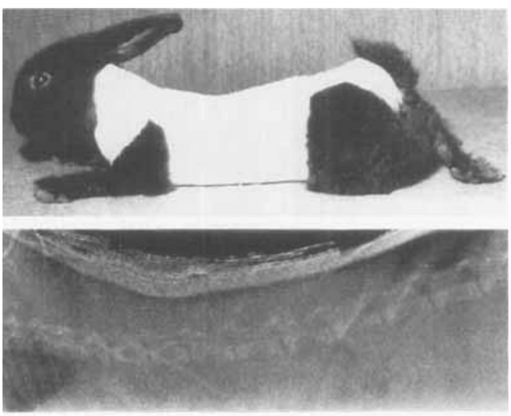


Figure 1. A 6-week-old rabbit with an external lordotizing splint and the corresponding lateral radiograph.

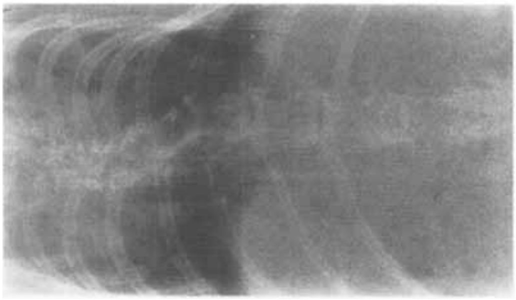


Figure 2 A. Rabbit No. 8 after 6 weeks with the splint. The PA radiograph shows a left convex thoracic curve with the apex at Th-8.

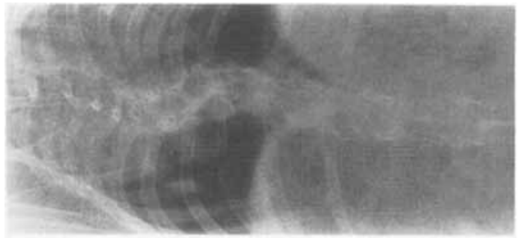
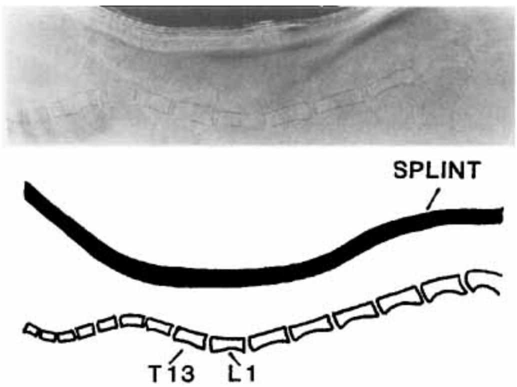


Figure 3 A. Rabbit No. 8 after 12 weeks. The PA radiograph shows a structural lateral curve in the thoracic spine with the apex at Th-8.



Figures 2 B and C (drawing). Corresponding lateral radiograph shows lordosis at the thoracolumbar junction and secondary lordosis with the apex at Th-8.

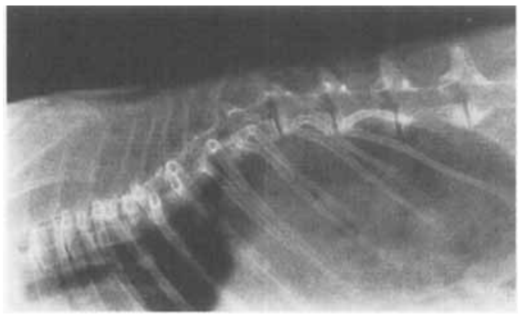


Figure 3 B. The lateral view shows thoracic lordosis with the apex in the Th-8 region.

The maximum scoliosis in the lordosis group was 110° and in the kyphosis group 46°. The correlation between the magnitude of lordosis in the thoracolumbar junction and the resulting scoliosis was r = 0.59. The scoliosis usually developed above the lordosis; the lordosis was initially at the Th-13–L-1 level; and after 2–6 weeks when the scoliotic curve appeared, the apex of the scoliosis was at the Th-7–Th-8 level, where a secondary lordosis was noted. When this curve progressed, secondary curves developed above and below the primary curve (Figures 2 and 3).

Discussion

Several procedures are described in the literature by which scoliosis can be induced experimentally in growing quadruped animals. The majority of these procedures involves division of muscles, ligaments, intercostal nerves, or ribs and transverse processes (Bisgard 1935, Swartzmann and Miles 1958, Michelsson 1965, Alexander et al. 1972). A growth disturbance induced by epiphysiodesis (Berquiristan et al. 1980) or local fusion (Ritsilä and Alhopuro 1975) also results in scoliotic deformities in growing animals. However, none of these procedures can be considered relevant to studies of the pathomechanics of idiopathic scoliosis. On the contrary, Karaharju (1967) and Snellman (1973) demonstrated that scoliosis induced by such methods has a tendency to correct itself by stimulating bone growth on the concave side.

The concept of rotated lordosis in the pathomechanism of scoliotic deformities has been put forward by the British authors Somerville (1952), Roaf (1958), and Dickson (1984). According to Dickson (1984), a scoliotic deformity is a rotated lordosis, as evidenced by experimental models in which asymmetric lordosis was induced using bands and electrocautery.

In our model, lordosis was induced by external means, and the apex was always located at the thoracolumbar junction. However, after 2 weeks, a secondary, and apparently more mobile, lordosis developed above this level: namely, at the site where the scoliotic deformity then appeared. It can be assumed that this mobile lordosis is the prerequisite for the development of scoliotic deformities.

There was no consistency in the directions of the convexities, implying that rotational asymmetry, as in growing human beings, does not occur in the lordotic spine of the rabbit (Mellin et al. 1988). Moreover, some rabbits that had kyphosis despite splinting also developed scoliosis. The reason for this may be that the splint, by immobilizing the thoracolumbar junction, has the secondary effect of increasing mobility in the thoracic spine, thus causing scoliosis. However, further study is still required.

The results of our experiment support the view that lordosis is a prerequisite for the development of scoliosis in rabbits. From our radiographic data, we could not conclude whether or not rotation or lateral deviation occurred first; possibly, they occur simultaneously, as would be expected to happen in human idiopathic scoliosis.

The curve patterns in the thoracic spine of rabbits were not like those in human idiopathic scoliosis. They were, however, reminiscent of patterns observed by Hakkarainen (1981), indicating that a deformity after splinting in the coronal or sagittal plane results in a similar type of spinal deformity, which is also called scoliosis. This can be interpreted as reflecting that the same kind of coupling in the pathomechanism of scoliosis occurs in rabbits as has been suggested to occur in human beings (White and Panjabi 1978), i.e., induction of either lordosis or lateral deviation in the spine results in the same type of scoliotic deformity.

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