

AFFERENT PAIN PATHS IN MAN RUNNING
FROM THE SPONGIOSA IN THE FEMORAL HEAD AND
PASSING THROUGH THE LUMBAR SYMPATHETIC
GANGLIA

BY

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INTRODUCTION

Amongst the operations used in the palliative treatment of painful osteoarthritis of the hip, is the not unimportant operation of drilling of the head of the femur by *Graber Duvernay's* method. Although this treatment is regarded sceptically in many clinics, we have found that it relieves the pain for varying lengths of time in about 50 % of patients.

It has therefore, seemed desirable to discover why this operation so frequently relieves the pain. The operation itself, viz: drilling of the head and neck of the femur with a drill (6 mm. diameter) is rather surprising, if only because recent information about the pain's pathogenesis suggests that the pain originates in the joint capsule, which has a very rich somatic and automatic innervation. It is reasonable to suppose that the relief of the pain, which frequently follows blocking of the sympathetic—either by procain or by irradiation with x-rays—is due to a sympathetic effect, acting either by causing changes in the circulation, and thereby affecting the mode of response of the pain end organs, or, more hypothetically, by blocking sympathetic pain paths leading from the joint capsule.

During some introductory investigations designed to study the response to drilling of the femoral head, I have studied the pain responses both without and with sympathetic block. The findings seem to be of some interest for the question of

the pain paths in the sympathetic system. As our knowledge in this field is limited, all observations concerning it must have some value at present, though later this value may—when observations and experimental investigations have accumulated—be reduced or perhaps altogether lost.

PAIN PATHS IN THE SYMPATHETIC

The presence of afferent sympathetic nerve paths is an open question. It is extremely difficult to fit together the different findings. This is probably due to the fact that they have been obtained, both by experimenting in animals and by studying pain in man, and it is necessary, in studying the physiology and anatomy of the sympathetic system, to show particular reserve in comparing the results obtained in animals with those obtained in man.

As early as 1896, *Dogil* showed that there were both motor and sensory cells in the stellate ganglion in dogs. *Foerster* suggested that there must be pain fibres in sympathetic nerves, since he could still elicit pain by pinching the arteries in the arm of a young man with complete interruption of the cervical and brachial plexuses.

Leriche, *Tardieu*, *Fontaine* and *Foerster* believe that there are pain fibres in the perivascular plexus, and that fibres from this plexus run direct to the sympathetic chain. It should be noted that this applies only to the proximal parts of the large vessels. *Leriche* and *Tardieu* also believe that the injection of corrosive fluids into the arteries causes pain, which is abolished by sympathectomy. *Moore* and *Singleton* were, however, unable to confirm this. They believe that the sympathetic ganglia have little importance in carrying the impulses from the vessels, and that the pain is purely somatic. The difficulty of solving this question is illustrated by some experiments which *Threadgill* made on dogs. He found, from studying the effect of heat and of injections of lactic acid into the arteries, that there must be centripetal sympathetic fibres which pass through the sympathetic ganglion into the

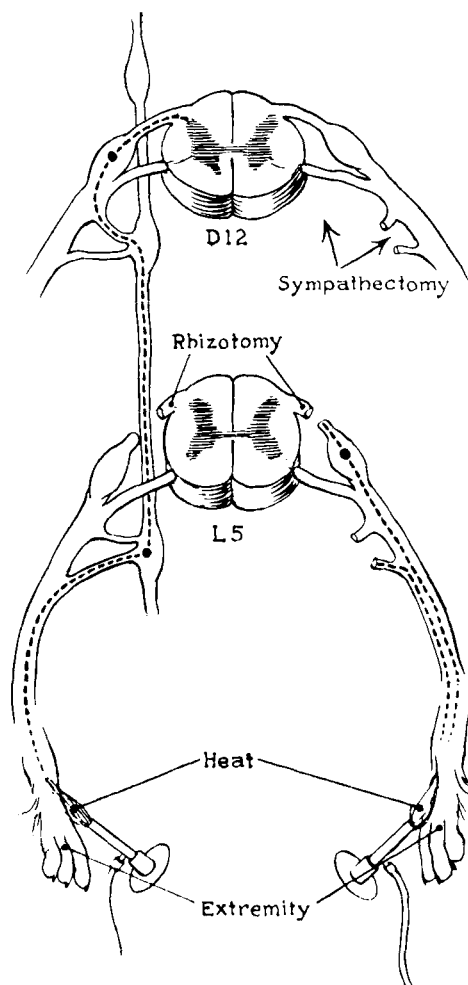


Fig. 1.

(Preparation 1).—Showing bilateral posterior rhizotomy of nerve root to leg with unilateral sympathectomy. Painful sensations from heat are manifested by reaction on the nonsympathectomized side only. The anterior roots are undamaged. (Threadgill. *Surgery* 1947.21.569).

posterior spinal nerve root and via the spinal ganglion into the posterior horn, there to release a painful sensation and perhaps a reflex response to pain (fig. 1). He also showed very nicely that when the connection with the spinal medulla

was interrupted by dividing the anterior and posterior roots, a vascular response could still be carried by the sympathetic alone, without the intervention of the spinal medulla (fig.2). These findings are very significant, but are in clear opposition to *Singleton's*.

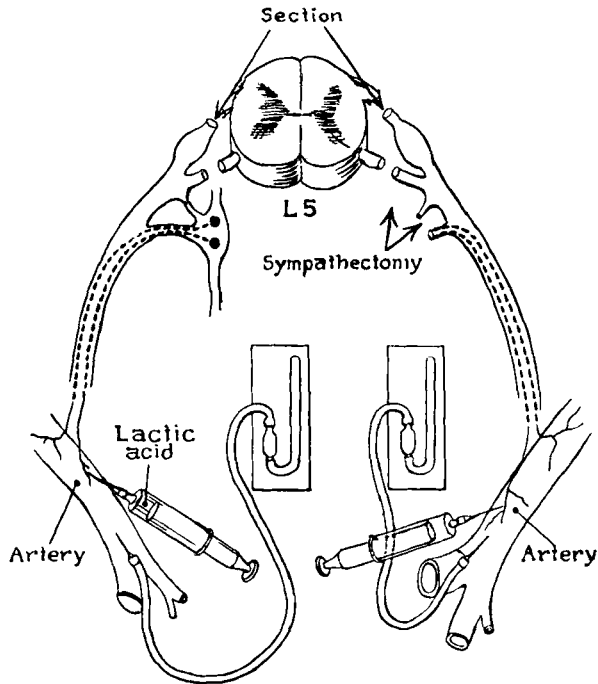


Fig. 2.

(Preparation 2).—Showing bilateral section of both anterior and posterior nerve root with unilateral sympathetic ganglionectomy. Lactic acid injection of artery of leg shows blood pressure changes on nonsympathectomized side only. (Threadgill. Surgery 1947.21.569).

Some other workers in this field, *Takats* and *Livingstone*, cannot wholly accept *Threadgill's* view.

Some interesting observations which *Arnulf* made on man should also be mentioned. Electrical stimulation of the sympathetic in man caused pain responses in certain areas corresponding to the ganglion stimulated; the pain was deep and never cutaneous. The topography varied but showed certain

main characteristics. (It is typical of sympathetic reactions that the behaviour pattern of the subject affects his responses and therefore the findings). Thus, stimulation of the left stellate ganglion provoked cardiac pain, and stimulation of both left and right stellate ganglia a deep pain in the scapular region.

When the 1st lumbar ganglion was stimulated, the pain was located in the lumbar region, the kidney area and the inguinal region. Stimulation of the ramus communicans sometimes caused a pain passing down the lower limb. After ramisection, stimulation of the 1st lumbar ganglion caused no pain. It is not clear from the paper how much the second lumbar ganglion was investigated, or whether the trunk was divided.

Arnulf believed that a painful sensation could be released from the first lumbar sympathetic ganglion, the sensation being felt in the lumbar and inguinal regions. Both isolation of the ganglion and spinal anaesthesia abolished the pain, and he concluded that there must be pain fibres in the sympathetic system. He further believed that the pain area is very variable and that there must be an individual determining factor.

OBSERVATIONS

All the subjects (7) were elderly persons with painful osteoarthritis of the hip requiring palliative relief of the pain by drilling. The operations were performed under local anaesthesia (procain 1 % without adrenaline). Only the skin and muscles were injected with this solution. In 5 cases the first and second lumbar ganglia were also blocked with 2 % procain without adrenaline. In 1 case the block failed, and this case is included among the patients in whom the sympathetic was not blocked. No sensory disturbances could be detected, so one can assume that the block affected only the sympathetic. The effectiveness of the sympathetic block was confirmed in all cases by the rise in temperature. The first case was examined on 4.2.42.

During the operation the pain response of the different

bone elements was noted, and when, in the cases without sympathetic block, the pain was severe, procain was injected into the burr-hole; the injection allowed rather less than 1 cm's further drilling before the next pain response. In some cases it was necessary to use N_2O-O_2 to produce general analgesia.

	Periosteum	Cortex	Spongiosa
No sympathetic block (3 cases)	3 +	3 ÷	3 +
Sympathetic block	2 ÷	4 ÷	4 +
(4 cases)	2 +		

Drilling of the head and neck of the femur with and without blocking of the 1st and 2nd lumbar sympathetic ganglia. Pain response ... + and ÷.

Fig. 3.

The results are shown in Table 3: In all cases without a sympathetic block there was a marked pain response when the periosteum was traumatised, and particularly when it was pulled. No pain was produced from the cortex. But severe pain arose from the spongiosa. Of the 4 cases with sympathetic block, 2 felt pain from the periosteum and 2 no pain; none of them felt pain when either the cortex or the spongiosa was bored. Thus there is a definite difference between the cases with and without sympathetic block, in that the cases with sympathetic block felt no pain from spongiosa; on the other hand there was less certainty in the case of the periosteal pain, though it should be noted that this was absent from 2 of the blocked cases.

DISCUSSION

These observations support the view that pain paths run from the spongiosa in the femoral head to pass through the sympathetic ganglia. If these observations are regarded in the light of *Threadgill's* and *Arnulf's* investigations, it is reasonable to suggest that there are pain fibres running in the sympathetic nerves. Whether these are purely sympathetic fibres, or are somatic fibres running in the sympathetic system with the sympathetic fibres, cannot as yet be determined.

The question, from which elements in the bone is the pain released, is difficult—not to say, impossible—to answer. It is however, reasonable to believe that the pain arises in the nervous apparatus of the bone vessels; it can hardly have anything to do with changes in the vascular milieu, since it is instantaneous, which suggests a direct irritation of the pain elements.

There is, however, also another observation which is difficult to explain, namely the mechanism of the pain in osteoarthritis deformans, which is relieved by drilling. The investigations have not so far been able to explain—apart from speculatively—why boring into the spongiosa abolishes the pain in some cases of osteoarthritis deformans. It may, however, be mentioned that some of our patients with arthrosis deformans of the hip have had temporary relief from pain after procain blocking of the sympathetic.

SUMMARY

During drilling of the head and neck of the femur—inforatio coxae—pain occurs when the spongiosa is reached. This pain is not felt when the 1st and 2nd lumbar sympathetic ganglia have been blocked with procain.

ZUSAMMENFASSUNG

Während der Bohrung im collum und caput femoris entstehen keine Schmerzen, wenn das 1. und 2. lumbale Sympaticusganglion mittels Procain blockiert worden ist. Dagegen werden von der Spongiosa aus Schmerzen ausgelöst wenn die Sympaticusblokade nicht vorgenommen wurde.

RESUME

Lorsqu'on perfore le col et la tête du fémur (inforatio coxae), il n'est pas ressenti de douleurs si les ganglions sympathiques des 1^{ère} et 2^{ème} vertèbres lombaires sont bloquées à la procaine; par contre les tissus spongieux déclenchent des douleurs quand le sympathique n'a pas été bloqué.

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