ANGINA IN THE ANALGESIC LIMB

BY

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In order to explain certain observations on pain reference, Cohen (1947) proposed a special hypothesis. His observations were that referred pain could be abolished or diminished by anaesthesia of the homosegmental area, and that it could be produced or increased by hyperaesthesia. He suggested that there was normally a continual stream of subliminal pain impulses coming from the body. In the case of angina the pain impulses from both the heart and the arm would reach a functionally related area in the sensorium and, when integrated with the cortical pattern of the body image, would be localized selectively in that segment. Cohen admitted that this continual stream of subliminal impulses was hypothetical, but claimed that his suggestion had the greatest virtue of a hypothesis—that it could be tested. The following experiments were designed to test it.

Argument

If a mixed nerve is infiltrated with procaine the various fibres are paralysed and recover in a constant order. Pain sensibility and sympathetic vasomotor tone are lost first; next comes temperature sensation; position sense, motor power, and superficial sensation go last and recover first. It should therefore be possible by means of a weak but extensive brachial block to prepare an arm that was analgesic but which had power and other forms of sensibility only slightly affected. If a patient with angina were so treated and the arm pain persisted, then subliminal impulses could have played no part in its production, because they must have been abolished. If pain were so abolished these impulses could still be postulated.

Experimental

The patient was walked over a test course and asked to describe his pain as it developed. The circulation of the arm was then occluded by a blood-pressure bandage and the patient opened and shut his hand till pain became intolerable. The number of these *ischaemic contractions* was noted. He was then shown the degree of pain produced by pin-prick, forced flexion of the fingers, and thumb pressure in the first interosseous web and over the flexor surface of the arm just above the wrist. The brachial block was then performed, sometimes with weak procaine (1%) to get the required degree of paralysis at its height, sometimes with more and stronger procaine to get it in the recovery phase. The technical difficulty is to get all parts of the arm in the same sensory state at the same time. With a satisfactory result no pain could be elicited below the mid-upper arm. Ischaemic contractions could be performed to the stage of paralysis, but without pain. Temperature sensation was usually impaired. Touch and position sense were objectively normal, though the limb might feel clumsy and "different." Power was only slightly affected if at all. Ptosis, a contracted pupil, and a hot red arm were always present.

The patient was then walked over the course again till angina was produced. This always required more effort than before the injection. On return his sensibility was again tested to see that the arm was still in the

required state. In eight patients the experiments were technically successful.

Case Reports

Case 1.—An intelligent obsessional Civil Servant aged 49. Ischaemic contractions before injection, 50. Twenty minutes after injection contractions stopped at 80 by paralysis, but no pain. No pain sensibility to other tests. Cotton-wool detected, but impaired. Arm felt clumsy, but power objectively normal and he could do up buttons and distinguish coins. Temperatures were accurately distinguished, but were less intense. After walking about five times as far as before test, angina was felt in chest, arm, and wrist. This was quite definite. The arm pain was as intense as he would have expected from the chest pain, though both were less. *Re-test after experiment:* Ischaemic contractions stopped at 70 by paralysis. No pain to other stimuli. Cotton-wool detected, but more impaired. Hot and cold distinguished only by simultaneous comparison; all called hot when done separately. Position sense and power objectively normal, but the arm felt more clumsy. *Comment:* Perfect analgesia; arm pain not altered.

Case 2.—A man aged 59, not of high intelligence, was very sensitive to pain. He had always had more pain in his arm than in his chest. Ischaemic contractions, 30. Fifteen minutes after injection contractions stopped at 80 by paralysis. Felt slight pin-prick everywhere except on the ulnar border. Area of hyperaesthesia over back of thumb and radial border of the wrist. Pain sensibility otherwise absent. Cotton-wool sensation absent over ulnar border, minimal stimuli otherwise detected, but less intense. Position sense and power objectively unimpaired, though he felt that the extensors of the wrist and elbow were weak. Walking was followed by a completely unmodified arm pain, later spreading to the chest in the usual way. *Re-testing:* Ischaemic contractions stopped at 100 by paralysis, otherwise as before the experiment. *Comment:* Perfect analgesia; arm pain not altered.

Case 3.—A market porter aged 42; co-operative, unsuggestible, and of moderate intelligence. Ischaemic contractions, 80. The brachial plexus was almost completely blocked and the test made in the recovery phase. Before the test ischaemic contractions stopped at 125 by paralysis. Did not feel pain with pin-prick or muscle pressure. Power normal except for weakness in shoulder. Distinguished coins, and fine movements performed. Felt all temperatures as warm. Cotton-wool normal, but no tickle except over inner arm. With considerable exertion the chest pain came on and the arm pain a few paces later, just as it always did. *Comment:* Perfect analgesia; arm pain not altered.

Case 4.—A messenger aged 58; a good observer. His left arm was amputated in 1917, and he still has a full-sized movable phantom. The angina came on in the right arm and was never felt in the phantom. It was felt in the arm before it went to the chest. Ischaemic contractions, 50. The brachial plexus was widely infiltrated and the test done in the recovery phase. Before testing pin-prick was dull except over the ulnar border, where it was pointed. No pain with pressure and finger bending. Cotton-wool was normally detected. The hand was still weak and clumsy and he could not do up his tie. After climbing two flights of stairs angina was felt in the chest, but nothing in the arm. After a few minutes' rest he climbed another flight. The usual angina was felt in the arm and then in the chest a few seconds later. *Re-testing:* No pain with pin-prick or muscle pressure. Ischaemic contractions stopped at 60 with pain. Cotton-wool, power, and fine movements normal. *Comment:* Moderate analgesia, power impaired; arm pain not altered.

Case 5.—A married woman aged 31 with mitral stenosis and aortic incompetence; a good witness but a bit frightened. After injection pin-prick was everywhere dull, except slightly pricking over the ulnar border. No pain with muscle pressure or finger bending. Cotton-wool

everywhere normal except definitely impaired over the thumb. Power and position sense normal except that she could not flex her elbow against gravity. Hot and cold could not be distinguished. After a long walk angina was felt in the upper arm. Later it was felt in the chest and then in the elbow. It did not spread to the wrist, as was usual. *Re-testing*: Slight flinching with muscle pressure and finger bending, but much less than normal. Pin-prick was painful in patches in the upper arm and fourth and fifth fingers. Cotton-wool, power, and temperature unchanged. *Comment*: Patchy analgesia, power impaired; arm pain less widespread.

Case 6.—An honest garrulous man aged 42, not very sensitive to pain or good at analysing symptoms. Ischaemic contractions, 100. After injection ischaemic contractions 110, almost paralysed but some deep aching. No pain with muscle squeezing. Pin-prick abolished except possibly for some sensibility in the hand. Cotton-wool always felt, but less than normal. Power and use of hand not affected. After strenuous walking angina was felt in the chest and arm as far as the elbow. The arm pain had the usual distribution and time relationship to the chest pain. Though quite definite, it was not as severe as he would have expected. *Re-testing*: Felt pin-prick "right at the end" all over the arm. Muscle and finger squeezing were just painful at the height of the stimulus. Ischaemic contractions stopped at 100 by pain. Other functions unchanged. *Comment*: Incomplete analgesia; arm pain less severe.

Case 7.—A decorator aged 51 was a good intelligent witness, hyperaesthetic. Ischaemic contractions, 55. After injection ischaemic contractions not tested. Completely analgesic to pin-prick and muscle and finger squeezing. Hot and cold not distinguished. Cotton-wool normal except for loss of tickle, especially along the ulnar border. Position sense not affected. Slight general weakness of hand. Did not swing his arm while walking. With walking the chest pain came at the normal point. At the same time there was a detectable pain in the usual distribution of the arm, but it was much weaker than that in the chest, instead of being stronger, as was usual. *Re-testing*: Cotton-wool normal. Temperature nearly normal. Power still impaired. Ischaemic contractions stopped at 110 by severe pain. Muscle and finger squeezing were just painful, though much less than normal. *Comment*: Moderate analgesia, power impaired; arm pain definitely less.

Case 8.—A man aged 46; a very analytical observer of his symptoms. He got pain in both arms equally. Ischaemic contractions, 70. Tested in the recovery phase after fairly complete paralysis. Pin-prick absent except over the central palm. No pain with muscle and finger squeezing. Ischaemic contractions stopped at 100 with paralysis and some tingling pain. Cotton-wool appreciated everywhere, but diminished. Some general muscular weakness. Fairly good distinction of temperature. With hard stepping exercise the pain appeared as usual in the chest and right arm. There was no pain at all in the injected arm. *Re-testing*: No pain with muscle and finger squeezing or pin-prick. Ischaemic contractions stopped at 70 by pain. Otherwise unchanged. *Comment*: Perfect analgesia, with impairment of touch and power; arm pain abolished.

Discussion

In Cases 1 to 4 there was no pain sensibility in the arm and yet the patients felt referred pain there. In Cases 5 to 7 angina was felt in the arm, but the arm was not completely analgesic. Nevertheless, considering the force of the stimulus required to produce pain, it can hardly be argued that subliminal impulses could have played any part. Case 8 gave a contradictory result, and no explanation is offered. It is concluded that hypothetical subliminal pain impulses could have played no part in producing the angina in seven of the eight cases. Although pain sensation was abolished,

touch, position sense, and movements were little affected, so that the arms all felt nearly normal. The fact that angina was referred to them is consistent with the view (Harman, 1948) that pain from an unperceived part (for example, the heart) will be referred to a perceived part of the same segment (for example, the arm).

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FATAL HAEMATEMESIS, FROM OESOPHAGEAL VARICES, IN PRESENCE OF LARGE PORTAL-CAVAL ANASTOMOSIS

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[WITH SPECIAL PLATE]

In recent years operations have been devised to produce large portal-caval shunts in order to prevent haematemesis in cases of portal venous obstruction with gastric or oesophageal varices (Blakemore, 1948; Linton *et al.*, 1948). The following case is reported because it shows a naturally developed shunt which is of the same order of size as those produced surgically and which failed to prevent fatal bleeding.

Collateral vessels are found at the following sites in portal venous obstruction (McIndoe, 1928):

"In classifying these rather numerous channels I have adopted a method given me by Dr. H. A. Harris, of University College, London. It has the advantage of being embryologic in conception and consequently easier to remember than the formidable anatomic lists in textbooks. The channels fall naturally into three groups, according to their situation.

"Group 1.—At the two situations in the gastro-intestinal tract where absorbing epithelium comes into contact with protective epithelium—that is, the cardia and the anus. The former represents the site of anastomosis of the coronary vein of the stomach with the intercostal, azygos minor, and diaphragmatic veins of the caval circulation, here producing oesophageal varices. At the latter, the superior haemorrhoidal vein of the portal circulation anastomoses with the middle and inferior haemorrhoidal veins of the caval circulation. Occasionally haemorrhoids develop, though they very rarely become large and are usually not clinically important.

"Group 2.—At the site of an obliterated embryonic circulation—that is, in the falciform ligament containing the para-umbilical veins. The umbilical vein is itself rarely, if ever, a part of the actual circulation, being entirely obliterated a few days after birth.

"Group 3.—At all situations in the abdomen where the gastro-intestinal tract, its appendages, or the glands developed from it become retroperitoneal developmentally or adherent to the abdominal walls pathologically. This includes the duodenum, small intestine, colon, omentum, spleen and pancreas, containing the veins of Retzius, and the liver