Endometrial metaplasias and reactive changes: a spectrum of altered differentiation

Alina Nicolae, Ovidiu Preda, Francisco F Nogales

ABSTRACT
Endometrial metaplasias and changes (EMCs) are conditions frequently overlooked and misdiagnosed. The aim of this review is to update current issues and provide a classification with a practical clinicopathological approach. Hormonal or irritative stimuli are the main inducing factors of EMCs, although some metaplasias have a mutational origin. EMCs vary from reactive, degenerative lesions to those able to associate with malignancy or those having a preneoplastic potential. The most common types of EMCs are ciliated tubal metaplasia (CTM) and mucinous metaplasia (MM), which occur in simple and complex glands, and possibly these architectural changes hold the same prognostic significance as they do in hyperplastic endometrioid lesions. Immunohistochemically, CTM is positive for LhS28, bcl-2, PAX2 and p16INK4A. Complex CTM is likely to be a precursor of ciliated endometrioid-type carcinomas. MMs should be evaluated architecturally, taking into account that their atypicity is minimal. The differentiation between simple MM and mucinous carcinoma may be extremely difficult. Surface complex, papillary MM in endometrial polyps can be considered as benign. Intestinal-type endometrial MM is rare and its presence should prompt further investigation of associated lesions in the endocervix. Endometrial squamous metaplasia (ESS) is often linked to chronic irritative situations. It should be differentiated from secondary involvement by a human papilomavirus-related cervical lesion. Morules is a benign, hormonally inert structures that are often markers of complex endometrioid glandular architecture, and they are associated with an attenuated malignancy. Endometrial reactive changes are commonly associated with desquamation or hormonal imbalance. The frequent, p16INK4A positive, benign surface papillary syncytial change may be misdiagnosed, in some cases, as surface serous adenocarcinoma. Eosinophilic, oxyphilic, oncocytic change may be misdiagnosed, in some cases, as surface serous adenocarcinoma. Eosinophilic, oxyphilic, oncocytic change may be misdiagnosed, in some cases, as surface serous adenocarcinoma.

INTRODUCTION
Endometrial pathology is an important part of the daily routine in histopathology. As a result of its wide morphological variation, the diagnostic interpretation of endometria remains one of the least reproducible fields in gynaecological pathology. In the past, little attention has been paid to endometrial metaplasias and changes (EMCs), and thus they are conditions that are frequently overlooked and misdiagnosed. In this review we analyse the current information on this subject and attempt to provide guidelines for their interpretation and classification that are clinically relevant.

EMCs comprise a morphologically heterogeneous group of proliferations and differentiations found in eutopic and ectopic endometria. Their epithelial or mesenchymal components are replaced either by excessive quantities of homologous cells or partly by heterologous elements. Epithelial EMCs are the most frequent, while mesenchymal EMCs uncommonly occur. The former may occur, mostly focally, in surface and glandular epithelium, but in rare cases they can involve the whole endometrial cavity. While some are usually associated with physiological conditions such as menstruation or pregnancy, most occur in conjunction with pathological situations such as polyps, hyperplasia and adenocarcinoma. EMCs are rarely pure and often various histological types can be seen overlapping in the same specimen.

The tissues derived from the Müllerian ducts and those corresponding to the ‘secondary Müllerian system’ have a remarkable capacity to undergo multiple differentiations into almost any type of epithelium as well as into various mesenchymal tissues. The endometrium has one of the highest turnovers of cells, only matched by the intestinal lining. From the newborn to late menopause, the endometrium never becomes afunctional, only inactive, and always responds to hormonal stimuli. The continuous endometrial growth, maturation and shedding, performed in short periods of time, involve a myriad of cell cycles and consequently there are multiple opportunities for genetic changes.

Origin
It is likely that endometrial renewal is accomplished by stem cells. Although their identification has not yet been established, various putative candidates have been proposed. These include clonogenic endometrial cells; CD146+PDGFRβ+ or CD29+CD73+CD90+ stromal cells and endometrial side population cells. The latter are likely to be responsible for endometrial regeneration and perhaps originate from bone marrow stromal cells. They mainly reside in the vascular endothelial walls and perivascular areas of the basal and functional layers.

Terminology
Metaplasias are adaptive phenomena involving a newly acquired morphology and function. The term change does not necessarily involve true cell transformation, but rather a reactive response of the nucleus or cytoplasm. Neometaplasia, a poorly defined term, usually refers to unusual.
differentiations in tumours that reflect their heterogeneity and multipotency. In this review, we will analyse endometrial metaplasias of epithelium and stroma, as well as some frequent reactive epithelial cellular changes.

A proposal of classification for these lesions is presented in table 1.

**Associated phenomena and pathogenesis**

EMCs are observed in a variety of non-neoplastic and neoplastic conditions in all ages. EMCs and hyperplasia are not mutually exclusive lesions and they often coexist and overlap, since both are related to unopposed oestrogen stimuli. Furthermore, EMCs have also been described in endometria of patients with progesterone-coated intrauterine devices, and even associated with the new selective progesterone-receptor modulators. As a rule, EMCs are frequently seen in endometrial polyps, endometriosis and in the benign epithelial component of some tumours such as adenosarcomas. Finally, they can occur in diverse conditions such as chronic inflammation, trauma and vitamin A deficiency.

It is clear from the frequent association of EMCs with neoplasia that they share some common pathogenetic pathways. However, since EMCs are such a highly heterogeneous group of lesions with different pathogeneses, it would be difficult to attribute them with a generical malignant potential. Although most EMCs are hormonally related and benign, some, such as morules, have a mutational origin and are mostly associated with glandular complexity and atypia. The malignant potential of reactive changes and stromal metaplasias is likely to be negligible.

Table 2 summarises the potential risk and association with malignancy of the different types of endometrial metaplasia and changes.

### Table 1: Classification of endometrial metaplasias and changes

<table>
<thead>
<tr>
<th>Endometrial metaplasias and changes</th>
<th>Epithelial</th>
<th>Stromal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ciliary, tubal (simple and complex)</td>
<td>— Intestinal variant</td>
<td>— Myoid, sex-cord like</td>
</tr>
<tr>
<td>Mucinous (simple and complex)</td>
<td>— Morules</td>
<td>— Osseous</td>
</tr>
<tr>
<td>Squamous</td>
<td>— Reactive changes</td>
<td>— Cartilaginous</td>
</tr>
<tr>
<td>Morules</td>
<td>— Surface, papillary syncytial change</td>
<td>— Adipose</td>
</tr>
<tr>
<td>Squamous</td>
<td>— Hobnail variant</td>
<td>— Smooth muscle</td>
</tr>
<tr>
<td>Reactive changes</td>
<td>— Oncocytic, oxyphilic, eosinophilic</td>
<td>— Myoid, sex-cord like</td>
</tr>
</tbody>
</table>

**EPITHELIAL EMCS**

Mucinous and tubal metaplasias are frequently admixed and are perhaps the lesions that cause the most problems of interpretation. They may occur in simple and complex glands, and their architectural changes possibly have the same prognostic significance as they do in endometrioid, hyperplastic lesions. Consequently, endometrial lesions with complex architecture are not restricted only to endometrioid-type glands, but may also involve mucinous or tubal glands.

**Endometrial ciliated and tubal metaplasia**

Ciliation is a characteristic feature of Müllerian epithelia, and its ubiquitous presence in the cervix, isthmus and normal proliferative endometrium could suggest that lesions exhibiting a predominant ciliated component do not represent a true metaplasia but rather a hyperplasia of ciliated cells. Nevertheless, the term ‘ciliated metaplasia’ is used when the majority of cells of surface epithelium or endometrial glands are predominantly replaced by ciliated cells (figure 1). The term ‘tubal metaplasia’ requires the presence of the three types of cell that constitute the tubal epithelium: ciliated, secretory and intercalary cells (figure 2). However, these differences are merely academic and are not particularly significant.

In the endometrium, ciliated and tubal metaplasia (CTM) is the most common type of metaplasia and also occurs frequently in the cervix, where its location at the squamocolumnar junction, mild atypicity, lack of intracytoplasmic mucin and frequent positivity for p16INK4A can lead to its misdiagnosis as an in situ endocervical adenocarcinoma. In the uterine isthmic region, ciliated glands are so common as to be considered normal.

Endometrial CTM is mostly described in conjunction with unopposed oestrogen levels, and its association with simple and complex endometrial hyperplasias and well-differentiated adenocarcinomas is striking. Residual CTMs can be found in atrophic endometria, where they remain unchanged even after radiotherapy. Endometrial polyps and adenosarcomas also have CTM as a common glandular component. Furthermore, endometriosis is a frequent site of tubal metaplasia and when it occurs in the ovary should be differentiated from benign serous neoplasms.

Simple CTM occurs in normal-size or cystic tubular glands and represents the most common type of benign EMC. However, complex CTM occurs in glands that have stellate or

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**Table 2: Association of metaplasias and changes with neoplasia and malignant potential**

<table>
<thead>
<tr>
<th>Type of endometrial metaplasia and change</th>
<th>Potential risk and association with malignancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morules</td>
<td>Nearly always</td>
</tr>
<tr>
<td>Ciliary, tubal complex</td>
<td>Frequent</td>
</tr>
<tr>
<td>Mucinous complex (including intestinal)</td>
<td>Frequent</td>
</tr>
<tr>
<td>Squamous</td>
<td>Rare</td>
</tr>
<tr>
<td>Surface, papillary syncytial change</td>
<td>Rare*</td>
</tr>
<tr>
<td>Oncocytic, oxyphilic, eosinophilic</td>
<td>Unknown</td>
</tr>
<tr>
<td>Clear cell, secretory</td>
<td>Never</td>
</tr>
<tr>
<td>Stromal metaplasia</td>
<td>Never†</td>
</tr>
</tbody>
</table>

*May be present as reactive change in the surface of carcinomas during bleeding episodes. †May be present in the vicinity of carcinomas.

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**Figure 1** Isolated tubular gland lined by ciliary cells.
angular contours (figure 3), which are found together with complex changes such as papillae (figure 5) or stratification that may even display a cribriform appearance\(^1\)\(^9\)\(^{17}\)\(^{18}\)\(^{27}\)\(^{30}\) (figure 4). We believe that the main discriminating feature between lesions with and without malignant potential is architectural, since atypia is usually minimal, even in ciliated adenocarcinoma. This is evident in the closely related lesion of mucinous metaplasia, where architecturally complex glands, even with no atypia, often associate and merge with endometrioid adenocarcinoma. Consequently, complex CTM of the endometrium should be managed as a complex endometrial hyperplasia\(^9\)\(^{30}\). However, when focal complex CTM is restricted to endometrial polyps it seems to have little relevance.

Although the CTM immunophenotype has been amply studied in the cervix, there are few immunohistochemical studies of endometrial CTM. LhS28, an antibody that reacts with basal body of cilia, helps to demonstrate ciliary differentiation\(^31\), while p16\(^{INK4A}\) is constantly positive usually in a mosaic or focal fashion\(^32\) (figure 5). CTMs have a low Ki67 index, and p53 shows a weak and heterogeneous pattern\(^32\). Similar to findings in the fallopian tube epithelium\(^33\), only the secretory cells of CTM are positive for bcl-2 (figure 6) and also for PAX2.

If complex CTM is likely to be a precursor of an endometrial carcinoma, which type of carcinoma does it precede? The likeliest candidate would be well-differentiated endometrioid carcinoma with extensive ciliary change\(^34\). There is no contrasted clinicopathological evidence that tubal metaplasias\(^32\) represent precursor lesions of serous carcinoma.

We have been able to demonstrate PTEN and K-ras mutations and microsatellite instability in some cases of complex CTM that had a concurrent weak p53 expression (A Nicolae, personal communication). This profile would support CTM as a precursor of endometrioid but not of serous carcinoma.

Although presence of cilia is associated with a high grade of cellular differentiation, it must be borne in mind that some well-differentiated endometrioid adenocarcinomas are of ciliated type\(^27\)\(^{34}\)\(^{35}\). This diagnosis should be reserved only for cases with features of invasion\(^27\), the exception being florid, cystic endosalpingiosis, which is a rare condition in which pseudoendometrioid glands with extensive CTM are found deep within the myometrium\(^36\).

**Endometrial mucinous metastasis**

Endometrial mucinous metastasis (EMM) often occurs in perimenopausal and postmenopausal women, on the surface of atrophic senile endometria and in patients undergoing hormonal treatment, when it may be also accompanied by squamous or tubal metaplasia\(^1\)\(^{37}\). EMM is frequent in tamoxifen polyps\(^38\)\(^{39}\), the benign glandular component of adenofibromas and adenocarcinomas\(^14\), and in ovarian and pelvic endometriosis\(^12\)\(^{15}\).

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**Figure 2** Tubal metaplastic glands showing secretory, ciliary and intercalary cells.

**Figure 3** Complex stellate and papillary area of complex tubal metaplasia.

**Figure 4** Complex, cribriform glands in tubal metaplasia.

**Figure 5** Mosaic p16 positivity in tubal metaplasia.
Mucinous metaplasia usually involves the endometrium focally rather than in a diffuse fashion. Rare, extensive EMM can lead to myxometra, an unusual condition defined as accumulation of mucus in the uterus. EMM can also occur as synchronous and multifocal lesions elsewhere in the female genital tract. In the same way as CTM, EMMs may arise as a response to hormonal stimuli. Because of their frequent association with other types of metaplasia (tubal, eosinophilic, papillary change), EMM can be regarded as one of the multiple morphological aspects of the same process. EMM can occur as a reactive phenomenon when associated with cervical stenosis or cervical agenesis, suggesting a potential irritative role of fluid retention. Nevertheless, mucinous lesions may represent monoclonal alteration of the endometrium, and this would explain their relationship with neoplasia. This is clearly seen in STK-11 gene mutations, especially in patients with Peutz-Jeghers syndrome, where EMM occurs as a spectrum of histological changes ranging from metaplasia to carcinoma, involving synchronously cervix, corpus, fallopian tube and ovary. Multifocality, however, can also occur sporadically.

In curettage material, interpretation of EMM can be difficult; indeed, a three-tier morphological classification of progressively architecturally complex lesions has been proposed. This approach, however, has been found to have little reproducibility and, consequently, simplification is preferable. We prefer interpreting EMMs into a two-category scheme using the terms simple and complex EMM. Simple EMM represents the substitution of the endometrial lining of glands and surface epithelium by tall, bland, columnar mucinous cells of endocervical type (figure 7). It shares common histochemical and immunophenotypical properties with benign endocervical epithelium, such as expression of various mucin core proteins. In complex EMM, the mucinous cells line architecturally crowded, irregular glands. Their columnar lining may present tufting, micropapillary or papillary infoldings (figure 8). More complex proliferations may have a microglandular or cribriform pattern similar to endocervical microglandular hyperplasia, even displaying clusters of neutrophils within intraepithelial microcystic structures. Budding or branching of the glands may also be present. The mucin-secreting cells can be intermixed with tubal-type cells and their nuclear atypia varies from absent to mild. Mitoses are rare. Complex EMMs may occur in association with complex endometrioid lesions (figure 9) and in the vicinity of, and often undistinguishable from, mucinous carcinomas.

Clinicopathologically, we consider simple EMM as benign lesions, while complex EMM should be managed in the same way as complex hyperplastic endometrioid glands, although bearing in mind that in EMM there is little (if any) atypicality. An exception would be cases of endometrial polyps with a surface EMM complex papillary proliferation; these are benign. Frequent misinterpretations of EMMs include microglandular endocervical hyperplasia and the rare microglandular variant of endometrioid carcinoma.

In endometrial biopsy interpretation of complex mucinous lesions, it should be remembered that minimal atypia does not preclude a diagnosis of mucinous adenocarcinoma. EMM rarely exhibit full intestinal type differentiation, which can occur in the endometrial surface and in polyps. This lesion is characterised by glands lined by columnar cells with a brush border, goblet cells and sometimes a variable number of neuroendocrine cells (figure 10). Similarly, their immunophenotype is characteristically intestinal with expression of villin, CK20, CDX2 and chromogranin. Intestinal metaplasia is commoner in the cervix where it is nearly always associated with in situ or invasive adenocarcinomas. For this reason, intestinal EMM should be managed with caution and any endocervical neoplastic lesions should be excluded.

**Endometrial squamous metaplasia**

In the Müllerian system, the incidence of squamous metaplasia increases caudally. While squamous metaplasia of the cervix is...
common, it is rare in the non-neoplastic endometrium and exceptional in the fallopian tube.52

Endometrial squamous metaplasia (ESM) replaces the surface or endometrial glands with mature, non-keratinising, well-differentiated squamous cells. The term squamous metaplasia should be restricted to benign lesions, while the term squamous differentiation should be applied preferentially to carcinomas.53 54 ESM is usually a focal process but can be diffuse, involving extensive areas of the endometrial cavity, when it is known as ichthyosis uteri.55

ESM may occur as a response to chronic irritative situations, such as cervical obstruction, chronic endometritis including tuberculosis,56 pyometra,57 58 and foreign bodies such as the earlier intrauterine devices.59 Various other situations including uterine artery embolisation of leiomyoma,60 vitamin A deficiency61 and even progestin therapy62 63 have been reported as possible aetiopathogenetic factors of ESM.

The malignant potential of ESM is low, with only a few reports of isolated cases of pure squamous carcinoma developing from ichthyosis uterus.64 These should be differentiated from the endometrial involvement by cephalad extension of human papillomavirus-related squamous cervical lesions such as verrucous carcinoma, cervical condylomata and squamous intra-epithelial neoplasia.55 66

ESM is frequently related to endometrioid carcinoma. It has been proposed67 that the finding of an extensive (>2.1 mm) solid squamous proliferation in a curettage specimen would imply a diagnosis of carcinoma, although this may be an exaggeration.68

The relationship of ESM with morules is interesting. Although ESM originates de novo from neoplastic glands, in a fifth of cases it coexists with morules (see below), where transitions between the distinct two types of metaplasia occur.1 23 53 58 This does not mean that neither all ESMs are necessarily neoplastic nor that all ESMs necessarily originate from morules.

Morules
Squamoid endometrial nodules and their morphological differences with ESM were reviewed as early as 1930 by Robert Mayer.69 The current term of morule, which refers to its morphological similarity with a mulberry, was subsequently coined in 1959.70

Morules are rounded, well-circumscribed aggregations of uniform, oval or spindle-shaped cells with regular, inactive nuclei and an eosinophilic cytoplasm. They merge with ESM in 20% of cases. Morules originate within the glandular epithelium, protrude and eventually plug the entire lumen, and this leads to epithelial atrophy, forming ‘free’ stromal nodules. Central necrosis of comedo type is more frequent in the larger morules, probably due to ischaemia. Optically clear nuclei are frequent.23 54

Although the occurrence of ESMs in normal endometria or polyps is rare23 (figure 11), they are nearly always associated with focal complex endometrial glandular lesions in the eutopic and the ectopic endometrial tissue.23 53 58 Morular metaplasia is also seen in endometrial polyps with complex glands and in atypical polypoid adenomyoma, where they are considered a requisite for diagnosis.46 Rarely, morules are associated with chronic endometritis, submucosal leiomyoma, irradiation and intrauterine devices,53 but this is likely to be coincidental rather than a pathogenetical relation.

Does morular metaplasia represent an early step in squamous differentiation, or do they represent two distinct phenomena? Some authors consider them an immature stage of squamous differentiation.1 57 58 Nevertheless, we believe they are separate entities based on their different biological potential,23 and their morphological70 and immunohistochemical features.23 53 54

Table 3 highlights the main immunophenotypical differences between morules and ESM. From a practical viewpoint, positivity for diffuse and membranous CD10, nuclear CDX2 and β-catenin is constant in morules and usually differentiates them well from ESM. Empty, clear nuclei contain biotin23 53 54 75 78 and are identical with those present in pregnancy, where they

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**Figure 9** Complex endometrioid hyperplasia with a glandular space lined by micropapillary mucinous metaplasia (arrow).

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**Figure 10** Complete intestinal metaplasia of endometrium. Isolated normal endometrial glands are present (arrow).

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**Figure 11** Morular metaplasia in a polyp associated with simple glands.
are related to steroid hormone hyperstimuli.78 The reactivity for various cytokeratins (not included in table 5) varies widely between studies.23 53 58

An interesting immunohistochemical feature of morular metaplasia is a neuroectodermal aberrant phenotype represented by the expression of neuron-specific enolase, synaptophysin, S-100, somatostatin and acetylcholinesterase.53 54 We have seen cases of massive morular metaplasia in endometrial lesions with chromogranin and synaptophysin positivity (figure 12) that prompted a differential diagnosis with neuroendocrine carcinoma.

Endometrial morules display identical histology and immunophenotype to those found in tumours of various sites such as gastrointestinal, lung and thyroid. They are highly specific in rare neoplasms such as low-grade adenocarcinoma of fetal lung type and the cribriform morular variant of papillary thyroid carcinoma.79 78 It has been proposed that tumours containing morules reflect a common pathway of carcinogenesis involving molecular alterations of the Wnt-signalling pathway with nuclear β-catenin accumulation.54 71 75 80 81 Also, all morules have in common nuclear expression of CDX258 76 77 and β-oestrogen receptor75 which appear to be related to their pathogenesis.

Morules are hormonally inert, with absence of α-oestrogen and progesterone receptors.23 53 58 75 79 and a very low proliferative index. Consequently, they neither participate actively in the neoplastic transformation compared with their oestrogen- and progesterone receptor-positive glandular counterpart nor are they in the neoplastic transformation compared with their oestrogen- and progesterone receptor-negative index. Consequently, they neither participate actively in the neoplastic transformation compared with their oestrogen- and progesterone receptor-negative index. Consequently, they neither participate actively in the neoplastic transformation compared with their oestrogen- and progesterone receptor-negative index. Consequently, they neither participate actively in the neoplastic transformation compared with their oestrogen- and progesterone receptor-negative index. Consequently, they neither participate actively in the neoplastic transformation compared with their oestrogen- and progesterone receptor-negative index. Consequently, they neither participate actively in the neoplastic transformation compared with their oestrogen- and progesterone receptor-negative index. Consequently, they neither participate actively in the neoplastic transformation compared with their oestrogen- and progesterone receptor-negative index.
endometrium of older patients and only rarely in the premenopausal menstrual mucosa. Although SPSC and serous carcinoma can be p53 positive, their staining pattern is different, being heterogeneous and weak in SPSC, and strong and diffuse in serous carcinoma and its precursors. Furthermore, the Ki67 index is high in serous carcinoma and very low or absent in SPSC.

Hobnail change
This change often appears as a reactive phenomenon after curettage or abnormal bleeding, and is a type of SPSC. Histologically, the surface and/or glandular epithelia are replaced by teardrop-shaped cells with an appearance reminiscent of the Arias-Stella phenomenon, clear cell carcinoma or the detached eosinophilic cells of a serous adenocarcinoma. They have scanty eosinophilic or clear cytoplasm and prominent apical nuclei that bulge into the luminal spaces. Hobnail change can also be associated with radiotherapy. In gestational and puerperal endometria hobnail change represents an Arias-Stella phenomenon. Similarly, it can be found in Mirena coil endometria.

Oxyphilic, oncocytic and eosinophilic changes
All these terminologies have the non-specific histological features of eosinophilia as their common denominator. These changes can be considered as reactive alterations rather than true metaplasias. They can occur in a host of normal, non-neoplastic and neoplastic endometria, where they may be associated with other types of epithelial metaplasias and changes, especially with SPSC and CTM. Among them, oncocytic cytoplasmic changes are the most unusual (figure 15) and can present with nuclear atypia, which is not necessarily a criterion for malignancy, since they may only represent degenerative phenomena. Oxyphilic or oncocytic changes can involve architecturally complex glands and even adenocarcinomas of the eutopic and ectopic endometrium.

The nature of these eosinophilic cells is poorly understood, being considered by some as a form of immature mucinous metaplasia, while for others, they represent a surface degenerative change. This is supported by their presence in the vicinity of endometrial granulomatous lesions.

The importance of recognising eosinophilic metaplasia resides in distinguishing it from oxyphilic or oncocytic adenocarcinoma, especially when the latter shows only minimal cytological atypia. Hepatoid areas associated with endometrioid carcinomas may also have oncocytic-type changes.

Clear cell or secretory change
The finding of secretory glands with vacuolated or apocrine-like cells in an endometrium with proliferative features points to a hormonal imbalance (spontaneous or iatrogenic) rather than to

Figure 12 Synaptophysin positivity in morules. Other neuroendocrine markers were also expressed.

Figure 13 Surface papillary syncytial change enveloping collapsed stromal balls.

Figure 14 Positivity for p16 highlights surface papillary syncytial change areas.

Figure 15 Oncocytic metaplasia.
neuroectodermal components are characteristic of malignant expressions of complex mesenchymal, epithelial and even differentiation, as well as osteogenic tissue. Unusual carcinomas, especially in those treated by progestogens, are a true metaplasia. This may also occur in some simple and complex hyperplasias, and even in well-differentiated adenocarcinomas, especially in those treated by progestogens. Distinction from a neoplastic proliferation such as clear cell carcinoma or a secretory variant of endometrioid carcinoma is based on the absence of architectural complexity, stromal invasion, cellular pleomorphism and mitotic figures.

STROMAL ENDOMETRIAL METAPLASIA
Although most endometrial metaplasias involve the endometrial epithelium, there are rare cases of mesenchymal metaplasias that are usually incidental findings with little clinical significance. The presence of heterotopic tissues in the normal endometrium is often explained as embedded fetal or embryonal tissue as a result of pregnancy termination. This may be the cause of unusual lesions such as glial nodules in the endometrium. In the absence of an organised histology of mesenchymal tissues and a history of previous obstetrical manipulation, metaplasia is the alternative to be considered.

As mentioned above, endometrial stem/progenitor cells are the most likely candidates for the development of a wide range of differentiations, including mesenchymal-type cells. Mesenchymal or stromal stem-cell-like precursors, isolated from the menstrual blood, show an in vitro multipotent capacity to induce myocyte, chondrocyte, and adipocyte differentiation, as well as osteogenic tissue. Unusual heterotopic cell types can also be differentiated. The multiple expressions of complex mesenchymal, epithelial and even neuroectodermal components are characteristic of malignant mixed Müllerian tumours.

Osseous metaplasia
Bone within the uterine cavity may have various origins. It can be a dystrophic phenomenon secondary to chronic endometritis or cervical surgery, and it may also occur in the vicinity of adenocarcinomas. The metaplastic nature of this condition is proved by genetic analysis and morphologically by its continuity with stromal cells. It should be differentiated from in utero fetal bone retention after pregnancy termination. Osseous metaplasia can be deeply embedded in the uterine mucosa and may present the same contraceptive effect as an intrauterine contraceptive device.

Cartilaginous metaplasia
Rare, benign appearing nodules of cartilage can be present in the endometrium. Transition between stromal and cartilaginous cells is helpful to identify them as metaplastic lesions. Although very rare, cartilaginous metaplasia of the uterus has been identified as a heterologous element of a metastatic metastatic breast carcinoma and thus should be considered in the differential diagnosis of malignant mixed Müllerian tumour.

Adipose metaplasia
Contrary to the myometrium and ovarian cortex, the endometrium rarely develops fatty tissue. Its presence has been described as a reactive phenomenon in the vicinity of endometrial tumours and polyps. Histologically, it appears as clusters or nodules of mature fat cells (figure 16), which blend at their periphery with the endometrial stroma, sometimes surrounded by a mild inflammatory reaction.

Smooth muscle metaplasia
Smooth muscle cells can be identified in the endometrium as isolated short fascicles or even as well-defined nodules. The latter can be considered as an intraendometrial leiomyoma or, possibly, an extension of the surface myometrium. Myoid differentiation possibly takes place from endometrial stromal cells, exemplified by its presence in ovarian endometriosis where it can induce, in an extreme form, the so-called uterus-like mass.

Small sex-cord-like structures with myoid differentiation, also known as plexiform tumourlets, are represented by sex-cord-like trabeculae that coexpress CD56, cytokeratins and myoid markers. They originate from the stroma of eutopic and ectopic endometria including adenomyosis.

Competing interests None to declare.

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