EXPERIMENTAL PROGRESSIVE SCOLIOSIS IN THE RABBIT

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"It is indeed unfortunate that our knowledge of the causes of scoliosis has not gone much beyond the observational stage: we know little more about it than what clinical and x-ray examination reveal." These words were written by Steindler in 1955. Although there has been considerable development of methods in the treatment of scoliosis, this condition can still be called the crux orthopaedica. As studies of scoliosis in man have not given us any idea of its pathogenesis, many authors have tried to elucidate the problem by animal experiments. However, in all the series of experimentally provoked scoliosis described in the literature the deformities have been slight. It appears that deformities corresponding in severity to the scoliosis which causes real disability in man have not been produced. So far, therefore, little light has been shed on the problems of scoliosis by such experiments. The experimental work done, however, has not been very systematic and there is still reason to agree with Arnd (1903): "In all other fields within the scope of surgery it is by experiment that a decision as to the correct form of therapy has been reached. It is to be hoped that the study of scoliosis may also reap some benefit from work of this kind."

Slight scoliosis has been provoked in animals in several ways: 1) Excision or denervation of muscles (Lesser 1888, Arnd 1903, Schwartzmann and Miles 1945, Miles 1947). 2) Resection of ribs (Bisgard 1935). 3) Fixation of vertebrae or ribs to each other (Wullstein 1902, Müller 1928, Pitzen 1927). 4) Operations on growth zones of vertebrae (Haas 1939, Pacher 1939, Nachlas and Borden 1951, Moser 1956). 5) Radiation (Engel and Richer 1939, Arkin and Simon 1950).
The importance of the force of gravity and the erect posture of man in the pathogenesis of scoliosis has often been stressed. The force of gravity does not act on the spine in the same way in animals as in man. This may have led some workers not to expect the production of severe scoliosis by animal experiment. It is known, however, that severe paralytic scoliosis may develop even during a period of continuous recumbency. In view of this fact the authors in undertaking this experimental work were convinced that it would prove possible to provoke severe progressive scoliosis in animals as a result of systematic experimental research.
OPERATIVE PROCEDURES AND RESULTS

The series of experiments planned included unilateral operations on all structures in the vicinity of the spine, but not on the vertebrae themselves. The operations were done on young rabbits.

Procedures not provoking scoliosis—The following procedures did not provoke any degree of scoliosis: section of the phrenic nerve; transposition of the rhomboid muscles to the ribs of the same side; transposition of the rhomboid muscles to the ribs of the contralateral side; transposition of the trapezius and the rhomboid muscles to the ribs of the contralateral side; electro-coagulation of the anterior growth zones of the sixth to eleventh ribs; excision of the sixth to eleventh costo-transverse muscles.
Procedures sometimes provoking scoliosis—The following procedures provoked slight and often transient scoliosis in some of the animals: 1) Excision of the erector spinae muscle from the pelvis to the upper thoracic region. Of nineteen animals, marked scoliosis developed in three, the maximum being a lumbar scoliosis of 35 degrees. 2) Section of the sixth to eleventh ribs and the corresponding intercostal nerves and arteries. Of eleven animals, marked scoliosis developed in three, the maximum being a thoracic scoliosis of 60 degrees. 3) Section of the seventh to twelfth intercostal nerves. Of nine animals, marked scoliosis developed in two, the maximum being a transient scoliosis of 30 degrees. 4) Tying together of the transverse processes of the sixth to eleventh thoracic vertebrae with nylon thread. Of twenty-eight animals, marked scoliosis developed in fourteen, the maximum being a scoliosis of 90 degrees.

Procedures regularly producing scoliosis—Two procedures provoked scoliosis in every animal which survived the operation: 1) Resection of about two millimetres of the sixth to eleventh
ribs lateral to the transverse processes. In twenty-five animals a maximum scoliosis of 125 degrees, and an average scoliosis of 52 degrees was produced. 2) Resection of the posterior ends of the sixth to eleventh ribs including the costal parts of both costo-vertebral joints. In twenty-two animals aged from seven to sixteen days at the time of operation, a maximum scoliosis of 170 degrees, a minimum of 40 degrees and an average scoliosis of 90 degrees was produced.

Thus, moderate or severe scoliosis regularly develops when the posterior ends of the sixth to eleventh ribs, including both costo-vertebral joints, are resected on one side in rabbits aged seven to sixteen days. In some animals in this series regeneration of bone in the operative field seems to have prevented the development of severe deformity. When a standard operation which provokes extreme scoliosis in every animal operated on can be developed it will be possible to make reliable experiments on the problems of treatment.

Some examples of experimentally provoked scoliosis are seen in Figures 1 to 17. As in most severe scolioses in man rotation of the vertebrae plays an important part in the deformity (Figs. 11 to 17).

**SUMMARY AND CONCLUSIONS**

1. By unilateral resection of the posterior ends of the sixth to eleventh ribs including the costal parts of both costo-vertebral joints, progressive scoliosis can regularly be provoked in young rabbits. Rotation of the vertebrae is prominent in the experimental deformity.

2. Although severe progressive scoliosis can be provoked by a surgical procedure we do not yet know the deforming forces which are released by the operation, but the way lies open for accurate studies on these factors.

3. It seems possible that studies on experimental progressive scoliosis may provide us with new methods to counteract or cure scoliosis in children. The goal is a means to reverse the deforming forces during growth so that the child's spine is straight when growth ceases.

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**REFERENCES**


