

STUDIES ON EXPERIMENTAL HYPERTENSION

XI. THE EFFECT OF EXCISION OF THE CAROTID SINUSES ON EXPERIMENTAL HYPERTENSION PRODUCED BY RENAL ISCHEMIA*

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Bouckaert, Elaut and Heymans (1) have reported increased carotid sinus excitability in dogs with hypertension produced by the method of renal ischemia (2). Their tests for sinus excitability were made on hypertensive dogs under anesthesia with chloralose, and they found that "the usual reflex responses of vaso-constriction and elevation of blood pressure, concurrent with the lowering of endovascular pressure in the carotid sinuses, were much more marked in the dogs with hypertension." Their conclusion was that chronic hypertension due to renal ischemia is associated with increased reflex excitability of the vasoconstrictor mechanisms, and that the hyperexcitability may be due to either central or peripheral nervous or humoral phenomena. Recently Verney and Vogt (3) tried to determine whether increased sensitivity to variations in pressure within the carotid sinus appears in dogs that are hypertensive due to renal ischemia. They thought, quite correctly, that increased sensitivity would vitiate readings of blood pressure from the van Leersum carotid loop, if the ipsilateral carotid sinus were not denervated. They found, however, that the range of responses in any one dog were much the same before and after the development of hypertension. Their method consisted of compression of one common carotid artery, while the direct, or so called mean blood pressure, in the femoral artery, was being recorded under local anesthesia. They concluded that, "no influence of renal ischemia is detectable; increased excitability in the arc of the sinus reflex is not, therefore, a factor contributing to the hypertension."

In contemplating the possible part played by the carotid sinus reflex in the phenomenon of persistent hypertension due to renal ischemia (2, 4, 5), consideration should be given the obvious danger of applying the results of brief experiments involving fleeting effects on blood pressure to the problem of chronic hypertension. It was thought that a persistent condition is best studied by a method that involves many observations over a long period, and that the results of brief experiments with single observations might be misleading. It was decided to test experimentally the part played

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by the carotid sinuses by means of their excision before or after the production of the hypertension. If the presence of the intact innervated carotid sinuses has any influence on this type of hypertension, their absence should alter or remove this effect. If the elevation of pressure after renal ischemia is due to peripheral vascular constriction effected by some mechanism that is independent of the carotid sinuses, then the resultant increased endovascular pressure in the carotid sinuses should tend to lower the systemic blood pressure. Previous excision or denervation of the carotid sinuses should remove this influence, and the blood pressure in such animals should reach unusually high values as a result of renal ischemia. Also, in animals already hypertensive due to renal ischemia, denervation or excision of the carotid sinuses should result in further elevation of the blood pressure.

Experimental Methods

The excision of the carotid sinuses was carried out by a method demonstrated to us by Professor C. Heymans of the University of Ghent, Belgium. The procedure consists of exposure of the common carotid and all its primary branches. They can be exposed through one midline incision or two lateral incisions. The common carotid artery is tied about 1 cm. below the bifurcation. The carotid sinus is identified, and the internal carotid artery is tied off well above it. All other branches of the common carotid artery are tied off. The portion of the common carotid artery and of its branches between the ligatures is excised. This includes the carotid sinus. In some of the animals one vagus and the depressor fibers of the other were also severed. This was done for us by Dr. Heymans on dog 3-68.

Renal ischemia was produced by constriction of the main renal artery by means of a clamp, as previously described (2), usually with an interval of a week or more between the operations on the two kidneys.

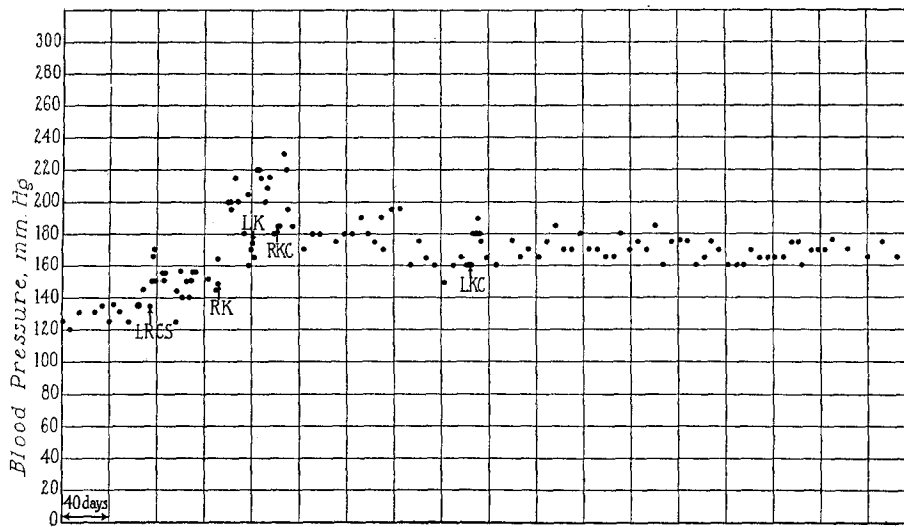
Femoral mean pressure was determined by inserting a 21 gauge needle connected with a mercury manometer by means of liquid system directly into the femoral artery (4).

The dogs received a hypodermic injection of a solution of morphine sulfate, 1/20 grain, and atropine sulfate, 1/3000 grain, per kg. of body weight. This was followed within half an hour by the administration of ether by the drop and cone method. In the animals in which local anesthesia was employed, the morphine and atropine were also injected before employing the local anesthetic.

The Influence of Previous Bilateral Excision of the Carotid Sinuses on Hypertension Induced by Constriction of the Main Renal Arteries

In four dogs (Nos. 3-53, 3-67, 3-69, 3-75) both carotid sinuses were excised, either at one operation, or with an interval between operations. This procedure usually had no significant, immediate or remote effect on the femoral mean blood pressure of these normal animals. If the blood

pressure did become slightly elevated, it usually returned to normal in a few days. In one animal (No. 3-75) a slight elevation persisted for several weeks (Text-fig. 1). After a variable period, when it was obvious that the blood pressure was unchanged, first one, and later the other main renal artery, was constricted by means of a clamp, as in previous experiments (2). The invariable result was elevation of femoral mean blood pressure, within a day or two after the production of renal ischemia, but the elevation was not of an unusual degree. In none of the animals did the



TEXT-FIG. 1. Dog 3-75. Collie, female, middle age, 12.2 kg.

LRCS, both carotid sinuses excised. RK, right main renal artery constricted. LK, left main renal artery constricted. RKC, right main renal artery occluded. LKC, left main renal artery occluded.

The animal is still alive.

blood pressure reach a level significantly higher than in dogs with carotid sinuses intact (2, 4). As in the latter, the blood pressure showed a tendency to drop in some of the animals. In these it was found necessary to tighten the clamps, or finally even to occlude the main renal arteries in order to effect persistent hypertension. Text-fig. 1 of dog 3-75 illustrates the effects of renal ischemia obtained in all four dogs. The only difference noted was that in animals with the carotid sinuses excised, the elevated blood pressure tended to fluctuate somewhat more than in animals with carotid sinuses intact. One animal (No. 3-69) died in the malignant phase, with hypertension and uremia due to renal excretory insufficiency,

because the constriction of the main renal arteries was excessive. The usual (6) necrotizing and inflammatory arteriolar disease was observed in many organs of this animal, but no arteriolar lesions occurred in the animals in which there was no significant renal excretory insufficiency accompanying the hypertension.

No. 3-53: Collie, female, middle age, 12.0 kg.

Aug. 10 to Dec. 14, 1937. During the normal period the femoral mean pressure usually varied between 120 and 145 mm. Hg. On one occasion it was 110, and on another it was 160 mm. Hg.

Dec. 15. Left carotid sinus excised. *Dec. 16, 1937, to Jan. 19, 1938.* Femoral mean pressure 110 to 140 mm. Hg.

Jan. 19. Right carotid sinus excised. *Jan. 20 to Feb. 1.* Femoral mean pressure 120 to 155 mm. Hg.

Feb. 1. Right main renal artery moderately constricted. *Feb. 2 to 14.* The femoral mean pressure rose from 180 mm. Hg, on Feb. 2, to 200 mm. Hg, on Feb. 8. It was 180 mm. Hg on Feb. 14, and chemical examination of the blood showed blood urea nitrogen (B.U.N.) 14.3 mg., creatinine (Cr.) 1.2 mg. and CO₂ combining power (CO₂) 49.5 volumes per 100 cc. of plasma.

Feb. 14. Left main renal artery moderately constricted. *Feb. 15 to May 26.* The blood pressure became reelevated. It reached a maximum of 205 mm. Hg, after which it fell gradually, and on May 26 it reached 150 mm. Hg. *May 26.* The constriction of the right main renal artery was increased so as to occlude the vessel. *May 27 to July 6.* The femoral mean pressure rose to a maximum of 180 mm. Hg, but on July 6 it was 165 mm. Hg.

July 6. The left main renal artery was occluded. *July 7, 1938, to May 15, 1939.* During this period of almost one year, the femoral mean pressure reached more than 200 mm. Hg on several occasions and was always 165 mm. Hg or higher. The fluctuation of pressure was greater than in animals with bilateral renal ischemia, with carotid sinuses intact, but the elevation of pressure was no greater. On Jan. 24, B.U.N. 13.1 mg., Cr. 1.4 mg., CO₂ 52.4 volumes per 100 cc. of plasma. On May 25, B.U.N. 20.3 mg., Cr. 1.3 mg., CO₂ 39.8 volumes per 100 cc. of plasma.

May 26, 1939. Femoral mean blood pressure, 150 mm. Hg. The constriction of the right main renal artery was increased so as to occlude the vessel. *May 27 to July 6.* The femoral mean blood pressure rose to 180 mm. Hg, but by July 6 it was back to 165 mm. Hg. *July 6.* The constriction of the left main renal artery was increased so as to occlude the vessel. *July 7 to Sept. 18.* The femoral mean blood pressure reached a maximum of 205 mm. Hg and has fluctuated between 170 and 190 during the past 14 months. On Sept. 18 it was 170 mm. Hg, still about 40 mm. Hg more than during the normal period of 4 months.

The animal is still alive.

No. 3-67: Mongrel, young, female, 9.4 kg.

Oct. 29 to Dec. 6, 1937. During the normal period the femoral mean blood pressure varied between 110 and 135 mm. Hg.

Dec. 6, 1937. The left carotid sinus was excised. *Dec. 7, 1937, to Jan. 19, 1938.*

The femoral mean pressure varied during this period between 115 and 150 mm. Hg. The animal was more excitable. On Jan. 19, the femoral mean pressure was 115 mm. Hg.

Jan. 19. The right carotid sinus was excised. *Jan. 20 to Feb. 1.* The femoral mean pressure varied between 120 and 165 mm. Hg. On Jan. 31, it was 120 mm. Hg, and on Feb. 1, it was 135 mm. Hg. Feb. 1, B.U.N. 7.5 mg., Cr. 1.4 mg., CO₂ 59.3 volumes per 100 cc. of plasma.

Feb. 1. The right main renal artery was greatly constricted. *Feb. 2 to 14.* The femoral mean pressure rose to 205 mm. Hg, and then fell gradually until, on Feb. 14, it was 170 mm. Hg.

Feb. 14, 1938. The left main renal artery was greatly constricted. *Feb. 15 to May 2.* The femoral mean pressure rose again and varied during this period between 195 and 250 mm. Hg. The maximum was reached on Feb. 18, on which day the chemical examination of the blood showed B.U.N. 12.0 mg., Cr. 1.3 mg., CO₂ 55.5 volumes per 100 cc. of plasma. On May 2, the femoral mean pressure was still 205 mm. Hg. On this day, B.U.N. 6.8 mg., Cr. 1.6 mg., CO₂ 53.0 volumes per 100 cc. of plasma.

At this stage this dog was used for another experiment, the details of which are irrelevant.

No. 3-69: Dalmation coach dog, male, young, 10.4 kg.

Oct. 29 to Nov. 30, 1937. During the normal period the femoral mean pressure varied between 120 and 145 mm. Hg.

Nov. 30. The left carotid sinus was excised. *Dec. 1, 1937, to Jan. 19, 1938.* The femoral mean pressure remained unchanged and varied between 120 and 140 mm. Hg.

Jan. 19. The right carotid sinus was excised. *Jan. 20 to Feb. 1.* The femoral mean pressure rose to 170 mm. Hg, on Jan. 21, but from then on it varied between 135 and 165 mm. Hg. The higher figures always occurred when the animal was tense, trembling or struggling.

Feb. 1. B.U.N. 9.8 mg., Cr. 1.3 mg., CO₂ 62.5 volumes per 100 cc. of plasma. The right main renal artery was greatly constricted. *Feb. 2 to 14.* The femoral mean pressure rose to a maximum of 180 mm. Hg and then fell gradually to 165 mm. Hg on Feb. 14. On this day, B.U.N. 24.0 mg., Cr. 1.2 mg., CO₂ 67.0 volumes per 100 cc. of plasma.

Feb. 14. The left main renal artery was greatly constricted. *Feb. 15.* The femoral mean pressure was 195 mm. Hg. *Feb. 16.* The femoral mean pressure was 230 mm. Hg, and the animal was uremic. B.U.N. 182.0 mg., Cr. 7.6 mg., CO₂ 27.1 volumes per 100 cc. of plasma.

Feb. 17, 1938. The animal was found dead. At autopsy, in the gross, there were petechiae and larger hemorrhages in the wall of the stomach, small and large intestine, including appendix, pancreas, epicardium and myocardium. Both kidneys showed marked degenerative changes. In the left kidney there was one conical mass of hemorrhagic necrosis. Microscopically, the petechiae and larger extravasations of blood were associated with the presence of arteriolar hyalinization and necrosis. Much of the hemorrhage appeared to be of capillary origin.

No. 3-75: Collie, female, middle age, 12.2 kg. (Text-fig. 1.)

Dec. 6, 1937, to Feb. 21, 1938. During the normal period the femoral mean pressure varied between 120 and 145 mm. Hg.

Feb. 21. Both carotid sinuses were excised at the one operation by the method described for dog 3-67. (See LRCS, Text-fig. 1.) *Feb. 22 to Apr. 14.* 2 days after the operation the femoral mean pressure reached a maximum of 170 mm. Hg. From that time, during this period, it varied between 125 and 155 mm. Hg.

Apr. 14. B.U.N. 13.5 mg., Cr. 1.3 mg., CO₂ 49.5 volumes per 100 cc. of plasma. The right main renal artery was greatly constricted. (See RK, Text-fig. 1.) *Apr. 15 to May 6.* The femoral mean pressure reached a maximum of 215 mm. Hg on April 22. On this day, B.U.N. 9.0 mg., Cr. 1.5 mg., CO₂ 71.5 volumes per 100 cc. of plasma. The femoral mean blood pressure fell gradually until it was 175 mm. Hg, on May 6. On this day, B.U.N. 15.0 mg., Cr. 1.1 mg., CO₂ 43.7 volumes per 100 cc. of plasma.

May 6. The left main renal artery was greatly constricted. (See LK, Text-fig. 1.) The femoral mean pressure rose again to a maximum of 220 mm. Hg on May 9, and until May 20 it varied between 200 and 220 mm. Hg. On May 26 it had dropped to 185 mm. Hg. B.U.N. 20.3 mg., Cr. 1.4 mg., CO₂ 66.5 volumes per 100 cc. of plasma.

May 26. The clamp on the right main renal artery was tightened so as to occlude the vessel. (See RKC, Text-fig. 1.) *May 27 to Nov. 2.* During this period the femoral mean pressure rose to 230 mm. Hg on May 31, and from that time fell very gradually to 160 mm. Hg. On Nov. 1, B.U.N. 15.8 mg., Cr. 1.3 mg., CO₂ 60.1 volumes per 100 cc. of plasma.

Nov. 3. The left main renal artery was occluded by tightening the clamp. (See LKC, Text-fig. 1.) *Nov. 4, 1938, to Sept. 11, 1939.* The femoral mean pressure rose to a maximum of 190 mm. Hg on Nov. 10, and it has varied between 160 and 180 mm. Hg during the last 9 months.

The animal is still living. (See Text-fig. 1.)

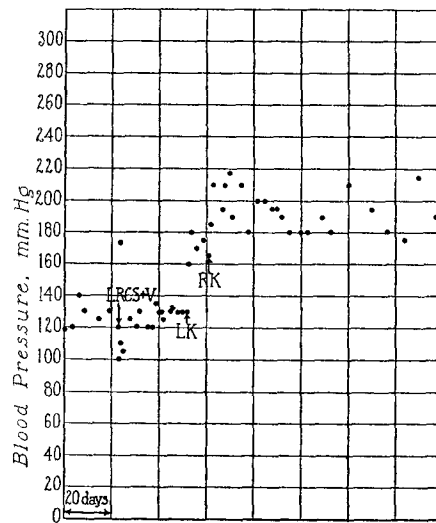
*The Effect of Excision of Both Carotid Sinuses and the Cardio-Aortic
Depressor Nerves on the Development of Hypertension and
Renal Ischemia*

In two animals (Nos. 3-68 and 4-17) both carotid sinuses were excised, one vagus was severed, and the cardio-aortic depressor fibers of the other vagus were cut. The operations did not produce a significant persistent elevation of blood pressure in either animal. In dog 3-68 (Text-fig. 2) the femoral mean pressure rose to 175 mm. Hg 20 minutes after the operation, but the next day it was 100 mm. Hg, and the highest value that it reached after that was 135 mm. Hg. In dog 4-17 there was no significant change of the blood pressure at any time following the excision of the carotid sinuses and section of the nerves. After an interval, the main renal arteries were constricted. In both animals, after this procedure, there was a significant rise of femoral mean pressure, but the pressure gradually fell, and it was necessary even to occlude the main renal arteries, in order to effect persistent elevation of blood pressure. In one of the animals (No. 4-17) renal excretory insufficiency resulted from excessive constriction of the main renal arteries, and uremia developed, which proved fatal. This animal de-

veloped the degenerative, necrotizing and inflammatory changes in the arterioles of many organs, except the ischemic kidneys, similar to the lesions previously described in hypertensive animals with renal excretory insufficiency (6).

No. 3-68: Collie, small type, female, middle age, 12 kg.

Oct. 29 to Nov. 19, 1937. During the preoperative period the femoral mean pressure varied between 120 and 140 mm. Hg.



TEXT-FIG. 2. Dog 3-68: Collie, small type, female, middle age, 12 kg.

LRC5 + V, both carotid sinuses excised; right vagus and cardio-aortic inhibitor fibers of left vagus severed. LK, left main renal artery greatly constricted. RK, right main renal artery greatly constricted.

The animal is still alive.

Nov. 19. The femoral mean pressure was 120 mm. Hg. The right carotid sinus was excised and the right vagus severed. The left carotid sinus was also excised and the cardio-aortic depressor fibers of the left vagus were severed.¹ Immediately after the operation, about 20 minutes after the excision of the second carotid sinus, the femoral mean pressure was 175 mm. Hg. On the morning of Nov. 20 it was 100 mm. Hg. Nov. 21 to Dec. 20. During this period the femoral mean pressure varied between 110 and 135 mm. Hg, and during the last 2 weeks of this period, from Dec. 7 to Dec. 20, it varied between 125 and 135 mm. Hg.

¹ These procedures were all carried out at the one operation and were performed for us in our laboratory by Professor C. Heymans of the University of Ghent, Belgium, during his visit to America. We wish here to acknowledge our sincere thanks to him for this aid.

Dec. 20. B.U.N. 18.8 mg., Cr. 1.8 mg., CO₂ 57.3 volumes per 100 cc. of plasma. The left main renal artery was greatly constricted. *Dec. 21 to 29.* The femoral mean pressure rose gradually to 180 mm. Hg and then fell to 165 mm. Hg.

Dec. 29. B.U.N. 14.3 mg., Cr. 1.4 mg., CO₂ 59.6 volumes per 100 cc. of plasma. The right main renal artery was greatly constricted. *Dec. 30, 1937, to Mar. 21, 1938.* The femoral mean pressure rose to a maximum of 220 mm. Hg, on Jan. 7, and since then it has varied between 180 and 210 mm. Hg.

Mar. 22, 1938, to Jan. 18, 1939. This dog was used for irrelevant experiments involving various procedures. It is still alive, and on Oct. 2, 1939, the femoral mean pressure was still 205 mm. Hg.

No. 4-17: Mongrel, male, middle age, 15 kg.

May 25 to June 15, 1938. During the normal period the femoral mean pressure varied between 115 and 135 mm. Hg.

June 15. Both carotid sinuses were excised. Left vagus and the cardio-aortic depressor fibers of the right vagus were severed. *June 16 to July 11.* The femoral mean pressure varied between 130 and 145 mm. Hg. On July 11 it was 135 mm. Hg.

July 11. The right main renal artery was moderately constricted. *July 12 to Sept. 14.* During this period the blood pressure gradually rose to 165 mm. Hg at which level it remained with slight variations.

Sept. 15. B.U.N. 12.8 mg., Cr. 1.5 mg. and CO₂ 47.0 volumes per 100 cc. of plasma. Two left main renal arteries were moderately constricted by means of clamps. *Sept. 16 to Nov. 3.* The femoral mean blood pressure rose in 4 days to 190 mm. Hg and then gradually fell to 145 mm. Hg, on Nov. 3. On this day, B.U.N. 15.0, Cr. 1.4 mg. and CO₂ 53.8 volumes per 100 cc. of plasma.

Nov. 3. The constriction of the right main renal artery was increased so as to occlude the vessel. *Nov. 5.* The blood pressure was 180 mm. Hg.

Nov. 7, 1938. B.U.N. 150.0 mg., Cr. 9.5 mg. The animal was found dead. The gross and microscopic examination of the tissues revealed the necrotizing and inflammatory lesions of the malignant phase in the small arteries and arterioles in stomach, intestines, urinary bladder, pancreas, heart and brain.

The Effect of Excision of Both Carotid Sinuses on the Blood Pressure of Animals with Previous Hypertension Due to Renal Ischemia

In three animals (Nos. 3-06, 3-10 and 4-36), with both main renal arteries previously constricted, in which the blood pressure was still elevated, but had subsided to a lower level, both carotid sinuses were excised. This had no significant effect on the femoral mean blood pressure of these dogs which remained within the same range as in the period immediately prior to this operation. Increased constriction of the main renal arteries, however, was followed by reelevation of the blood pressure, which persisted. (See Text-fig. 3, dog 4-36.)

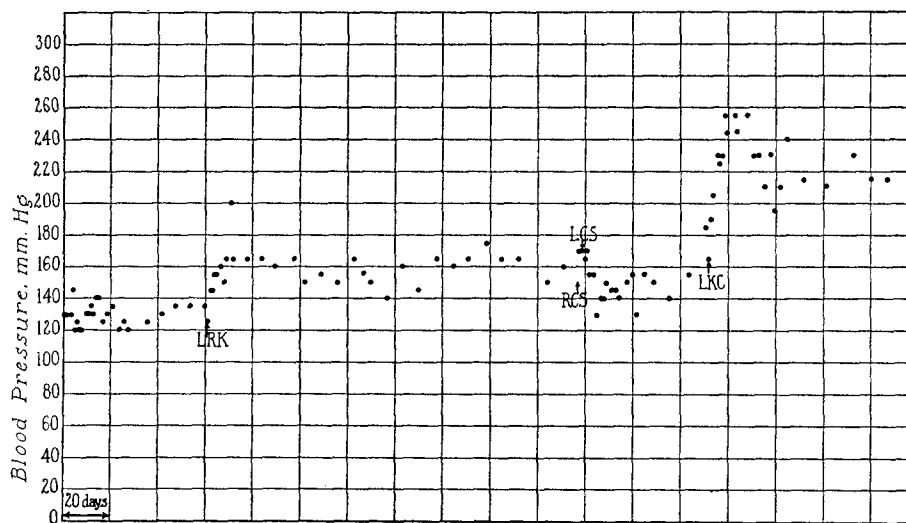
No. 3-06: Police, male, old, 28.8 kg.

Dec. 1, 1936, to Mar. 16, 1937. During the preoperative period the femoral mean

pressure varied between 125 and 140 mm. Hg. On Mar. 16, B.U.N. 13.5 mg., Cr. 1.1 mg., CO₂ 54.6 volumes per 100 cc. of plasma.

Mar. 16. Left main renal artery moderately constricted. *Mar. 17 to June 14.* The femoral mean pressure rose to a maximum of 195 mm. Hg on Mar. 23 and then fell gradually to 145 mm. Hg on June 14.

June 15. Right main renal artery moderately constricted. *June 16, 1937, to Mar. 8, 1938.* The femoral mean pressure rose to a maximum of 210 mm. Hg on July 2. It remained elevated for many months, but gradually fell until, on Mar. 8, it was 160 mm. Hg.



TEXT-FIG. 3. Dog 4-36. Police, female, young, 19 kg.
 LRK, left and right main renal arteries constricted. RCS, right carotid sinus excised. LCS, left carotid sinus excised. LKC, left main renal artery occluded.
 The animal is still alive.

Mar. 8. Left carotid sinus excised. *Mar. 9 to Apr. 13.* The blood pressure varied between 140 and 170 mm. Hg.

Apr. 13. Right carotid sinus excised. *Apr. 15 to May 4.* The femoral mean pressure varied between 130 and 160 mm. Hg. On May 4, it was 130 mm. Hg.

May 4. The right main renal artery was occluded. *May 5 to 31.* The femoral mean pressure rose slightly to a maximum of 175 mm. Hg. *May 31.* Left main renal artery occluded. *June 1 to Sept. 6.* The femoral mean pressure varied between 140 and 175 mm. Hg.

Sept. 6. The left kidney was decapsulated. A fish skin bag was applied around the kidney to reduce accessory circulation. There was much loss of blood during the operation. *Sept. 7 to 26.* The femoral mean pressure varied between 95 and 130 mm. Hg. On Sept. 26, it was 130 mm. Hg.

Sept. 27. Right nephrectomy. B.U.N. 14.2 mg., Cr. 1.6 mg., CO₂ 54.3 volumes per 100 cc. of plasma. *Sept. 28 to Nov. 4.* The femoral mean pressure rose to a maximum of 195 mm. Hg, and then persisted, but varied between 170 and 190 mm. Hg. On *Sept. 23*, B.U.N. 23.2 mg., Cr. 2.9 mg., CO₂ 43.6 volumes per 100 cc. of plasma. On *Nov. 4*, femoral mean pressure was 170 mm. Hg, B.U.N. 30.0 mg., Cr. 3.1 mg., CO₂ 42.5 volumes per 100 cc. of plasma.

Nov. 5, 1938. There was a sudden change in the appearance of the animal. *Nov. 8.* Found dead. Ulcerated, perforated bladder with peritonitis.

No. 3-10: Hound, female, middle age, 10.4 kg.

Jan. 5 to Feb. 16, 1937. During this period the femoral mean blood pressure varied between 105 and 120 mm. Hg. On *Feb. 2*, laminectomy with section of the anterior nerve roots of the spinal cord from the sixth thoracic to the second lumbar inclusive was performed, but this had no significant effect on the blood pressure.

Feb. 18. The left main renal artery was moderately constricted by a clamp. *Feb. 19 to 24.* The blood pressure rose only slightly, to 145 mm. Hg, on *Feb. 23*.

Feb. 25. The right main renal artery was moderately constricted by a clamp. *Feb. 26 to Apr. 22.* During this period the femoral mean pressure rose to 215 mm. Hg and remained at a high level until *Apr. 2*, but gradually fell to 150 mm. Hg, on *Apr. 22*. On this day, B.U.N. 31.5 mg., Cr. 1.3 mg., CO₂ 53.0 volume per 100 cc. of plasma.

Apr. 22. The constriction of the left main renal artery was increased so as to occlude the vessel. *Apr. 23, 1937, to Mar. 8, 1938.* The femoral mean blood pressure during this period of about one year again reached a maximum of 210 mm. Hg and for many months varied between 170 and 185 mm. Hg. Gradually it fell to 160 mm. Hg, on *July 26*, and, with minor variations, remained at this level.

Mar. 8. The left carotid sinus was excised. *Nov. 9 to Apr. 13.* The femoral mean blood pressure varied between 145 and 165 mm. Hg. On *Apr. 13* it was still 160 mm. Hg.

Apr. 13, 1938. The right carotid sinus was excised. There was no immediate effect on the blood pressure. In the afternoon the dog was found dead.

No. 4-36: Police, female, young, 19 kg. (See Text-fig. 3.)

Oct. 14 to Dec. 6, 1938. During the normal period the femoral mean blood pressure varied between 120 and 145 mm. Hg.

Dec. 6. B.U.N. 10.5 mg., Cr. 1.6 mg., CO₂ 52.0 volumes per 100 cc. of plasma. The right main renal artery and two main left renal arteries were moderately constricted by clamps. (See LRK, Text-fig. 3.) *Dec. 7, 1938, to May 23, 1939.* During this period the femoral mean blood pressure showed a slight rise to 165 mm. Hg and remained quite constant at this level. Only once was the blood pressure well above this level.

May 23. To test whether the removal of both carotid sinuses would cause increased elevation of blood pressure, the right carotid sinus was extirpated on *May 23* (see LCS, Text-fig. 3), and the left, on *May 25* (see RCS, Text-fig. 3). On *May 24* and *25* the femoral mean pressure was 170 mm. Hg. *May 26 to July 20.* The femoral mean pressure varied between 130 and 170 mm. Hg. There was no significant elevation of blood pressure as a result of excision of both carotid sinuses.

July 20, 1939. The constriction of the left main renal artery was increased so as to occlude the vessel. (See LKC, Text-fig. 3.) The next day the femoral mean blood pressure rose to 190 mm. Hg and increased daily until it reached 255 mm. Hg on *July 27*.

From that it varied between 195 and 255 mm. Hg, with practically all values above 200 mm. Hg. The increased constriction of one renal artery accomplished what the excision of the carotid sinuses failed to do.

The animal is still alive.

SUMMARY AND CONCLUSIONS

Excision of both carotid sinuses, with or without section of cardio-aortic inhibitor fibers, was not followed by a significant change of femoral mean blood pressure from the normal. This procedure did not interfere with the development of hypertension produced by renal ischemia. There was no significant difference between the levels of hypertension due to renal ischemia in animals with both carotid sinuses previously excised and in those with both carotid sinuses intact.

In one of three animals with hypertension due to renal ischemia, in which the elevated blood pressure had gradually subsided, there was a slight and only temporary reelevation of pressure after excision of both carotid sinuses. In the other two animals, excision of the carotid sinuses had no effect on the blood pressure. In all three, however, increased constriction of the renal arteries caused significant and persistent reelevation of the blood pressure.

The carotid sinus has no demonstrable influence upon hypertension caused by renal ischemia, although in such animals it probably plays the same part in the regulation of blood pressure as it does in normal animals (7).

BIBLIOGRAPHY

1. Bouckaert, J. J., Elaut, L., and Heymans, C., *J. Physiol.*, 1936, **89**, 3P.
2. Goldblatt, H., Lynch, J., Hanzal, R. F., and Summerville, W. W., *J. Exp. Med.*, 1934, **59**, 347.
3. Verney, E. B., and Vogt, M., *Quart. J. Exp. Physiol.*, 1938, **28**, 253.
4. Goldblatt, H., *Ann. Int. Med.*, 1937, **11**, 69.
5. Goldblatt, H., *Harvey Lectures*, 1937-38, **33**, 237.
6. Goldblatt, H., *J. Exp. Med.*, 1938, **67**, 809.
7. Heymans, C., and Brouha, L., *Le tonus vasculaire, Journées Internationales Périodiques de Cardiologie de Royat*, 1937.