The Origin and Clinical Significance of Thyroid Murmur

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SUMMARY

The thyroid murmur was analyzed in respect to the various characteristics of the murmur per se, the changing aspects in the diseased state as well as the process of the therapy, and finally the pathogenesis by angiography and cast preparations of the thyroid.

1. The thyroid murmur was recorded in 37 out of 39 cases of hyperthyroidism and it was often continuous murmur with systolic accentuation. The murmur was best recorded at the isthmus of the gland, and the murmur over the right lobe was significantly louder in many cases. The reason of this localization was discussed, based on the anatomy of the vessels.

2. The intensity and duration of the murmur were well correlated with the severity of the signs and symptoms in the individual case. Thus it is concluded that the routine phonography of the thyroid gland has an important diagnostic value in the assessment of the diseased state as well as the objective judgement of the treatment.

3. Investigated by the angiography and cast preparations, the most probable origin of the thyroid murmur was mainly in the region of the arterio-venous and arterio-arterial anastomoses. The accessory importance of the other conditions, such as hyperkinetic state and the compression of the artery by the congestion of the gland, was also discussed.

Additional Indexing Words:
Auscultation Phonocardiography Severity of hyperthyroidism Angiography Cast preparation Arteriovenous anastomoses

It is well-known that many phonocardiographic features characterize the hyperkinetic circulatory state caused by hyperthyroidism. These are the precordial vibratory phenomena and the characteristic acoustical events in

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the neck. Of these, the thyroid murmur, probably originating in the peripheral arterio-venous fistula, has not been well studied by modern phonocardiography (phonoangiography) as well as angiography of the thyroid.

The present communication illustrates the various characteristics of the thyroid murmur with special reference to many facets of the disease process. Particular attention is paid on the origin of the murmur which is investigated by the angiography of the thyroid and its cast preparation.

**Materials and Methods**

**Materials:** Thirty-nine cases of hyperthyroidism aged from 15 to 59 were studied. Forty patients with simple goiter were similarly studied as control. In severe cases the subjective complaints such as palpitation, exophthalmos, tremor, hyperhydrosis and weight loss were present, and the objective findings including BMR, I\(^{131}\)-uptake, I\(^{131}\)-T\(_3\)-RSU, I\(^{131}\)-RU, and serum cholesterol were definitely abnormal. Mild cases were those who had some of the subjective complaints and only slight abnormality in the objective findings. The moderate cases were those in between these two. Of the 18 cases studied, 10 had been treated with isotope (I\(^{131}\)) with a dose of 10,000 rad. per Gm. of thyroid calculated by the Allen-Goodwin formula. The other 8 was treated by PTU (propylthiouracil) with a daily dose of 150-300 mg.

**Phonocardiogram:** Thyroid murmur was recorded using the Mingograph-Cardirex Siemens 31B and a crystal microphone. Paper speed was 50 mm. per sec. Prior to the recordings, the patients was ordered to have the rest of 10 to 20 min. The same examiner held the microphone as much as possible to minimize the changes of murmur by pressure applied to the microphone. Recordings were done in the supine position placing the microphone over the struma at the isthmus and laterally over the upper and lower portions of both right and left lobes at a constant amplification through each filter. The maximum amplitude of the murmur during the peak of systolic accentuation was measured from the mean value of 5-6 beats recorded in the held expiration. All recordings were made only after confirming that there was no notable change in thyroid murmur secondary to changes of body position, jugular vein compression or respiration. Thus, the thyroid murmur was strictly distinguished from the intracardiac or carotid murmurs and the venous hum.

**Angiography and cast preparation:** There are several ways of performing microangiography of extirpated thyroid gland, such as the method of Schlesinger\(^4,5\)} or the Ringer solution added gelatin injection method. However, there are several difficulties with these established techniques: it is not possible to obtain angiography and cast preparations simultaneously, and since these fluids do not congeal rapidly, they tend to leak through the injured vessels of the ruptured thyroid capsule. Considering the imperfectness of the previous methods, the following improved technique was utilized in the present study: The thyroid gland obtained at surgery or at autopsies was immediately washed thoroughly with Ringer's solution of 37°C. In a majority of cases, a solution of 7-8 centipoises* of 20%

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* The viscosity of blood is approximately 4 centipoises.
Micropaque and Neopren Latex in equal concentration was injected into the A. thyreoidea superior and inferior at the pressure of about 100 mm.Hg. Subsequently, the thyroid glands were left for approximately one hour at room temperature and then radiographed with Softex CMBR X-rays. The X-ray film used was KODAK 649–0 type. Then the parenchyma of the thyroid glands were dissolved with 40% sodium hydroxide to get a cast preparation of the thyroid vessels. In a few cases, the anatomy of the vessel was further studied by the cast preparations using resin.\textsuperscript{7,8} The cases of angiography and cast preparation were as follows: 5 cases of hyper-thyroidism, 2 of simple goiter, one of thyroid cancer and 2 of normal autopsied.

**Results**

1. Incidence and location of thyroid murmur (Fig. 1): The thyroid murmur was audible in 35 (87%) out of 39 hyperthyroid cases with apparent struma, whereas it was recorded in 37 cases (94.8%). As for the control group it was neither audible nor recordable in any patients except a case discussed later. The murmur was best heard at the thyroid isthmus and somewhat less well heard at the point lateral to the upper portion of the right lobe. It was especially audible at the soft portion of the large struma.

2. Thyroid murmur and clinical findings: The intensity of the murmur was correlated well with the severity of hyperthyroidism (Fig. 2). There was

![Fig. 1. Frequency of various localizations of the thyroid murmur.](image)

1) isthmus
2) lateral to the upper portion of the right lobe
3) lateral to the lower portion of the right lobe
4) lateral to the lower portion of the left lobe
5) lateral to the upper portion of the left lobe
considerable correlation between the maximum amplitude of the murmur, the BMR, the I$^{131}$-uptake, and I$^{131}$-$T_3$-RU (Fig. 3). Fig. 4 demonstrates typical cases in which the thyroid murmur was revealed to be continuous with a systolic accentuation. The severer the case is, the larger and longer the systolic accentuation. In milder case, the systolic accentuation was less prominent and tended to be limited only to the systolic phase and characterized phonocardiographically by a spindle shape.

3. Effect of therapy on thyroid murmur (Fig. 5): With isotope therapy, the thyroid murmur was abolished in 4 in which the struma disappeared. In the other 6 cases, the murmur diminished in intensity with concomitant improvement in both subjective and objective findings.

With PTU therapy, however, the murmur diminished in 3 out of 8 cases without improvement in the size of struma. The other objective as well as subjective improvements were noticed in these 3 cases, and the improve-
ments were not observed in the remainder.

Though there was the parallelism between the intensity of the thyroid murmur and the thyroid function in the individual cases, the following 2 cases deserve to the detailed description.

Patient M.S.: A 21-year-old female with severe hyperthyroidism had a thrill and intense murmur laterally to the upper portion of the left lobe. Contrary to the expectation, the murmur did not diminish in intensity following the successful treatment with PTU. Surgical exploration revealed that the severe adhesion between A. thyreoidea superior and the surrounding tissue and the unusual branching of the artery. The presumptive conclusion to the persistence of the murmur was the abnormal anatomical situation of the artery which was probably bent to produce the stenosis.

Patient T.I.: A 20-year-old female with simple goiter erroneously treated with PTU. This case initially had no clinical manifestations except a goiter. Erroneously given PTU, 300 mg. daily for 4 months, provoked the high-pitched continuous thyroid murmur accompanied by the elevation of I\(^{131}\)-uptake after withdrawal of PTU. The murmur was abolished 3 weeks later (Fig. 6).

4. Angiographic and cast model findings: Thyroid vessels examined
by X-rays and photography of the cast preparations demonstrated several characteristics, such as the marked growth of the smaller vessels, serpiginous blood vessels, and many arterio-arterial and arterio-venous anastomoses (Fig. 7, 8).

The microangiogram taken by the Softex of a 200μ. piece of tissue showed a number of "basket" form vessel structure arising from arteries of 40–100 μ. to the venules or the capillary nets and many arterio-arterial and arterio-venous anastomoses (Fig. 9, 10). A look of the Hematoxylin-Eosin staining of the identical tissue piece of 20μ. in thickness microscopically showed that the contrast medium was successfully injected from the smaller arteries and veins to the capillary without leakage (Fig. 11). The cast preparation with resins proved, in 80–100μ. part, a number of the arterio-arterial and arterio-venous anastomoses filled with the mixture of red acryric resin injected from the artery and blue acryric resin injected from the vein (Fig. 12).
Fig. 5. The change of the thyroid murmur before (left tracings) and after (right tracings) treatment in 3 demonstrable cases. After PTU and isotope therapy the thyroid murmur decreased in intensity.
Fig. 6. A case of simple goiter, erroneously treated by PTU. After the withdrawal of PTU, the value of $^{131}I$ uptake increased, but the $^{131}I-T_3$RSU and $^{131}I-T_3$RU were within normal range. After PTU given up, the thyroid murmur decreased in intensity.

Fig. 7. The cast preparation of thyroid vessels of hyperthyroidism by the Neopren-Latex. The serpiginous blood vessels and many anastomoses are seen.
DISCUSSION

The present study firstly disclosed that the thyroid murmur is continuous in nature with systolic accentuation especially in severe cases, while in mild or treated cases the murmur assumes a spindle form, the pattern of which is similar to that of arterial pulse wave. According to Lian, the thyroid murmur had continuous character in only 20% of patients, whereas other investigators pointed out the high incidence of the continuous murmur especially in severe cases. The present result revealed that the incidence of various types of the murmur depends on the diseased process and the stage of the treatment. The over-all incidence of the thyroid murmur is
also dependent on the various factors, but the real incidence is probably high in cases with apparent struma as in the result of the present study.

According to Lian, the thyroid murmur originates from a. thyreoidea superior and this may explain the localization of the murmur in some cases of thyroid murmur. The prominence of the murmur laterally to the right lobe may well be explained by the branching of the thyroid vessels. In view of such a relationship, however, the high incidence of the murmur over the isthmus in the present study is not explained with a good reason (see below).

As to the pathogenesis, it has been believed that the thyroid murmur may be caused by arterio-venous fistulas. This is manifested by either the increased oxygen saturation in venous blood of thyroid gland or the character of the murmur usually heard in any arterio-venous shunt. This is further elucidated by the special method in the present study, by which the arterio-arterial or arterio-venous anastomoses of basket type were clearly demonstrated in cases with thyroid murmur. The high incidence of the maximal audibility of the murmur over the isthmus may be explained by the rich anastomoses in this area, but this has to be clarified by further examinations.

Though the present study did not deal with the hemodynamic aspect of the hyperthyroidism, it is obvious that the accelerated blood flow due to hyperkinetic state in hyperthyroidism plays a role in the genesis of the thyroid murmur. This is easily understandable, because the intensity of the murmur diminishes following an appropriate therapy. However, the appearance of the loud continuous murmur after prolonged PTU therapy in a case of simple goiter strongly suggests that the primary importance of the origin of the murmur is the proliferation of vessels accompanied by the hyper-
plasia of the gland,17,18) which is not always accompanied by the hyperkinetic state. Another accessory factor of the murmur seems to be the congested thyroid gland with a tense capsule, which may produce the stenosis of the arteries and the corresponding vascular murmurs.

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