

February 2007

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### Recommended Citation

Roth, Lawrence M. and Talerman, Aleksander, "The enigma of struma ovarii" (2007). *Department of Pathology, Anatomy and Cell Biology Faculty Papers*. Paper 19.

<http://jdc.jefferson.edu/pacbfp/19>

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# The enigma of struma ovarii

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## Keywords:

Struma ovarii, germ cell tumours, monodermal teratoma, peritoneal strumosis, malignant struma, papillary carcinoma, follicular carcinoma, ovary.

## Summary

Since its first description in the early part of the twentieth century, struma ovarii has elicited considerable interest because of its many unique features; however, at present a number of aspects remain enigmatic. Although the typical presentation is that of a pelvic mass, unusual clinical manifestations such as hyperthyroidism, ascites, and Meigs' syndrome have been recognised. Uncommon macroscopic and especially histological patterns in struma can cause difficulties in diagnosis. Cystic strumas are challenging to diagnose both macroscopically and histologically. Proliferative changes within struma can be misdiagnosed as cancer. In regard to the occurrence of thyroid-type carcinoma in struma ovarii, precise terminology should be utilised, and the term 'malignant struma ovarii' should be avoided because it has been used for several different pathological entities. Papillary carcinoma is the most commonly occurring thyroid-type carcinoma in ovarian struma; however, cases of follicular carcinoma are not infrequent. Histological malignancy in struma does not necessarily equate with biological

malignancy, and the majority of thyroid-type carcinomas do not spread beyond the ovary. Strumal carcinoid, a neoplasm apparently unique to the ovary containing elements of both struma and carcinoid, has been misdiagnosed as 'malignant struma ovarii' in the past. The differential diagnosis of extra-ovarian spread of struma includes the usual types of thyroid cancer, minimal deviation follicular carcinoma, and peritoneal strumosis. This review emphasises articles both recent and past that have significantly advanced our knowledge of struma ovarii and related neoplasms.

## INTRODUCTION

Unusual aspects of struma ovarii have elicited considerable interest since its first description. Although it had been described earlier, Ludwig Pick first recognised that struma ovarii was composed of thyroid tissue in the early part of the twentieth century and suggested that ovarian goitres are actually teratomas in which thyroidal elements have overgrown the other tissues.<sup>1,2</sup> In 1933, Plaut showed that the thyroid tissue in struma ovarii is morphologically, biochemically, and pharmacologically identical to that of the cervical thyroid gland.<sup>3</sup> Smith reviewed the literature, and found 152 cases up to 1946 of which approximately 5% had extra-ovarian dissemination.<sup>4</sup> In their monograph on ovarian tumours, Fox and Langley concisely and accurately summarised our knowledge of struma ovarii up to 1976.<sup>5</sup> In the same year Yannopoulos and associates comprehensively reviewed the literature regarding malignant struma ovarii.<sup>6</sup> In the latest World Health Organization (WHO) classification, struma ovarii and malignant thyroid tumours arising within struma are included in the thyroid tumour group under the heading monodermal teratoma and somatic-type tumours associated with dermoid cysts.<sup>7</sup> In that regard struma ovarii is the most common type of monodermal teratoma, accounting for nearly 3% of all ovarian teratomas.<sup>8</sup> It is defined as an ovarian teratoma that is composed predominantly (over 50%) or entirely of thyroid tissue or forms a macroscopically recognisable component of mature cystic teratoma.<sup>9</sup> Also included in this category, however, are cases of mature cystic teratoma having less than 50% thyroid tissue that contain functional or histologically or biologically malignant thyroid tissue.<sup>10</sup>

Although thyroid tissue can be identified histologically in up to 20% of cases of mature

cystic teratoma, it is macroscopically recognised in less than 3%.<sup>9</sup> The age incidence of struma ovarii is similar to that of mature cystic teratoma. The peak age incidence of struma is in the fifth decade, but cases have been reported in older post-menopausal women and uncommonly occur in pre-pubertal girls.<sup>9</sup> In addition to the usual signs and symptoms of a pelvic mass, ascites occurs in one-third of cases, and occasional patients have Meigs' syndrome. Clinical evidence of hyperthyroidism occurs in about 5% of cases.<sup>9</sup> Thyrotoxic crisis is a rare, but life threatening complication following excision of struma in which hyperthyroidism was not diagnosed pre-operatively.<sup>11</sup> Struma ovarii is the most common type of ovarian tumour associated with peripheral steroid cell formation.<sup>12</sup> Strumal carcinoid, a neoplasm unique to the ovary, is composed of both monodermal teratoma (struma) and secondary somatic tumour (carcinoid). Although classified by the WHO as a form of carcinoid, it alternatively can be interpreted as struma with a secondary somatic neoplasm and for that reason will be discussed in this review. Struma ovarii containing thyroid- type carcinoma must be distinguished from rare cases of papillary or follicular thyroid carcinoma metastatic to the ovary.<sup>13,14</sup> Extrathyroidal strumas are not limited to the ovary. We are aware of two cases of struma salpingii, one of which was associated with struma ovarii.<sup>15,16</sup> A case of struma uteri attached to the uterine cervix and vaginal wall unaccompanied by other teratomatous elements has recently been reported.<sup>17</sup> Infrequently struma has been described in the testis.<sup>18,19</sup>

## UNUSUAL MACROSCOPIC APPEARANCES

Struma is typically identified as a brown or green-brown solid, gelatinous mass, either in

pure form or less frequently associated with mature cystic teratoma or rarely with mucinous cystadenoma or Brenner tumour (Fig. 1A). Although most cases of struma ovarii are solid or solid and cystic on macroscopic examination, predominantly or entirely cystic tumours can lead to errors in diagnosis (Fig. 1B).<sup>20</sup> Most of the latter cases are multilocular cysts, but about 10% are unilocular. In most cases small solid areas protrude into the cyst lumens or are noted in the cyst wall. The non-specific histological appearance of large areas of many cystic strumas compounds the diagnostic difficulty (see following section).

## UNUSUAL HISTOLOGICAL PATTERNS AND CELL TYPES

Struma ovarii typically consists of normal-appearing thyroidal tissue composed of thyroid follicles of various sizes and often is associated with mature cystic teratoma (Fig.2A,B). Occasionally, the thyroid tissue may show changes associated with hyperactivity, hypoactivity, or have the appearance of an adenomatous nodule or nodular goiter.<sup>8</sup> Histologically, ovarian struma can also resemble thyroid adenoma of follicular, fetal, or embryonal type or thyroid carcinoma;<sup>9,21</sup> however, if there are unequivocal histological features of malignancy, this finding should be indicated in the diagnosis. Although in some cases the appearance has been recognized as that of thyroid adenoma, these tumors have generally been reported under the term 'struma ovarii.' Perhaps our understanding of these lesions and assessment of their malignant potential would be better served by diagnosing such lesions as 'struma ovarii with features of multinodular adenomatous goitre or thyroid-type adenoma,' specifying the type. Changes of toxic goitre occasionally may be seen in struma ovarii associated with clinical hyperactivity, including small follicles lined by hyperplastic epithelium with pseudopapillary infoldings as well as pale

and peripherally vacuolated colloid. Focal lymphocytic infiltrates can occur. These histological alterations must be distinguished from thyroid-type papillary carcinoma. Rarely, struma takes the form of Hashimoto's (automimmune) thyroiditis.<sup>22,23</sup>

Although typical struma ovarii is readily identified, unusual histological manifestation may lead to failure of recognition.<sup>24</sup> These include solid patterns, prominent microfollicles conveying a pseudotubular appearance, abundant eosinophilic cytoplasm imparting an oxyphilic appearance, and abundant clear cytoplasm. Not infrequently, the various patterns and cell types overlap. Recognition of these patterns together with a careful search for thyroid follicles, the presence in some cases of birefringent calcium oxalate crystals in the colloid, and immunohistochemical stains for thyroglobulin or thyroid transcription factor-1 (TTF-1) will confirm the diagnosis in problematic cases.

As stated earlier, struma ovarii can have a histological appearance that mimics thyroid-type adenoma. Of the unusual histological growth patterns, the solid pattern is most often encountered. This type consists of nests or sheets of tumor cells that may be interrupted to a variable extent by small numbers of thyroid follicles, usually microfollicles. In some cases trabecular, pseudotubular, or thin, cord-like formations can occur (Fig. 2C). The microfollicular pattern is the next most common type encountered. On low magnification, microfollicles are prominent which are either empty or contain eosinophilic colloid.

In neoplasms displaying either a solid or microfollicular pattern the tumour cells usually have moderate amounts of pale eosinophilic cytoplasm, but in some instances most of the neoplastic cells have abundant eosinophilic or clear cytoplasm. Tumours with an oxyphilic

appearance may be confused with a variety of oxyphilic cell tumours both primary and metastatic including hepatoid carcinoma, oxyphilic Sertoli cell tumour, and metastatic melanoma and hepatocellular carcinoma; cases of struma with a clear cell appearance must be distinguished from primary ovarian clear cell adenocarcinoma or metastatic renal cell carcinoma.<sup>9,24</sup>

Struma ovarii can mimic ovarian tumours in the sex-cord-stromal category. Struma having a pseudotubular pattern can mimic Sertoli cell tumour, and one with a cord-like arrangement with small follicles resembles granulosa cell tumour. Strumas with a nest-like pattern separated by delicate fibrovascular septa resemble paraganglioma. Recognition of areas of the neoplasm that exhibit the more typical patterns of struma ovarii and/or immunohistochemical stains for thyroglobulin or TTF-1 can assist in the differential diagnosis.

The various patterns of struma can be confused with carcinoid. The microfollicular variant can be confused with acinar formation in an insular carcinoid, and a trabecular pattern can be mistaken for trabecular or strumal carcinoid.

As mentioned in the previous section, the epithelium lining the variably sized cysts of predominantly cystic strumas can have a largely non-specific appearance composed of flattened to cuboidal cells.<sup>20</sup> Clues to the correct diagnosis include the identification of thyroid follicles in the cyst wall or in fibrous septa separating locules of tumour, the detection of foci of typical struma through ample sampling, or the association with mature cystic teratoma. In some cases, immunohistochemical staining for thyroglobulin or TTF-1 may be required to establish or confirm the diagnosis.<sup>25</sup>



Occasional strumas contain mucin in follicular lumens or are admixed with mucinous elements. In patients who have been subjected to pelvic radiation, isolated nuclear atypia can occur, and these alterations need to be distinguished from those of malignancy.<sup>21</sup>

## ASSOCIATION OF STRUMA OVARIUM WITH NON-THYROID NEOPLASMS

Struma ovarii is an obligatory component of strumal carcinoid and occasionally is associated with other neoplasms of somatic type including Brenner tumor and mucinous cystadenoma that also can accompany mature cystic teratoma.

### Strumal carcinoid

Strumal carcinoid is a distinctive form of ovarian teratoma characterized by a mixture of thyroid tissue and carcinoid; other teratomatous elements are noted in over 80% of cases. It is the second most common type of primary ovarian carcinoid and is usually discussed along with other forms of that neoplasm. We interpret strumal carcinoid as a monodermal teratoma (struma) with a secondary somatic tumour (carcinoid) (Table 1). Strumal carcinoid has been reported in a patient with multiple endocrine neoplasia syndrome type 2A (Sipple's syndrome).<sup>27</sup> Metastasis in strumal carcinoid is uncommon, occurring in about 2% of cases.<sup>26,28</sup>

The thyroid and carcinoid components can be intimately admixed or may be distinct macroscopically and histologically (Fig. 3). Even in the cases where the thyroid and

carcinoid components are distinct, there is usually an admixture of these elements at their interface, suggesting that the carcinoid arises from the struma. In areas where the thyroid tissue is pure, it can resemble normal thyroid, colloid goitre, macrofollicular or microfollicular adenoma, or rarely can be manifest as papillary or follicular thyroid-type carcinoma.<sup>26</sup> The neoplastic neuroendocrine cells have a higher growth rate and progressively invade the struma, replacing the follicular lining cells.<sup>29</sup> Glands or cysts containing goblet cells can occur, and occasionally the tumour is associated with a mucinous (goblet cell) carcinoid.<sup>30</sup> The carcinoid component has a trabecular pattern in about one-half of cases, most of the others show a mixed trabecular and insular pattern, and occasional cases have a pure insular appearance.<sup>9</sup>

The thyroidal component of strumal carcinoid expresses TTF-1; however, the carcinoid element is for the most part negative, indicating that the carcinoid component bears no relationship to thyroidal differentiation.<sup>31</sup> The neuroendocrine component of strumal carcinoid is frequently positive for chromogranin, somatostatin, and serotonin.<sup>32</sup> The thyroidal component is positive for thyroxine, and several neoplasms have contained calcitonin-positive cells (Fig. 4);<sup>29,33</sup> however, calcitonin has also been detected in 2 of 15 cases of trabecular carcinoid, a neoplasm that does not contain thyroid elements.<sup>34</sup> In strumal carcinoid amyloid deposits can occur in proximity to the calcitonin-producing cells.<sup>35,36</sup> Despite these similarities, the histological appearance of strumal carcinoid differs significantly from that of medullary thyroid carcinoma. Neurosecretory granules observed by electron microscopy resemble those of both trabecular carcinoid and medullary thyroid carcinoma (Fig. 5). On occasion, strumal carcinoid, like trabecular carcinoid, can cause severe constipation due to tumour-producing peptide YY.<sup>37,38</sup> Constipation resolves after removal of the tumour. The neoplastic neuroendocrine cells are strongly positive for peptide

YY by immunocytochemistry.

The differential diagnosis of strumal carcinoid includes trabecular carcinoid, a neoplasm that is only one-third as common as strumal carcinoid. Cases with a presumptive diagnosis of trabecular carcinoid should be thoroughly sampled histologically for evidence of thyroid follicles. In the older literature cases of strumal carcinoid were misdiagnosed as 'malignant struma ovarii'; however, the histological appearance of strumal carcinoid does not closely resemble that of the various types of thyroid carcinoma.

#### Brenner tumour

Although the vast majority of ovarian Brenner tumours are of surface epithelial origin, in at least nine cases they have been associated with struma ovarii suggesting a germ cell origin.<sup>39-41</sup> Mature cystic teratoma was identified in the ipsilateral or contralateral ovary in most cases.

#### Mucinous cystadenoma

A case of struma ovarii with coexistent mucinous cystadenoma in the absence of biphasic or triphasic teratoma has been reported<sup>42</sup> and represents mixed endodermal differentiation in monodermal teratoma. This association is not unexpected, since endodermally-derived mucinous cystadenoma also occurs in cases of mature cystic teratoma.

## ASSOCIATION OF STRUMA OVARII WITH THYROID-TYPE CARCINOMA

With regard to the occurrence of malignancy in struma ovarii the literature is confusing since many of the cases reported as 'malignant struma ovarii' have been misdiagnosed and no large series has been carefully documented. A number of cases reported as 'malignant struma ovarii' in the older literature were actually examples of strumal or insular carcinoid.<sup>10</sup> Due to inadequate sampling of the primary tumour an important component may be missed leading to an inaccurate diagnosis. Uniformly accepted criteria for malignancy in struma ovarii have yet to be established.<sup>9</sup> Because of varying usage and the lack of a precise definition, it is recommended that the term 'malignant struma ovarii' no longer be utilised for cases of malignancy that develop in ovarian struma. The term, 'thyroid-type carcinoma originating in struma ovarii' (specifying the type) is more appropriate to describe this entity.

Strict histological criteria are required for the diagnosis of carcinoma because proliferative changes including areas of densely packed follicles or pseudopapillary formations in the struma can be confused with malignancy.<sup>21</sup> Several different types of thyroid carcinoma arising in struma ovarii have been described. Among these are papillary carcinoma<sup>43</sup> including the follicular variant,<sup>44,45</sup> follicular carcinoma<sup>46</sup> including its oncocytic variant,<sup>47</sup> and arguably insular carcinoma,<sup>48</sup> a type of poorly differentiated carcinoma. To our knowledge the oxyphilic variant of papillary carcinoma, anaplastic carcinoma, medullary carcinoma, or other uncommon forms of thyroid carcinoma have not been reported in association with struma ovarii.

Papillary carcinoma is the most common thyroid-type carcinoma to occur in struma

ovarii. Criteria for papillary carcinoma include overlapping, ground glass, irregularly contoured nuclei lining papillary formations with fibrovascular cores or vascular invasion; however, not all these features need be identified to establish the diagnosis (Fig. 6).<sup>21</sup> These tumours exhibit nuclear features similar to those of their counterparts in the thyroid gland including grooves, intranuclear cytoplasmic inclusions, and finely granular chromatin. The identification of psammoma bodies in the context of a thyroid-type papillary neoplasm is highly supportive of the diagnosis of malignancy. Similar nuclear features are present in the follicular variant of papillary thyroid carcinoma; however, papillary architecture is absent.

Follicular carcinoma is the second most common type of carcinoma to arise in struma ovarii and varies in its degree of differentiation (Fig. 7). The diagnosis of well-differentiated follicular thyroid-type carcinoma is more difficult than that of papillary carcinoma since capsular invasion is an important criterion in follicular carcinoma located in the neck but there is usually no capsule in the corresponding ovarian lesion. In such cases the identification of invasion into the surrounding ovarian tissue, vascular invasion, or metastases is evidence of malignancy. The oncocytic variant of follicular carcinoma is similar in appearance to that of classical follicular carcinoma, but the cytoplasm is abundant, eosinophilic, and granular.

Insular carcinoma is infrequent. It is a morphologically distinct type of poorly differentiated thyroid carcinoma of follicular cell origin that forms nests or islands composed of monotonous small cells with rounded nuclei and scant cytoplasm.<sup>49</sup> Although the tumour predominantly has a solid infiltrative growth pattern, microfollicles are frequently encountered, some of which contain colloid. Vascular invasion is common, and variable numbers of mitoses are present.

These histological changes of malignancy in struma, however, often do not equate with clinical malignant behaviour, and most cases of thyroid-type carcinoma arising in struma ovarii do not have a clinically aggressive course. Occasional cases of thyroid-type carcinoma may arise in the absence of detectable benign struma ovarii. In these cases the malignancy may arise from thyroid tissue in mature cystic teratoma and overgrow the tissue without forming typical struma ovarii.

Struma ovarii containing thyroid-type carcinoma must be distinguished from rare instances of follicular, papillary, or other types of thyroid carcinoma metastatic to the ovary.<sup>13,14</sup> Cases of the latter are not associated with mature cystic teratoma and often show the typical patterns of metastatic tumour in the ovary. They usually have a prior history of thyroid carcinoma, but in one case the primary tumour had been resected 12 years earlier.<sup>14</sup>

#### EXTRA-OVARIAN SPREAD OF STRUMA HAVING AN INNOCUOUS APPEARANCE

If thyroid-type carcinomas of conventional type spread to the peritoneum, the diagnosis is easily made. However, the occurrence in the peritoneal cavity of thyroid tissue that has an innocuous appearance causes diagnostic and nosological problems.

Struma ovarii with peritoneal dissemination (peritoneal stunosis)

Uncommonly, cases of struma ovarii with extra-ovarian spread can have a histologically

benign appearance. The term 'peritoneal strumosis' or 'strumatosiis' has been applied by some for benign-appearing peritoneal implants detected at the time of laparotomy in the absence of an identifiable somatic thyroid-type carcinoma (Fig. 8).<sup>50</sup> The terminology has not been uniformly applied, and two similar cases were referred to as 'malignant struma ovarii' with peritoneal dissemination.<sup>51</sup>

These cases typically have an indolent clinical course, however only a few cases have long follow up.<sup>50,51</sup> One explanation of these cases is that they represent implants from struma ovarii or mature cystic teratoma containing thyroid tissue due to capsular tears or tumour rupture, although to our knowledge such findings have never been demonstrated. Alternatively, it has been suggested that they represent spread from an extremely well-differentiated follicular carcinoma. We believe the designation 'struma ovarii with peritoneal dissemination' is most appropriate to indicate our current state of knowledge regarding this concept.

#### Minimal deviation follicular thyroid-type carcinoma

Peritoneal strumosis must be distinguished from well-differentiated follicular carcinoma arising in struma ovarii that spreads to the peritoneum. A diagnosis of peritoneal strumosis is not tenable when follicular carcinoma is present or suspected in the ovary. When follicular thyroid-type carcinoma arising in struma spreads beyond the ovary, it may involve the peritoneum as well as para-aortic lymph nodes and, when more advanced, the liver and lungs. We have encountered a case we interpret as extremely well-differentiated follicular carcinoma which had an innocuous appearance resembling that of colloid goitre, yet spread to the peritoneum and para-aortic lymph nodes (Fig. 9). Such cases are similar to those

described in the thyroid gland that show such a high degree of differentiation that they simulate the appearance of non-neoplastic thyroid.<sup>49</sup> In fact similar cases occurring in the thyroid were referred to in the past by the incorrect and deservedly obsolete expression 'benign metastasising goitre'. We believe the term 'minimal deviation follicular thyroid-type carcinoma' is appropriate when the lesion arises in struma ovarii. Because of its innocuous appearance, extra-ovarian dissemination must occur before the diagnosis is established. The corollary of this hypothesis is that cases with the appearance of typical struma ovarii can rarely metastasise in the absence of atypical features.

As indicated above, it is not possible to distinguish peritoneal strumosis from this variant of follicular carcinoma histologically. As far as we know, in all cases that can be interpreted as peritoneal strumosis in the literature, the extra-ovarian spread was detected at the time of initial diagnosis of the struma.<sup>50-53</sup> It is likely that cases where extra-ovarian spread occurs subsequent to the excision of the struma are, in fact, metastatic thyroid carcinoma. If pelvic lymph nodes or distant metastases occur, then the diagnosis of metastatic carcinoma can be fully established. Nevertheless, there are cases where the diagnosis is problematic, and it may be necessary to rely on outcome data to establish the diagnosis. To establish a diagnosis of strumosis, a follow up of at least 5 years without evidence of progression is required. However, in cases with an equivocal diagnosis treated by thyroidectomy followed by radioactive iodine therapy, it may never be possible to reach a definite conclusion.

## **CONCLUSIONS**

Although it has been more than 100 years since the first description of struma ovarii, a number of aspects remain enigmatic. Better recognition of the wide range of macroscopic



and histological features of struma will improve accuracy of diagnosis. More precise description of the spectrum of histological changes using terminology applicable to the thyroid gland as well as accurate diagnosis and long term follow up will improve our knowledge of this entity. Precise criteria should be used for the histological diagnosis of malignancy in cases of struma confined to the ovary with consideration of the proliferative changes that can mimic cancer. Malignant cases should be diagnosed according to the histological criteria for the various forms of thyroid-type carcinoma. Our assessment of the prognosis of patients with extra-ovarian dissemination of struma must include a critical appraisal of cases diagnosed as 'malignant struma ovarii' in the literature. The relationship of minimal deviation follicular carcinoma to peritoneal strumosis must be studied in order to determine if there is a reproducible way to diagnose peritoneal strumosis prospectively and indeed to establish whether it exists as a distinct entity.

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## FIGURES

Figure 1

### Struma ovarii

(figures courtesy of Drs. Robert E. Scully and Robert H. Young, Boston, MA USA).

(A) Note the solid, red-brown area of thyroid tissue, on the left adjacent to mature cystic teratoma.

(B) Cystic struma consists of a multiloculated cyst that contains green to brown gelatinous material.

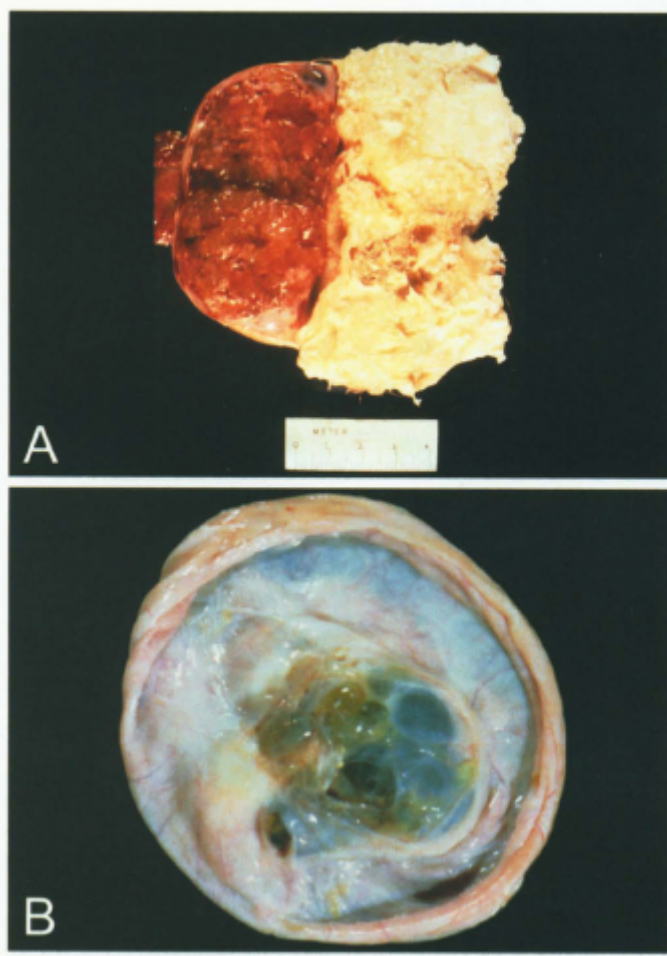


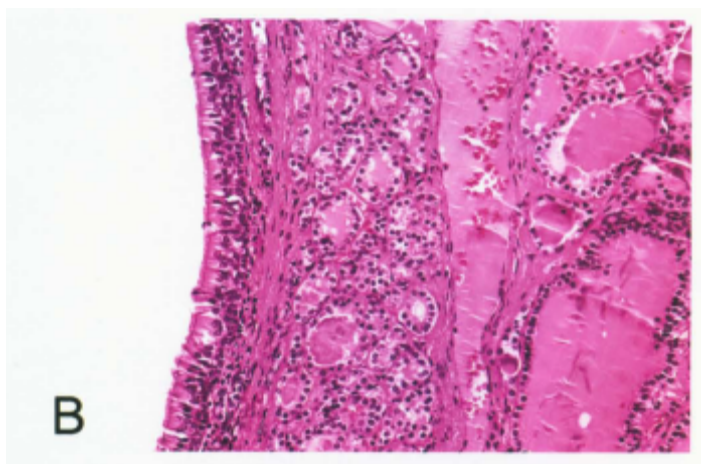
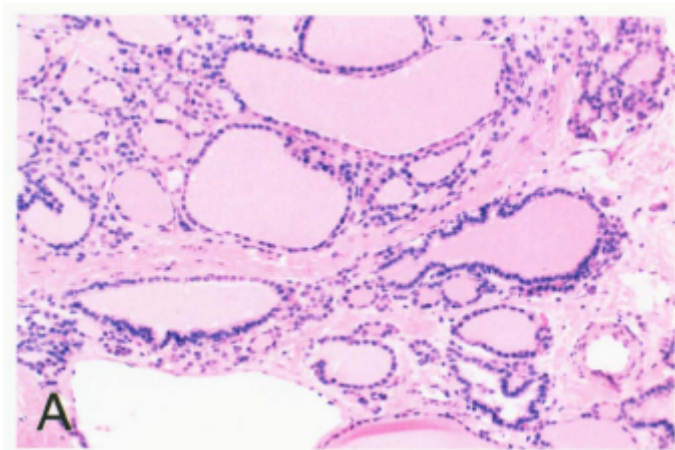
Figure 2

Struma ovarii.

(A) Colloid-containing follicles of varying size are noted. Some of the follicles are irregular in shape.

(B) Macrofollicular and microfollicular pattern is contiguous to ciliated columnar epithelium of mature cystic teratoma on the left.

(C) Struma ovarii with features of thyroid adenoma. A solid nested pattern is observed adjacent to a trabecular pattern. Ovarian stroma is noted in the upper portion of the field. Inset: Note the trabecular pattern.





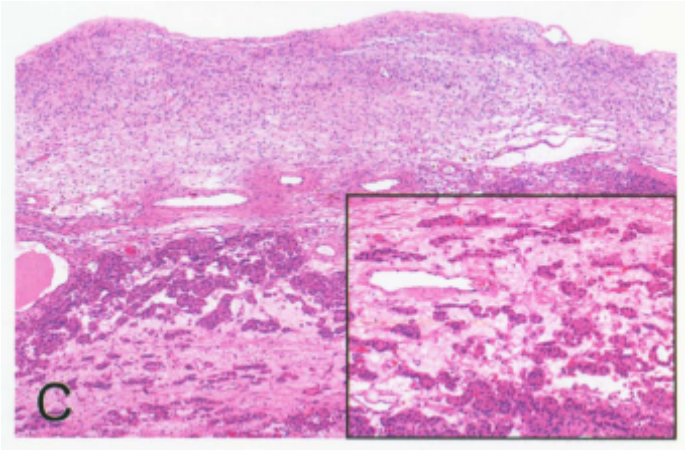


Figure 3

Strumal carcinoid.

- (A) Large brown nodule of struma is sharply demarcated from the white to pale yellow carcinoid. Note that a nodule of carcinoid is pushing into the struma suggesting that the former has a higher growth rate (figure courtesy of Dr. Fattaneh A. Tavassoli, New Haven, CT, USA).
- (B) Thyroid tissue composed of numerous colloid-containing follicles is noted on the right, and trabecular carcinoid is seen on the left.

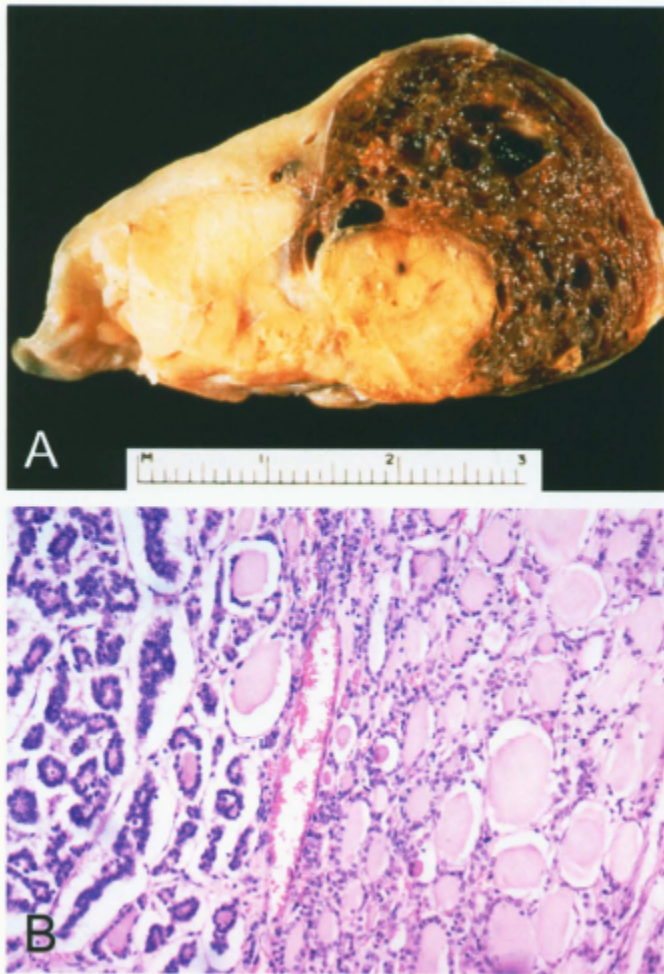


Figure 4

Strumal carcinoid.

(A) Immunostain for thyroxine is mostly positive in the follicles.

(B) Immunostain for calcitonin is positive in both the interfollicular areas and in the follicular lining epithelium. The latter finding is due to neuroendocrine cells progressively replacing the follicular epithelium due to a higher growth rate.

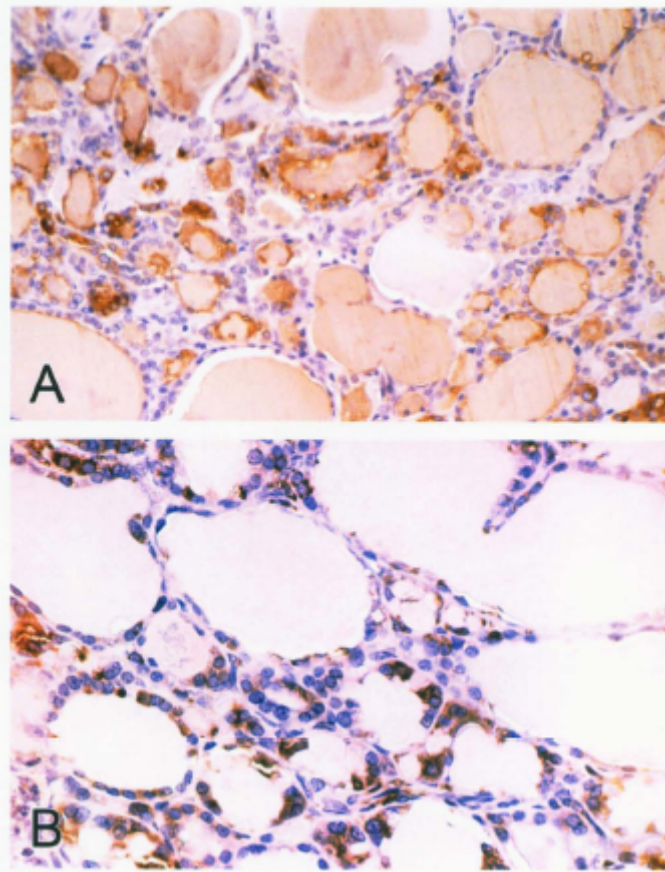


Figure 5

Strumal carcinoid.

Electron micrograph shows thyroid follicular cells adjacent to colloid at the top of the field and scattered neuroendocrine cells containing abundant small, uniform round neurosecretory granules among other follicular cells.

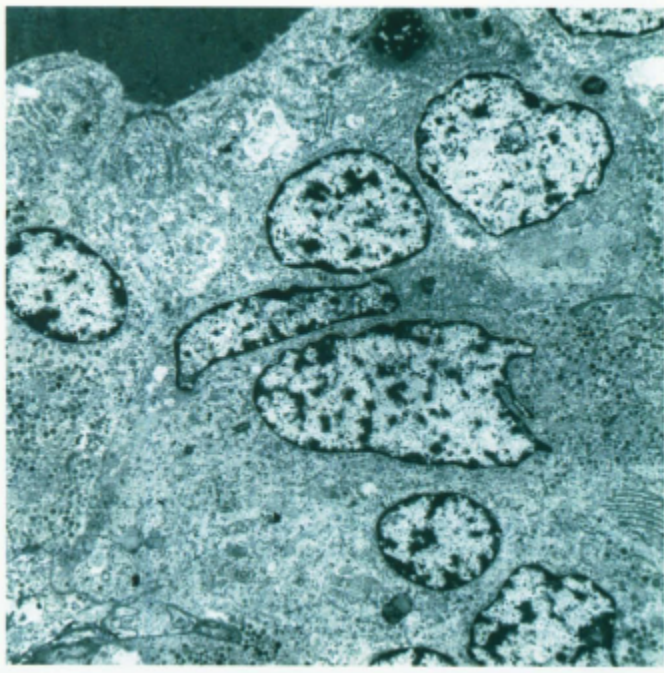


Figure 6

Papillary thyroid-type carcinoma arising in struma ovarii associated with mature cystic teratoma.

(A) The papillary neoplasm on the right is adjacent to sebaceous elements.

(B) Higher magnification shows fibrovascular cores.

Inset: Note the nuclear features of papillary carcinoma including crowded, overlapping nuclei with occasional optical clearing and prominent amphophilic nucleoli.

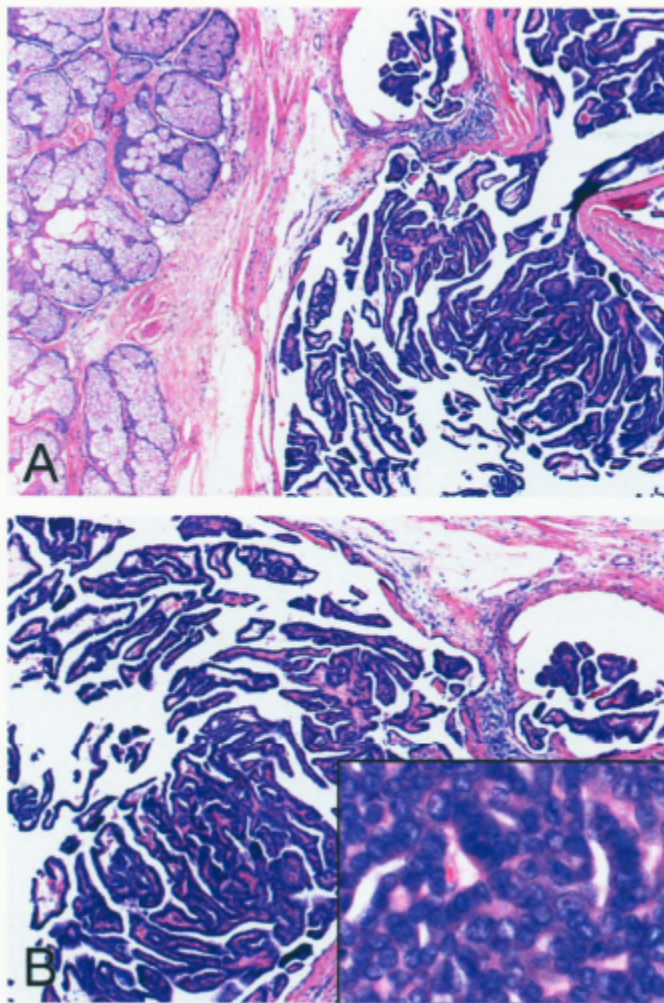


Figure 7

Invasive follicular carcinoma arising in struma ovarii.

Note several follicles of struma to the left, separated from a focus of invasive, poorly-differentiated follicular carcinoma by fibrous stroma (figure courtesy of Drs. Zhang Jianmin and Longdi Fan, Weiling, China).

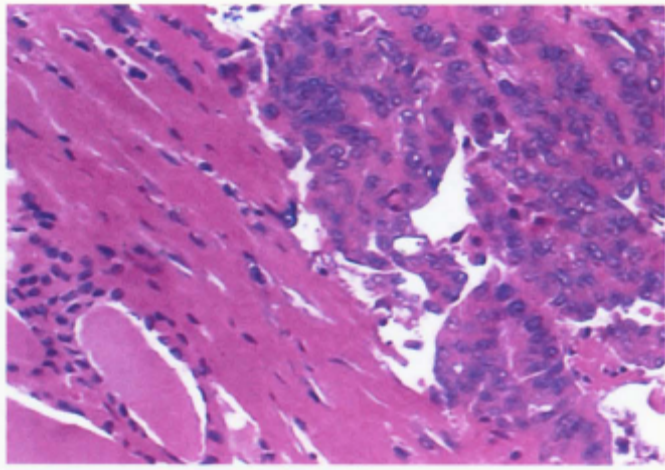


Figure 8

Struma ovarii with peritoneal dissemination (peritoneal strumosis).

Omental nodule composed of innocuous-appearing thyroid tissue has a thick fibrous capsule containing fat (figure courtesy of Dr. O. Ljungberg, Malmö, Sweden).

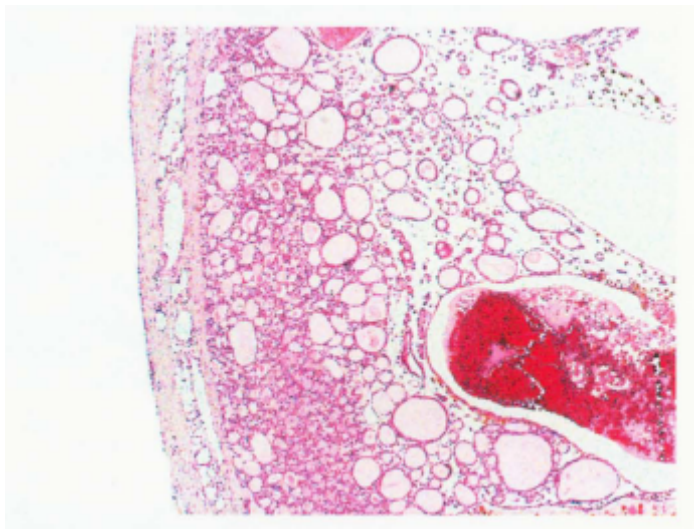


Figure 9

Metastatic minimal deviation follicular carcinoma arising in struma ovarii.

(A) Omental nodule composed of innocuous-appearing thyroid follicles surrounded by fat. The findings are histologically indistinguishable from those of peritoneal strumosis.

(B) Para-aortic lymph node shows similar thyroid follicles surrounded by lymphoid follicles containing germinal centers. Nuclear alterations of papillary thyroid-type carcinoma are absent.

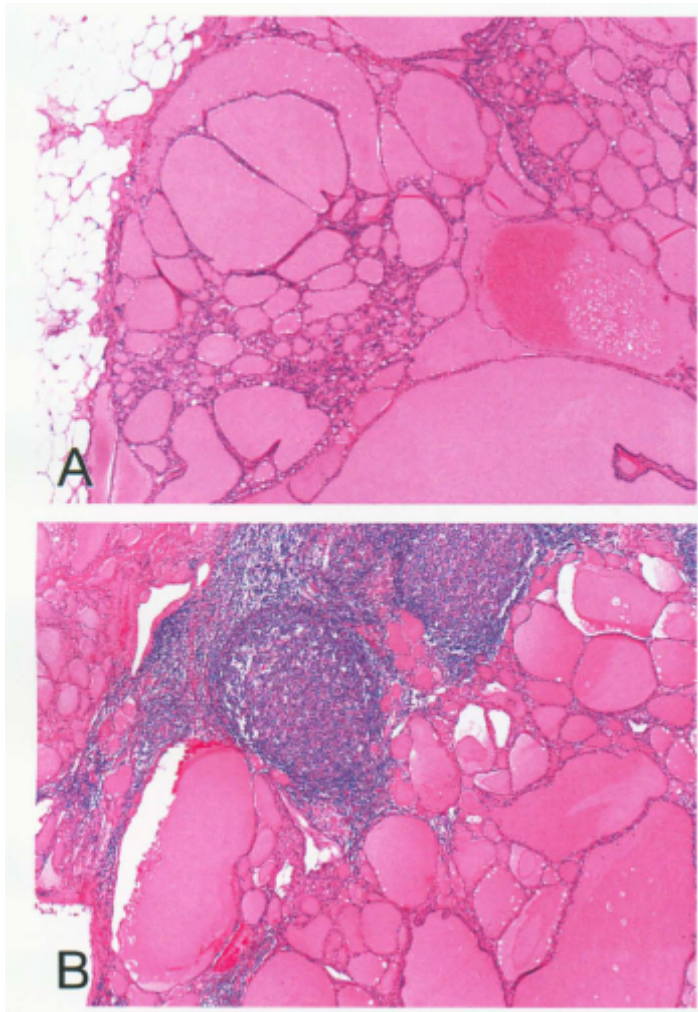


Table 1

Classification of thyroid tumor group

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1. Struma ovarii
  - a. Typical
  - b. Variant with non-thyroid type neoplasm
    - i. Variant with carcinoid (strumal carcinoid)
    - ii. Variant with Brenner tumor
    - iii. Variant with mucinous cystadenoma
  - c. Variant with thyroid-type tumor
    - i. Papillary carcinoma
      1. Typical
      2. Follicular variant
    - ii. Follicular carcinoma
      1. Typical
      2. Minimal deviation variant
      3. Oncocytic variant
    - iii. Insular carcinoma

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The oncocytic variant of papillary carcinoma, anaplastic carcinoma, medullary carcinoma, and other rare forms have not thus far been reported.