Disturbances of Cell Growth

Table of Contents

Introduction to non-cancerous growth disturbances ........................................ 2
Neoplasia Nomenclature ......................................................................................... 4
Differences between Benign and Malignant Neoplasia ......................................... 8
Introduction to Non-Cancerous Disturbances of Growth

Objectives

Upon completion of this lesson, you will be able to:

1. Define atrophy, hypertrophy, and hyperplasia
2. Recognize and describe the lesions of agenesis, aplasia, and hypoplasia.

ATROPHY

Atrophy implies that an organ or cell has DECREASED in size. This means that it WAS full-grown and has now shrunken. We covered atrophy during the Cell Injury portion of this course, so this should be a review.

HYPERTROPHY

Hypertrophy happens when there is an increased demand on cells within an organ. Each cell becomes much larger. The classic example of hypertrophy happens in MUSCLE. When a muscle has to become stronger, each muscle cell expands, creating an overall increase in size of the muscle, but there is no increase in the number of cells.

HYPERPLASIA

Hyperplasia means in increase in the number of cells in an organ. For instance, when a mammary gland goes into lactation phase, the cells divide and multiply, making a bigger gland and also more cells.

Hypertrophy and Hyperplasia

[Diagram showing the processes of hypertrophy and hyperplasia]
Developmental Disturbances (Anomalies)

Developmental disturbances are often called anomalies. Both genetic and environmental causes are responsible for the anomalies acquired before an organ reaches its mature and adult form. Some inherited disorders are associated with well described chromosomal anomalies, which may or may not be associated with a genetic history. External (environmental) agents that act on the developing fetus to cause developmental anomalies are referred to as teratogens. Infections, a potential teratogen, may be transmitted from the mother and be potentially serious, especially if transmitted during early gestation.

Types of Developmental Disturbances

**Hypoplasia, aplasia, and agenesis.** An organ may never reach full size (hypoplasia), or may not develop at all (agenesis), or may develop but not be recognizable as the organ at all (aplasia).
Neoplasia Nomenclature

Objectives
Upon completion of this lesson, you will be able to:

1. Know the rules for naming tumors of epithelial and mesenchymal origin
2. Know the names of neoplasms that have different nomenclature rules
3. Know the difference between benign and malignant neoplasms, how they behave

Neoplasia literally means “new growth” and when it occurs, the mass is called a neoplasm.

There are many terms that are used when describing neoplasms. The definitions of these terms follow:

1. Tumor – simply means a localized swelling from any cause (but was initially used to denote the swelling associated with inflammation). As commonly used today, a tumor is a swelling or growth, but often implies that the growth is neoplastic.

2. Benign – a benign neoplasm is one that will always remain localized to the site at which it developed. This is not to imply that benign neoplasms cannot result in serious or fatal disease. For instance, a benign neoplasm in the brain can cause death.

3. Malignant – is a more aggressive neoplasm with the potential to invade tissues and to spread to distant sites (a process known as metastasis).

4. Cancer – synonymous with malignant neoplasm; often used in human medicine

5. Carcinogenesis - the process by which neoplasia occurs

6. Oncology - the study of neoplasia

A neoplasm is a purposeless overgrowth of one of the cellular components in the body. Such growths are either benign or malignant and in general differ from normal tissue in that they are of no conceivable use to the host.

Naming a neoplasm
Neoplasms have two parts to their name. The first part refers to the tissue it comes from, and the second part determines whether it is benign or malignant.
So, all tumors are named according to their tissue or origin. The body has two main categories of types of tissues (epithelial and mesenchymal). In general, epithelial tissues are those that do body system functions, such as digestion, respiration, excretion, or are on surfaces. Mesenchymal are all the tissues in between – all connective tissue, muscle, bone, and blood.

**Neoplasms of epithelial origin:**

**Adenoma** - term applied to benign neoplasms of epithelial origin that form glandular patterns. They usually have well organized cells and they are not invasive (because they are BENIGN).

**Malignant epithelial neoplasms** are called carcinomas; they are more disorganized and they can INVADE and may also METASTASIZE.
Neoplasms of mesenchymal tissue:

Benign neoplasms of mesenchymal (connective) tissue are simply named by adding the suffix -oma to the proliferating cell type.

- Fibroblast → → → → → → fibroma
- Fat cell → → → → → → lipoma
- Blood vessel → → → → → → hemangioma
- Lymphatic vessel → → → → → → lymphangioma
- Bone → → → → → → osteoma
- Cartilage → → → → → → chondroma

Malignant tumors of connective tissue are simply called sarcomas: hence fibrosarcoma, liposarcoma, hemangiosarcoma and so on.

- Fibroblast → → → → → → fibrosarcoma
- Fat cell → → → → → → liposarcoma
- Blood vessel → → → → → → hemangiosarcoma
- Lymphatic vessel → → → → → → lymphangiosarcoma
- Bone → → → → → → osteosarcoma
- Cartilage → → → → → → chondrosarcoma

Some neoplasms with specialized names:

<table>
<thead>
<tr>
<th>Benign variety</th>
<th>Malignant form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhabdomyoma - benign tumor of striated muscle</td>
<td>Rhabdomyosarcoma - malignant counterpart</td>
</tr>
<tr>
<td>Leiomyoma - benign tumor of smooth muscle</td>
<td>Leiomyosarcoma - malignant counterpart</td>
</tr>
<tr>
<td>Benign melanoma – benign tumor of melanocytes</td>
<td>Malignant melanoma – malignant counterpart</td>
</tr>
<tr>
<td>Seminoma – benign tumor of seminiferous epithelium</td>
<td>Malignant seminoma – malignant counterpart</td>
</tr>
<tr>
<td>Plasmacytoma – benign tumor of plasma cells</td>
<td>Multiple myeloma – malignant tumor of plasma cells</td>
</tr>
</tbody>
</table>
Some more neoplasms with specialized names:

- **Mast cell tumor** – name given to both benign and malignant counterparts

- **Teratoma** - a tumor derived from cells representing all three embryonal germ layers (e.g., an ovarian teratoma may contain skin, gut, and bone). Such tumors may be benign or malignant depending on the sex and species.

- **Leukemia** - neoplastic cells originate in the bone marrow and circulate in the blood
Differences between Benign and Malignant Neoplasia

Objectives Upon completion of this section you will be able to:

1. Be familiar with the difference between benign and malignant neoplasia

- Neoplastic cells have certain characteristics that help us figure out whether they are benign or malignant
  - Benign neoplasms are slow growing and expansile
  - Malignant neoplasms are rapidly growing and often associated with necrosis, as they outgrow their blood supply
  - Benign neoplasms are well differentiated – i.e. resemble the tissue of origin
  - Malignant neoplasms can be anaplastic – i.e. DON’T resemble the tissue of origin

Comparison of benign and malignant neoplasms

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benign</th>
<th>Malignant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth Rate</td>
<td>Slow</td>
<td>Fast</td>
</tr>
<tr>
<td>Mode of Growth</td>
<td>Expansile</td>
<td>Infiltrative</td>
</tr>
<tr>
<td>General Effects*</td>
<td>Uncommon</td>
<td>Common</td>
</tr>
<tr>
<td>Metastases (**)</td>
<td>None</td>
<td>Common</td>
</tr>
<tr>
<td>Recurrence after removal</td>
<td>Rare</td>
<td>Common</td>
</tr>
<tr>
<td>Gross:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capsule</td>
<td>Common</td>
<td>Uncommon</td>
</tr>
<tr>
<td>Necrosis</td>
<td>Rare</td>
<td>Common</td>
</tr>
</tbody>
</table>

*Some benign neoplasms may prove fatal because of their location (e.g. brain), secondary complications (excessive hemorrhage, blockage of intestinal tract, etc.).

** Most reliable criterion

Neoplasia is irreversible.

Neoplastic growth is relentless. Once a cell is transformed into a neoplastic one, it never will be normal again. Growth controlling mechanisms present in normal cells are permanently impaired in neoplastic cells.
The doubling rate of benign cells is relatively slow. If it is not removed however, a neoplasm, even a benign one, has the potential to become very large. The growth rate is much faster in malignant neoplasms.

**Characteristics of benign neoplasms**

*As benign neoplasms expand, they can compress surrounding tissues.*
Benign neoplasms do not penetrate (invade) adjacent tissues as they grow; they compress them. This growth pattern is known as expansile growth, like the expansion of a balloon. As compression occurs, a demarcation is formed between surrounding tissues and the neoplasm. Sometimes a fibrous connective tissue band surrounding the neoplasm -- a capsule -- enhances the demarcation. At surgery the demarcation allows the removal of the lesion without much surrounding damage.

*Benign neoplasms do not have the capacity to invade or metastasize.*
Benign neoplasms never invade surrounding tissues; they never metastasize. When examined under the microscope, benign neoplasms are composed of well-differentiated neoplastic cells that resemble the tissue from which they originated. Cells of benign neoplasms stay attached to each other, they do not wander off. Because of their cohesiveness, they do not enter blood or lymphatic vessels to spread elsewhere.

**Characteristics of Malignant neoplasms**

*Malignant neoplasms have the capacity to invade and metastasize.*
Malignant neoplasms grow rapidly and have the capacity to invade surrounding tissues. Because of this invasive growth pattern, they are not well demarcated from the surrounding tissues.
Characteristics of Malignant cells

Malignant cells can invade surrounding tissues.
Malignant cells possess the ability to break away and enter surrounding tissues, a feature known as "invasion." The name cancer, in fact, comes from this malignant property. In the Zodiac, Cancer is the crab. In this metaphor, the crab body is the malignant neoplasm, the pincer-tipped legs the invading tentacles. To invade, malignant cells lose their attachment to their neighbors, move about on their own, and go to new parts of the body.

Some effects of neoplasia on the host

Benign Neoplasms

Benign neoplasms may produce deformities.
While benign neoplasms rarely threaten life, they can cause problems. Benign neoplasms often produce some sort of swelling either on the surface or within deeper tissues.

Benign neoplasms may compress surrounding structures.
As benign neoplasms enlarge they may compress some surrounding structure causing blockage or another problem. A benign tumor in the heart might compress the electrical system and lead to acute heart failure. A benign tumor in the brain could press on a critical structure and cause behavioral abnormalities or death.

Benign neoplasms may cause bleeding, infection, or other complications.
Occasionally, benign tumors may bleed, become infected, or otherwise exhibit adverse complications.

Malignant Neoplasms

Malignant neoplasms replace normal functioning tissues.
Malignant neoplasms produce their devastating effects by replacing normal tissue. For example, if a malignancy spreads to bone marrow, normal blood-cell-producing cells are replaced with undifferentiated malignant cells incapable of producing blood cells. A patient's supply of red cells decreases causing anemia. The number of white blood cells
also decreases impairing the patient's immune system. It is no wonder that cancer patients often become weak and prone to fatal infections.

**Malignant neoplasms are often accompanied by a host of complications.**  
A malignancy may outgrow its blood supply causing local tissue death (necrosis). Depending on its location (e.g. intestine) it may become infected. This plus a weakened (compromised) immune system may lead to an overwhelming fatal infection.

**Metastatic malignant neoplasms cause severe body wasting-cachexia.**  
Severe weakness, loss of weight, and generalized body wasting is considered to be characteristic of terminal cancer patients. The term for these changes is cachexia. This is characterized by loss of body fat and muscle, and reduced appetite.

<table>
<thead>
<tr>
<th>Cachexia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cancer cachexia occurs in a large number of cancer patients and is characterized by anorexia, weight loss, generalized muscle weakness, and multiple organ dysfunction, often despite normal calorie intake. Cachexia is a complex syndrome that can be triggered by a combination of factors including anorexia, surgery, radiation therapy or chemotherapy, alterations in lipid and carbohydrate metabolism, and increased muscle catabolism.</td>
</tr>
</tbody>
</table>