Adenoma and Cylindroma of the Bronchus*

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The subject of bronchial adenoma and cylindroma remains a highly controversial one. Despite differences of opinion as to origin, nomenclature, pathology, malignancy or benignancy, and treatment much has been learned about these unusual tumors, mainly through the cooperative efforts of endoscopists, surgeons, and pathologists. The various series of cases reported in the literature have done much to make clinicians and pathologists aware of the specificity of these entities and to narrow the points of disagreement among those who work in the field of thoracic disease.

This paper consists of an analysis of 20 cases of adenoma and two of cylindroma that have been seen during the past 12 years. Table I summarizes the age, sex, symptoms, duration, roentgen findings, bronchoscopic findings, diagnosis, treatment and end results of these patients. Several are discussed in greater detail to emphasize important features of the symptomatology, bronchoscopic aspects, histopathology or treatment.

Representative Cases

Case 5: G.W. This patient, a 25 year old white male, developed pleurisy in 1933 for which aspiration of the chest and adhesive strapping were done. Studies for tuberculosis were negative and in the next six years frequent colds and fever were present during the winter months. In 1939 he had his first hemoptysis with repeated attacks occurring in the next three months. On physical examination the percussion note, fremitus and breath sounds were reduced over the entire left chest. Roentgen and lipiodol studies revealed a density of the entire left chest considered to be both atelectatic and inflammatory in nature. Bronchoscopic examination revealed a polypoid tumor arising from the left main bronchus proximal to the left upper lobe orifice. Biopsies were reported as diffuse small round cell carcinoma. A left pneumonectomy was done on August 1, 1939. The patient expired on the eighth postoperative day following the sudden development of tension pneumothorax.

Pathology: A study of the resected lung showed the tumor to be 15 mm. in diameter; it was attached to the wall of the main bronchus over an

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area measuring 5-10 mm. in diameter. The distal bronchi were filled with varying amounts of foul mucopus and blood. Microscopically the tumor was composed of "a disorderly, diffuse proliferation of small to medium sized faintly granular cells with deeply staining irregular nuclei. They are occasionally found in cord-like or alveolar arrangements." There were two spicules of bone also present, and at the base of the tumor there was invasion of the bronchial wall. The hilar nodes were negative for tumor (Figs. 1 and 2). The diagnosis was "Bronchogenic Carcinoma." The autopsy failed to reveal any evidence of distant metastases. The cause of death was acute empyema secondary to left bronchial fistula and acute fibrinous pericarditis.

Review of the biopsy and surgical specimen slides have resulted in changing this to a final diagnosis of adenoma of the bronchus. The uniformity of the cells with tendency to glandular pattern separated by their connective tissue stroma can be seen in the photomicrograph. In figure 2 invasion into the wall of the bronchus can be seen. Of significance is the proximity of tumor tissue to a large caliber vessel. Bone spicules are also seen but they are representative of adult and not neoplastic bone. In view of our present concepts of bronchial adenoma, this case can justly be classified as a typical adenoma.

Case 13: E.O. This patient is a 34 year old white female who had complained of bronchitis with cough and sputum for six years. She had attacks of pleurisy and two years before entering the hospital thoracotomy was done for empyema. Subsequently she had repeated attacks of cough and sputum with episodes of fever and hemoptysis. Physical findings revealed diminution of the percussion note and breath sounds over the entire left lung; roentgen films showed a marked pleural density.

FIGURE 1, Case 5: (5X) Cross section of tumor in the left main bronchus. Note broad base of tumor and relation to cartilage, large vessel, and adjacent lymph nodes. No tumor present in the bronchial nodes.
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<th>Case</th>
<th>Age</th>
<th>Sex</th>
<th>Symptoms</th>
<th>Duration</th>
<th>Roentgen Findings</th>
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<th>Histopathology</th>
<th>Treatment</th>
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<th>Final Diagnosis</th>
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<tr>
<td>1.</td>
<td>M.S. 50</td>
<td>F</td>
<td>Pneumonia 10 mos. ago, cough, sputum, hemoptysis</td>
<td>10 mos.</td>
<td>Density, left lower lobe</td>
<td>Obstruction, left lower lobe bronchus</td>
<td>Adenoma</td>
<td>Lobectomy, left lower lobe</td>
<td>Death - 3rd day, cardiac failure</td>
<td>Adenoma</td>
</tr>
<tr>
<td>2.</td>
<td>H.V.K. 36</td>
<td>F</td>
<td>Recurrent pneumonia with cough, sputum, hemoptysis</td>
<td>5 yrs.</td>
<td>Atelectasis, right lower lobe</td>
<td>Polypoid tumor right bronchus below middle lobe orifice</td>
<td>Small cell bronchogenic carcinoma</td>
<td>Right pneumonectomy</td>
<td>Well 7 yrs.</td>
<td>Adenoma</td>
</tr>
<tr>
<td>3.</td>
<td>O.L. 63</td>
<td>M</td>
<td>Cough, episodes of fever and hemoptysis</td>
<td>5 yrs.</td>
<td>Triangular density - left base posterior chest</td>
<td>Tumor obstructing lower lobe bronchus</td>
<td>Adenoma</td>
<td>Left lower lobectomy</td>
<td>Well 1 1/2 yrs.</td>
<td>Adenoma</td>
</tr>
<tr>
<td>5.</td>
<td>O.W. 25</td>
<td>M</td>
<td>Cough, sputum, hemoptysis</td>
<td>6 mos.</td>
<td>Density, left upper chest, partial atelectasis, left lower lobe</td>
<td>Tumor, left main bronchus, level of upper lobe orifice</td>
<td>Small round cell carcinoma (1938)</td>
<td>Pneumonectomy (1939)</td>
<td>Death 6 POD</td>
<td>Adenoma</td>
</tr>
<tr>
<td>6.</td>
<td>S.J. 63</td>
<td>F</td>
<td>Cough, chills, sweats</td>
<td>Many years</td>
<td>Atelectasis middle lobe</td>
<td>Tumor within middle lobe orifice</td>
<td>Carcinoma Adenoma</td>
<td>Pneumonectomy</td>
<td>Well 2 yrs.</td>
<td>Adenoma</td>
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<tr>
<td>7.</td>
<td>C.J. 31</td>
<td>M</td>
<td>Cough, episodes of streaked sputum</td>
<td>Several years</td>
<td>Atelectasis, left lower lobe</td>
<td>Obstruction, lower lobe bronchus</td>
<td>Adenoma</td>
<td>Left lower lobectomy</td>
<td>Well 2 1/2 yrs.</td>
<td>Adenoma</td>
</tr>
<tr>
<td>8.</td>
<td>C.G. 49</td>
<td>F</td>
<td>Pneumonia</td>
<td>3 yrs.</td>
<td>Right upper lobe atelectasis</td>
<td>Obstruction, right upper lobe bronchus</td>
<td>Adenoma</td>
<td>Endoscopic Removal</td>
<td>Well 4 1/2 yrs.</td>
<td>Adenoma</td>
</tr>
<tr>
<td>9.</td>
<td>L.S. 40</td>
<td>M</td>
<td>Cough, episodes of fever</td>
<td>10 yrs.</td>
<td>Atelectasis right upper lobe</td>
<td>Tumor mass obstructing right bronchus</td>
<td>Granulation tissue</td>
<td>Pneumonectomy</td>
<td>Well 2 yrs.</td>
<td>Adenoma</td>
</tr>
<tr>
<td>10.</td>
<td>E.S. 26</td>
<td>F</td>
<td>Wheeze, pneumonia, hemoptysis</td>
<td>3 yrs.</td>
<td>Atelectasis, right upper lobe</td>
<td>Tumor obstructing right main, originally from right upper lobe</td>
<td>Adenoma</td>
<td>Pneumonectomy</td>
<td>Well 4 yrs.</td>
<td>Adenoma</td>
</tr>
<tr>
<td>No.</td>
<td>Patient</td>
<td>Age</td>
<td>Sex</td>
<td>Symptoms</td>
<td>Duration</td>
<td>Lesion</td>
<td>Lesion Descriptions</td>
<td>Procedure</td>
<td>Outcome</td>
<td>Diagnosis</td>
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<tr>
<td>11.</td>
<td>C.H.</td>
<td>50</td>
<td>F</td>
<td>Cough, wheeze</td>
<td>2-3 yrs.</td>
<td>Atelectasis, left lung</td>
<td>Obstruction, left main bronchus, 1½ cm. beyond coryna</td>
<td>Adenoma</td>
<td>Pneumonectomy</td>
<td>Well 4 yrs.</td>
</tr>
<tr>
<td>12.</td>
<td>L.M.</td>
<td>53</td>
<td>F</td>
<td>Cough, hemoptysis</td>
<td>1½ yrs.</td>
<td>Atelectasis, right lung</td>
<td>Tumor mass at coryna obstructing right main bronchus</td>
<td>Carcinoma</td>
<td>Adenoma</td>
<td>Repeated bronchoscopy</td>
</tr>
<tr>
<td>13.</td>
<td>E.O.</td>
<td>34</td>
<td>F</td>
<td>Cough, sputum, pleurisy, empyema and hemoptysis</td>
<td>6 yrs.</td>
<td>Density, atelectasis, left lung</td>
<td>Obstruction, left main bronchus 1½ cm. beyond the coryna</td>
<td>Adenoma</td>
<td>Pneumonectomy attempt, thorocoplastry and cauterization</td>
<td>Well 8 yrs.</td>
</tr>
<tr>
<td>14.</td>
<td>R.H.</td>
<td>49</td>
<td>F</td>
<td>Cough, wheezing</td>
<td>1 yr.</td>
<td>Atelectasis, right lower lung field</td>
<td>Pedunculated mass from right middle and lower lobe spur</td>
<td>Adenoma</td>
<td>Bronchoscopic removal 2x</td>
<td>Well 3 yrs.</td>
</tr>
<tr>
<td>15.</td>
<td>E.B.</td>
<td>35</td>
<td>F</td>
<td>Cough, hemoptysis</td>
<td>1 yr.</td>
<td>Atelectasis, left lower lobe</td>
<td>Obstruction, lower lobe bronchus</td>
<td>Adenoma</td>
<td>Bronchoscopic removal</td>
<td>Well 2½ yrs.</td>
</tr>
<tr>
<td>17.</td>
<td>L.L.</td>
<td>32</td>
<td>M</td>
<td>Cough, sputum</td>
<td>3 mos.</td>
<td>Atelectasis, right upper lobe</td>
<td>Polypoid mass from right upper lobe</td>
<td>Adenoma</td>
<td>Repeated bronchoscopic removal 7x</td>
<td>Well 4½ yrs.</td>
</tr>
<tr>
<td>18.</td>
<td>J.K.</td>
<td>48</td>
<td>M</td>
<td>Cough, sputum, hemoptysis</td>
<td>5 yrs.</td>
<td>Atelectasis, right lower lobe</td>
<td>Obstruction, right lower lobe bronchus</td>
<td>Adenoma</td>
<td>Refused treatment</td>
<td>Living</td>
</tr>
<tr>
<td>19.</td>
<td>R.M.</td>
<td>34</td>
<td>F</td>
<td>Cough, sputum streaking</td>
<td>2 yrs.</td>
<td>Atelectasis, left upper lobe</td>
<td>Obstruction, left upper lobe orifice</td>
<td>Adenoma</td>
<td>Repeated bronchoscopy</td>
<td>Not seen 3 yrs.</td>
</tr>
<tr>
<td>20.</td>
<td>J.B.</td>
<td>50</td>
<td>F</td>
<td>Cough, hemoptysis</td>
<td>9 yrs.</td>
<td>Atelectasis, right lower lobe</td>
<td>Obstruction, right lower lobe bronchus</td>
<td>Adenoma</td>
<td>Bronchoscopy twice</td>
<td>Not seen 3 yrs.</td>
</tr>
<tr>
<td>21.</td>
<td>M.L.</td>
<td>34</td>
<td>F</td>
<td>Cough, sputum, hemoptysis</td>
<td>7 yrs.</td>
<td>Density, lower left chest</td>
<td>Obstruction left lower lobe bronchus</td>
<td>Adenoma</td>
<td>Repeated bronchoscopy</td>
<td>Improved</td>
</tr>
<tr>
<td>22.</td>
<td>T.M.</td>
<td>35</td>
<td>F</td>
<td>Cough, hemoptysis</td>
<td>4 yrs.</td>
<td>Density, entire left lung</td>
<td>Left main bronchus</td>
<td>Adenoma</td>
<td>Repeated bronchoscopy</td>
<td>Improved</td>
</tr>
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</table>
with little aerated lung on the left side. Bronchoscopy demonstrated a polyloid tumor in the left main bronchus which produced complete obstruction 1.5 centimeters distal to the coryna. Biopsy sections were interpreted as adenoma of the bronchus. Pneumonectomy was attempted in 1944 but was abandoned because of the complete obliteration of the pleural space by extremely dense fibrous tissue. A month later, thorocoplastic and cautery drainage of a large dilated bronchus was accomplished. The patient has a persistent bronchial fistula which drains purulent material, but she has no cough or hemoptysis unless the drainage tube becomes obstructed. She has been able to do all household tasks for the past three and one-half years. No further bronchoscopy has been done.

Pathology: Only biopsy specimens could be studied but large pieces of tissue were examined (Fig. 3). Microscopically the architecture was variable. At one extreme, well formed glandular structures separated by connective tissue trabecula were seen; while in other areas solid clusters of cells with only scattered septa were found. The cells were usually cuboidal to columnar with faint pink cytoplasm. The nuclei were round to oval with uniformly scattered fine chromatin material. No mitotic figures were seen.

The diagnosis in this patient is adenoma of the bronchus. She has had symptoms for 10 years but shows no evidence of any metastases from her primary tumor. Only biopsy specimens were obtained, and she obviously has residual tumor.

Case 6: S.J. This patient was a 63 year old nun who had been coughing for many years but particularly frequently during the past 10 weeks. Pain in the right chest, night sweats and anorexia were present, but at no time had she had hemoptysis. Roentgenograms revealed an atelect-
tatic shadow sharply outlining the right middle lobe. On bronchoscopic examination approximately 1 centimeter within the middle lobe orifice an obstruction was encountered from which tissue was obtained. The first diagnosis was carcinoma of the bronchus, and with that assumption, the right lung was removed in February 1946.

Pathology: The tumor nodule was within the middle lobe orifice; it was 6-7 mm. in diameter and attached over a mucosal surface of approximately 8 mm. The lung tissue distal to the tumor was atelectatic. Microscopically fine trabeculations of connective tissue separated clusters of cuboidal to columnar cells having eosinophilic cytoplasm and uniform vesicular nuclei. A glandular arrangement was frequently seen, but no secretion was apparent in the spaces. There was no evidence of extension beyond the cartilaginous plates or invasion into the nearby lymph nodes. Final diagnosis was adenoma of the bronchus. The patient is living and well with no evidence of metastasis or recurrence.

Case 3: G.L. This patient is a 53 year old white male who complained chiefly of cough of at least five years' duration. Two years previously he had an attack of pneumonia associated with pleural fluid which was aspirated at another hospital. Shortly thereafter his first hemoptysis occurred. He had spells of coughing, fever, and expectoration of large quantities of pus shortly before admission followed by more bleeding. Roentgenograms of the chest revealed an atelectatic shadow corresponding to the left lower lobe. On bronchoscopy a tumor was found located just below the orifice of the left upper lobe obstructing the lower lobe bronchus. The biopsy was reported as adenoma of the bronchus. The patient had a lobectomy in December of 1946, and has been well since with no further pulmonary symptoms.

FIGURE 3, Case 13: (440X) Adenoma in which glandular structures are separated by thin collagenous tissue septa. Note cell and unclear uniformity, and the marked cellular hyperplasia which has resulted in the lumina being filled with cells.
Pathology: A flat fleshy tumor measuring 1.2 centimeters in diameter was found just distal to the site of amputation. It involved an area of bronchial wall 8 mm. in diameter, and the tumor extended through the wall in somewhat dumb-bell fashion so that a nodule of tumor measuring 6-8 mm. in diameter was present beyond the bronchus. The distal lung tissue was solid and airless with fibrous tags on the pleural surfaces and dilated bronchi containing purulent secretion within the parenchyma. No tumor metastases were present in the lymph nodes. The microscopic pattern was one of solid clumps of cells separated by thin connective tissue septa (Fig. 4). The individual cells were cuboidal with eosinophilic cytoplasm and vesicular round nuclei. Little or no tendency to glandular formation was apparent. The final diagnosis was adenoma of the bronchus. (Figure 4).

Case 14: R.H. This patient, a 49 year old white female, complained of cough of a year's duration and attacks of pleural pain. There was no previous hemoptysis. Roentgenograms had shown a density in the right lower lung. Because of a diagnosis of unresolved pneumonia, the patient had a bronchoscopic examination elsewhere which revealed a papillary tumor interpreted as adenoma. Bronchoscopy in 1942 revealed the tumor to be papillary in character and to originate at the entrance to the right lower lobe, immediately below the middle lobe orifice. The major portion of the tumor was removed with bronchoscopic forceps and by electrocoagulation and a small residual portion was removed similarly four months later. At least six subsequent examinations have been made and no tumor tissue has been found. The patient has been well, without symptoms for five years. Pathologic diagnosis was adenoma of the bronchus.

Pathology: The variation in the microscopic picture is seen in figure

FIGURE 4, Case 3: (440X) Adenoma consisting of occasional acini but for the most part diffuse sheets of cells which still retain uniformity. Nuclei little and mitotic figures absent.
5 under 110× magnification. On one side an anastomosing network of cells is found separated by connective tissue of varying dimensions often containing thin walled vessels. At the other margin, the cells are found scattered or in clusters. Glandular pattern is not well demonstrated. The individual cells, however, were cuboidal, eosinophilic and with little variation as to size, shape or staining. Although there is little tendency to form glands, the final histopathologic diagnosis is adenoma of the bronchus. It is made on the character of the individual cells. This variation in the microscopic picture in biopsy or surgical specimens is not uncommon, and careful study of the individual cells is of importance in establishing the final diagnosis (Fig. 6).

Case 11: C.H. This patient, a 50 year old white female, had symptoms of cough for five years, particularly severe in the past three to four months. The dyspnea was characterized by inability to completely force out air, and there had been some wheezing at times. Bronchoscopic examination revealed a round tumor occluding the left main bronchus, lying 1.5 cm. below the bifurcation of the trachea. A biopsy was interpreted as adenoma of the bronchus and in July, 1944 her left lung was removed. The tumor had infiltrated the wall of the bronchus making it friable, and as a result the bronchus tore during the procedure. A segment was removed above the line of defect and closure effected. The convalescence was uneventful and the patient remained symptom free for four years. In June, 1948 she was examined again because of gradually progressive dyspnea and a sudden change in voice. The left vocal cord was found to be paralyzed, the trachea compressed and the corynxa markedly distorted. Irregular tissue removed from the entrance of the stump of the left main bronchus showed tissue similar to that found on the first bronchoscopic examination.

FIGURE 5, Case 14: (110X) Adenoma consisting of anastomosing cords of cells forming false acini at one margin and solid sheets and clusters of cells in an adjacent area.
Pathology: Study of the resected lung showed that the segment of bronchus above the point of accidental rupture contained tumor tissue along 1.2 cm. of its 2.8 cm. length. The neoplasm elevated the bronchial mucosa for a distance of 8 mm. and involved all but 2 mm. of the circumference. The bronchus attached to the lung contained tumor extending into several of the smaller branches. The bronchi of the upper lobe were dilated and contained mucopus, and the parenchyma was firm and atelectatic. The lower lobe bronchi were slightly dilated. Microscopically the tumor was composed of clusters of epithelial cells in a rather dense stroma with little evidence of vascularity. There was great tendency to form glands of several layers' thickness and many of these contained pink or purple secretion. Frequently several glands were present in a cluster of cells, and in other instances the cell groups were solid. These clusters were seen to invade into the tissues beyond the cartilaginous plates. The individual cells were variable from columnar to cuboidal and the nuclei varied in size, shape and staining. The final diagnosis in this specimen was cylindroma of the bronchus (Fig. 7).

Case 12: L.M. This patient was a 53 year old white female who complained of episodes of hemoptysis for 10 months and cough for four months. X-ray film of the chest demonstrated a partial atelectasis of the right lung. On bronchoscopic examination in January, 1941 a tumor was found partially filling the right main bronchus and extending to the coryna. A biopsy specimen was reported as bronchogenic adenocarcinoma. Because of the extent of the tumor to involve the coryna, surgical removal was considered impossible, and the subsequent course of treatment was repeated bronchoscopic removal of tumor to maintain an airway into the right lung. Between these procedures the patient's
clinical course was punctuated by episodes of hemorrhage and dyspnea. Eventually, after five years, the tumor grew into the trachea and serial chest x-rays showed nodular densities appearing in the left lung with gradual development of a complete atelectasis of the right. Because of the slow course of what was supposed to be a bronchogenic carcinoma, the biopsy specimens were reviewed. There was a variation of opinion among pathologists as to whether the lesion was an adenoma, a cylindroma, or a bronchogenic adeno-carcinoma. The patient finally expired due to a massive hemorrhage and asphyxia. This was five and one-half years after the tumor had been discovered.

Pathology: At necropsy, there was complete atelectasis of the right lung with deviation of the mediastinum to the right side. The collapsed lung contained firm gray tumor which bulged into the trachea from the normal bronchial site, invaded the hilar lymph nodes and involved roughly 75 per cent of the lung parenchyma. At the periphery were six to eight solitary metastases, and in the opposite lung were more than a dozen discrete masses of tumor ranging from a few millimeters to centimeters in diameter. The left main bronchus contained a large amount of freshly clotted blood which was the cause of her sudden asphyxia. Metastatic lesions were seen in the kidney.

Microscopically the tumor was composed of varying sized clusters of cells either solid or forming one or more glandular spaces (Fig. 8A). In some areas the stroma was largely replaced by broad sheets of cells with many glandular spaces containing pink or purple mucinous material while in others the thin stromal tissues formed branching networks around the cell groups. The individual cells were variable in size and usually contained only a small amount of cytoplasm. The nuclei were generally deep staining, occupied almost all of the cell space, and varied

FIGURE 7. Case 11: (110X) Cylindroma. The stroma is more dense and the acini are likened to "cylinders" frequently containing secretion and often having multi-layered cell walls.
in size and shape. Mitotic figures could be seen but only very occasionally. The microscopic appearance of the metastatic foci was the same as the primary. The final diagnosis was cylindroma of the bronchus with metastases of hilar lymph nodes, contralateral lung and kidney (Fig. 8B).

FIGURE 8A. Case 12: (440X) Cylindroma in which acini are single or multilayered or solid masses of cells. Note presence of secretion in many glandular spaces.—FIGURE 8B. Case 12: (110X) Kidney with cylindroma metastasis reduplicating histologic picture of primary lesion, Figure 8A.
Discussions

Origin: A brief review of Table 1 reveals that in every patient in this group, the neoplasm was found in a major bronchus. This same feature has been mentioned in most of the reported cases, although, Maier and Fischer reported five cases of adenoma in each of which the tumor was found in a small branch bronchus and gave none of the usual symptoms of pulmonary suppuration. It is of interest to note that microscopic lesions strongly suggestive of adenoma have been seen in two of our patients not reported in this series. One of these lesions was found accidentally in a right lower lobe removed for bronchiectasis, the other in a lung removed at autopsy in an individual who died of arteriosclerotic heart disease. In each case, the lesion was remote from a large bronchus.

Heretofore, the origin of these tumors was considered by most physicians to be from the glands of the main large bronchi. On the other hand, Stout and Hamperl believe that adenomas arise from special cells called onkocytes. These can be seen best by special staining techniques and are found in the bronchial mucosa, and serous and mucinous glands. Womack and Graham and Albertini propose the theory of origin from embryonal bronchial buds. Harris studied serial sections of human embryos and further stresses the importance of the similarity between the haphazard arrangement of bronchial glandular elements in the embryos to the picture seen in adenomas. These authors also emphasize the frequency with which other tissues such as cartilage, bone, muscle, and fat occur in adenomas and believe this fact to be additional support of the theory that they derive their origin from embryonic bronchial buds.

From the studies of the cases in our series, we believe that the origin is most likely from either the serous or mucinous glands of the main bronchi.

Nomenclature: Many different names have been proposed in the various series reported in the literature. Among them are “mixed tumors of the bronchus,” “malignant adenoma of the bronchus,” “benign glandular tumor of the bronchus,” “carcinoid of the bronchus,” “basal cell carcinoma of the bronchus,” etc. Although “mixed tumor” is used because of the presence of other tissues, bone was seen in only two of our cases (No. 4 and No. 5) (Fig. 2). In these two cases the bone was not neoplastic tissue but developed as a result of metaplastic changes secondary to long standing infection. Case No. 4 in our series had a total pneumonectomy elsewhere; this case was reported by Mallory. We agree with his interpretation that the presence of the bone tissue.
in the tumor may be due to metaplasia associated with long standing pulmonary infection.

"Malignant adenoma" is almost a paradoxical term. Adams, Steiner and Block\textsuperscript{12} have advocated it because in their series of five patients metastases were found in four. "Carcinoid" has been proposed since the tumor has a resemblance to the peculiar argentaffin tumor of the appendix. However, almost all cases fail to show silver granules. In one of the cases in Holley's\textsuperscript{13} series, silver staining granules were found in biopsy tissue. No special staining technique was carried out in our material.

The term "basal cell" tumor of the bronchus is proposed because of the resemblance to certain skin tumors known as epithelioma adenoides cysticum which is considered a variety of basal cell carcinoma of the skin. This term seems more fitting because of the clinical characteristics rather than the actual histopathologic picture.

Lastly, Moersch, Tinney and McDonald\textsuperscript{14,15} have divided these tumors into the adenoma and cylindroma groups, stressing distinct differences as to histology and clinical course. This division is a rational one. "Adenoma of the bronchus" immediately suggests a specific type of bronchial tumor; although differences of opinion regarding many phases of this clinical entity do exist, these differences are becoming narrower. The cylindroma is a distinct variant with clinical as well as pathological criteria that make it a separate entity.

\textit{Symptomatology}: Tables II through IV summarize the main clinical features of adenomas and cylindromas as they occurred in the cases of this series. A greater incidence in the female, with occurrence most frequently in the 30 to 40 year age group, and

\begin{table}[h]
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\begin{tabular}{|c|c|c|}
\hline
 & Male & Female \\
\hline
Adenoma & 6 & 14 \\
\hline
Cylindroma & 0 & 2 \\
\hline
\end{tabular}
\caption{Sex Distribution}
\end{table}

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|c|c|}
\hline
 & 20-30 yrs. & 30-40 yrs. & 40-50 yrs. & 50-60 yrs. & 60 & over \\
\hline
Adenoma & 2 & 10 & 4 & 3 & 1 \\
\hline
Cylindroma & 0 & 0 & 0 & 2 & 0 \\
\hline
\end{tabular}
\caption{Age Distribution}
\end{table}
with hemoptysis occurring in at least 80 per cent of the patients is well in accord with other reports. It is worthwhile to correlate the pathologic changes with the symptoms most frequently found.

First, the prominent symptom of hemoptysis appears to be the result of the actual tumor architecture and blood supply. The photomicrographs readily reveal the small thin wall vessels that course between the glandular and cord-like elements. Trauma from coughing can easily disrupt the continuity of vessel walls with resulting hemoptysis. The other symptoms which develop

| TABLE IV |
| INCIDENCE OF HEMOPTYSIS |
|---|---|
| Adenoma | 15 | 5 |
| Cylindroma | 1 | 1 |

| TABLE V |
| SUMMARY OF TREATMENT AND END RESULTS |

**ADENOMA:**

*Bronchoscopy,*

Biopsy only .......................... 1
Complete removal. Living and well. Symptom free .......... 5

*Partial Removal,*

Improved .................................. 4
Died ........................................ 0

*Surgical Resection,*

Pneumonectomy ......................... 4
Living and well .......................... 1
Died ........................................ 1

Lobectomy,

Living and well .......................... 1
Improved .................................. 1
Died ........................................ 1

Others,

Improved .................................. 1

Total Cases .................................. 20

**CYLINDROMA:**

*Bronchoscopy,*

Partial Removal,

Died ........................................ 1

Pneumonectomy,

Improved .................................. 1

Total Cases .................................. 2

*Case 11: Recent evidence of recurrence.

**Case 15: Thoracotomy only. Tumor still present.*
are related to the mechanical factors caused by bronchial obstruction. As the tumor grows into the lumen the passage of air currents over it is altered producing the wheeze so characteristic of the early stage of the symptoms. With more pronounced and finally complete obstruction, air exchange stops and the lung distal to the tumor becomes atelectatic. Varying degrees of bronchopulmonary suppuration may follow, leading to bronchiectasis or abscess or extension beyond the lung to involve the pleural space. Marked pleural reaction was present in four of the cases operated.

Pathology: From the standpoint of gross pathology, the smooth, rounded, red appearance of the lesion seen bronchoscopically is quite characteristic and needs no further comment. Of the 10 patients operated, it was possible to study the surgical specimens in seven, the others having had their surgery elsewhere. Of the five surgical specimens which we have classified as adenoma, all had broad points of attachment such as described in cases No. 3 and No. 5. Occasionally there was extension of tumor through the wall in dumb-bell shape fashion. The gross and microscopic features of the two cases classified as cylindroma have already been described (Cases No. 11 and No. 12, Figs. 7 and 8).

From biopsy or surgical specimens, this series may be divided into two groups. Twenty cases were considered as adenoma and two as cylindroma. In reviewing the adenoma specimens, it was at once apparent that variation in the microscopic picture did exist. Moreover, in large biopsy specimens, variations were seen in the same slide. Figures 2 and 3 are both adenomas, yet Figure 2 demonstrates the lumina of the acinar spaces to be filled with cells. In another area of this particular specimen, solid sheets of cells were present with little or no dividing stroma. Figure 3 is a classical example of what is currently being accepted as an adenoma. Yet Figure 4 again demonstrates the diffuse cellular character which may be seen. In this patient, the tumor extended in a dumb-bell manner through the wall of the bronchus. Figure 5 is taken from Case No. 14. At this low power we again have an example of variation in the architecture in the same field. Of the five specimens obtained by pulmonary resection which allowed examination of the entire tumor, invasion by small clusters of cells into the deeper tissues of the bronchus was seen in four. Figure 6 under low power (Case No. 1) demonstrates this very well.

Only two cases in this series are classified as cylindroma (see abstracted cases 11 and 12). Microscopically the invasion was evident as clusters of tumor cells were found invading freely between the plates of bronchial cartilage. Figure 7 is a photomicrograph from the surgical specimen of case No. 12. Figure 8A and B are from the primary tumor in the lung and metastases...
to the kidney respectively of the same case. This histologic pattern is accurately reproduced in the latter.

Despite the variation in the architectural arrangement of the adenoma group, the individual cells are very similar. Briefly, these cells are cuboidal to columnar, have a faint eosinophilic granular cytoplasm and round to oval nuclei. The chromatin network is usually fine and scattered. Mitoses are extremely rare. Even in those adenomas in which glandular spaces are almost totally lacking, it is difficult to find mitotic figures.

The cylindroma type, however, has a different type of cell and many times it is difficult to make out individual cell borders. The nuclei are more variable and the chromatin is more dense and stains more deeply. When a glandular pattern is observed in the adenoma group, seldom, if ever, is secretion found while in the cylindroma type a pink to purple mucin-like material can be seen. Comparison of the photomicrographs reveals the differences mentioned.

From the standpoint of pathology, it is valid to divide these tumors into the two types, since the cylindroma is an active, invading tumor in contradistinction to the adenoma. In one of the cylindromas distant metastases were observed. However, while tumors in the adenoma group also demonstrate small invading clusters of cells, distant metastases could not be demonstrated. In the two patients who came to necropsy, the invasive feature of the true adenoma is undeniable (See Figures 1 and 6).

Thus, the fundamental question may be raised as to whether these tumors should be considered benign or malignant. It is not necessary that the presence of metastases be a criterion of malignancy. For example, gliomas of the central nervous system do not metastasize but rightfully are considered malignant. Basal cell carcinomas of the skin are malignant tumors yet metastasis is uncommon. It is interesting that original diagnosis in early cases of various series reported was frequently bronchogenic carcinoma. The fact that the clinical course was so unlike bronchogenic carcinoma eventually led to re-evaluation, and accordingly the diagnosis was changed to adenoma. Likewise, in our series the diagnosis in early cases was carcinoma. The re-evaluation has led to the correct interpretation.

More recently, further classification is developing. Some writers in reviewing cases have realized that some classified as adenoma were different enough histologically as well as clinically. Holley divides the two into a carcinoid and mixed tumor type. We prefer to use the adenoma and cylindroma terms similar to the terminology suggested by Moersch, Tinney and McDonald. The cases herein presented give further support that this distinction
is necessary since the cylindroma type is unquestionably a more invasive tumor.

From the foregoing study and discussion of the cases herein presented, two statements may be made. First, these bronchial tumors represent a group entirely separate from bronchogenic carcinoma both from a pathologic and clinical standpoint. Second, it is further possible and desirable to subdivide the group and to recognize an adenoma and cylindroma type.

**Treatment and Results**

The therapeutic procedures available to the endoscopist or surgeon are numerous. Endoscopically the tumor may be resected by forceps removal or may be coagulated with the electrocoagulating bronchoscope. Large tumors obstructing major bronchi may be removed in massive sections through a coring technic of advancing the entire bronchoscope through the lesion into tumor-free bronchus beyond. This may be followed by electrocoagulation of residual tumor tags. The appreciable danger associated with such bronchoscopic procedures is the hemorrhage due to the well-known vascularity of adenomas. It has been suggested that if bronchoscopic means of removal are to be used the tumor first be injected with a sclerosing agent or radon seeds to reduce the possibility of this complication.

The therapeutic procedures available to the surgeon are primarily lobectomy and pneumonectomy. Segmental lobectomy may be considered, but generally the tumor involves a bronchus leading to at least a whole lobe if not the entire lung. Bronchotomy with removal of a tumor with a section of the bronchus has been described for certain benign tumors, and this might be considered in rare cases of adenomas. Such a technic is valueless if the lung distal to the tumor is sufficiently involved in a suppurative process to necessitate its removal. It becomes necessary to employ other procedures discussed below at times when surgical exploration makes it apparent that lobectomy or pneumonectomy is not surgically feasible.

With the numerous bronchoscopic and surgical procedures available the following factors influence the choice of therapy: Immediate radical excision (pneumonectomy) is advocated if the tumor proves to be a cylindroma type. A variation of approach may be considered if the tumor proves to be adenomatous in character.

In this series of cases, bleeding associated with cautious forceps removal of tissue for biopsy became one of the criteria which determined whether further attempts to remove tissue would be made bronchoscopically or whether this method would be aban-
doned immediately. Repeated attempts at endoscopic removal of a freely bleeding tumor will ultimately result in fatal hemorrhage. In only one case in this series radon seeds were injected into the tumor in an attempt to reduce hemorrhage prior to endoscopic removal. The procedure did not appear to influence bleeding.

The position of the tumor will in itself be an important factor influencing the choice of therapy. Upper lobe lesions as a rule cannot be completely removed through the bronchoscope because of their anatomically inaccessible position, unless, as occurred in one case in this series, the tumor lies in the orifice of an upper lobe bronchus. Tumors originating in the main bronchi or the lower lobe bronchi are easily accessible bronchoscopically and the re-establishment of bronchial continuity is therefore feasible and practical by this technic.

Another factor influencing the choice of therapy is the condition of the lung distal to the obstruction. If extensive pulmonary suppuration and irreversible parenchymal change have taken place which would of themselves necessitate a lobectomy or pneumonectomy, endoscopic attempts to remove the tumor are obviously of value only to enhance drainage prior to surgery.

Finally, the continuation of bronchoscopic tumor removal is dependent on the results being obtained. If the bronchus can be cleared by simple endoscopic removal during two or three sessions and checked from time to time, radical surgery hardly seems necessary. However, if there are rather regular recurrences, extirpation of the lobe or the lung is advocated.

Table V summarizes the treatment employed in this series. Of the 20 adenomas, 10 have been treated by bronchoscopic removal alone and 10 by external surgical approach. Of the 10 bronchoscopically treated patients, one had a biopsy only. (This patient is the only one in the series not traceable). Five of the 10 are living and well, symptom free and with no evidence of residual tumor. Four are living and improved, with residual tumor but for the most part asymptomatic. There have been no deaths in this group.

Ten cases were treated surgically: seven by pneumonectomy and three by lobectomy. Of the seven pneumonectomies four are living and well. One operated elsewhere is improved but with surgical complications remaining. One is improved following attempted pneumonectomy, although it was not surgically feasible to remove all the tumor. One postoperative death following pneumonectomy was due to sudden development of tension pneumothorax and empyema. This case is discussed in detail above. Of the three lobectomies, one is living and well with no residual tumor. One is improved although the tumor was incompletely
removed. This patient was operated elsewhere and it was the decision of the surgeon to do only a lobectomy rather than remove the entire lung due to circumstances at the time of the surgery. The third lobectomy died postoperatively due to cardiac failure.

The two cylindromas in this series were treated by opposite extremes of therapeutic possibilities. This was due not to a desire to test either therapeutic procedure but to the factors inherent in the tumors themselves. In the first patient, the tumor was considered surgically inoperable at the time the diagnosis was first established because of the invasion from the right bronchus into the trachea. This patient lived five and one-half years because of frequent bronchoscopic removal of tumor tissue. The second patient had a total pneumonectomy and remained well for four and one-half years without further therapy. Recently she developed dyspnea and hoarseness, and examination has shown a paralysis of the left vocal cord and extensive mediastinal metastases with recurrence of the tumor in the bronchial stump.

The results of treatment of this series correspond with those of other reports. Both bronchoscopic and surgical measures were available and were used according to the indications and contraindications discussed.

SUMMARY

Twenty cases of adenoma and two of cylindroma of the bronchus are presented and analyzed according to their history and clinical, x-ray and bronchoscopic findings. The histopathology is discussed to emphasize the differentiation between adenomas and cylindromas. The adenomas are considered as extremely slowly growing but invasive tumors, rather than metastasizing malignant neoplasms, whereas cylindromas meet all the criteria of malignant lesions.

Choice of therapy was influenced by the location and histologic character of the lesion, the presence or absence of bronchopulmonary changes peripheral to the lesion, the degree of hemorrhage associated with the bronchoscopic procedures, and the response to endobronchial therapy. Of the 20 cases of adenoma, 10 were treated by bronchoscopy alone and 10 by subsequent surgical procedures. Of the former group (bronchoscopic), complete removal was effected in 5, of whom 4 are improved, and 1 was seen for biopsy only and has not been traceable. Of the latter group (surgical), total pneumonectomy was performed in six cases; four are living and well, one improved, and one died postoperatively. Lobectomy was performed in three cases; one is living and well, one improved, and one died postoperatively. The 10th surgically
treated patient merely had a thoracotomy with cautery drainage, resection being impossible due to extensive adhesions. In the cylindroma group, one patient was treated bronchoscopically for 5½ years merely to keep the tracheal and bronchial airway open since the tumor had involved the entire right bronchus and invaded the trachea at the time of diagnosis. The second patient in this group was treated by immediate pneumonectomy but had a recurrence 5½ years later.

**RESUMEN**

Se presentan veinte casos de adenoma y dos de cylindroma bronquial y se analizan de acuerdo con su historia clínica, los rayos X y los hallazgos broncoscópicos. Se discute la histopatología para hacer resaltar la diferencia entre cilindromas y adenomas. Los adenomas son considerados como tumores extremadamente lentos para crecer, pero invasores más bien malignos y metastatizantes en tanto que los cilindromas reúnen todas las características de neoplasias malignas.

La elección de tratamiento fue influida por la ubicación y el carácter histológico, la presencia o ausencia de cambios broncopulmonares distales a la neoplasia, el grado de hemorragia consecutivo a la broncoscopia y la respuesta al tratamiento endobronquial. De los 20 casos de adenoma, 10 fueron tratados por broncoscopia y 10 por subsecuentes procedimientos quirúrgicos. Del primer grupo (broncoscópico), se logró extirpación completa en 5, de los que 4 han mejorado y uno solo fue visto para biopsia y ahora se ha perdido de vista. Del segundo grupo (quirúrgico) se hizo neumonectomía total en 6 casos; cuatro están vivos y bien, uno mejorado y uno murió en el postoperatorio. Se hizo lobectomía en tres casos; uno está vivo y bien, uno mejoró y uno murió en el postoperatorio.

Al décimo caso, tratado quirúrgicamente, solamente se le hizo toracotomía con drenaje al cautelar, pues la resección fue imposible debido a adherencias muy extensas. En el grupo de cilindromas, un enfermo fue tratado por cinco años con broncoscopia solamente para mantener abierto el paso de aire a traquea y bronquios, puesto que el tumor había invadido completamente el bronquio derecho y la traquea cuando se hizo el diagnóstico. El segundo enfermo de este grupo fue tratado con neumonectomía inmediata, pero tuvo una recurrencia a los cinco y medio años más tarde.

**REFERENCES**

Discussion

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I was glad to read in the abstract of Dr. Holinger's paper that the emphasis was put on pathology, because I believe that the crux of the confusion in this subject of benign adenoma and similar tumors lies in the pathology; the necessity for sorting out several different types, at least these two; particularly differentiating the adenoma from the cylindroma. That is a step in the right direction, taken by Van Hazel, Holinger and Jensik. I had the privilege of hearing a most interesting discussion at the Thoracic Surgeons' meeting in Quebec recently; papers by Goldman of San Francisco and Neuhof and Rabin of New York, and then a lot of discussion. Neuhof and Rabin presented 65 cases and they made a particular point of restricting their list to adenoma cases, and stated that they were leaving out cylindromas, mixed tumors and several others that they mentioned. In the discussion they were criticized for leaving out these cases,
by some who do not recognize the differential histopathologic diagnosis.

It has been our contention that the typical adenoma has no inherent tendency to become malignant. We do not say that none become malignant. We of course insist that the low grade character of the malignant cylindromas is important in deciding what treatment should be given. We have been increasingly impressed with the importance of taking into consideration the extrabronchial portion of the growth, as Dr. Holinger has well demonstrated in some of his sections. This is important, not so much from the point of view of further extension or metastasis, but because of bronchial compression by the extra-bronchial portion of the growth. There is one fact that stands out clearly in our minds, namely, that these cases should be individualized as to treatment. They should not be automatically subjected to lung resection as a carcinoma should.

We presented a report of 20 cases of adenoma in 1944 at a meeting of the Thoracic Surgeons, subsequently published in the Journal of Thoracic Surgery in April, 1945. Since then we have had 11 cases. Of the first 20, three were treated surgically, two by lobectomy and one by pneumonectomy; 17 were treated bronchoscopically. Of the 11 recent cases, three were treated by surgery and eight bronchoscopically. Thus there were 31 cases, seven treated surgically and 23 bronchoscopically.

Closing Remarks

Robert J. Jensik, M.D., Chicago, Illinois: We hope to add something to unequivocally establish these lesions as definite entities. I was pleased to see that the first two photomicrographs shown by Dr. Jackson were classified as cylindromas, because we feel strongly on that point, that this type must be separated from the adenomas. We are not original in this observation because others, including the Rochester group, have emphasized this differentiation.

We believe that the cylindroma types are certainly more invasive, and as you saw in one case in our series, there were definite distant metastases. Reviewing the histopathology, it is important to stress that cylindromas practically all have some evidence of secretion in the glandular forms that are present; whereas in the adenoma types we seldom see that. In adenomas we may see piling up of cells and obliteration of glandular pattern, but there is not criteria enough to say that malignant degeneration has occurred. In one of our cases the course has been at least eight years and yet there is no evidence of any distant metastasis and the patient is living and well.
As to whether they are benign or malignant, I think we might avoid that issue by saying that we should consider even adenomas invasive but with nowhere near the invasive tendency of cylindromas. We believe that since distant metastases are so uncommon in the adenomas one is not justified in saying the tumors must be considered benign. After all, such tumors as gliomas occurring in the central nervous system, or basal cell tumors of the skin, are considered malignant, yet metastases are rare.