Flat Serrated Colorectal Lesions at CT Colonography: Appearance, Relevance, and Pitfalls

Ashley R. Cahoon, MD, David H. Kim, MD, Meghan G. Lubner, MD, Perry J. Pickhardt, MD
Objectives

• Discuss the spectrum and characteristics of flat serrated polyps.
• Review the incidence, pathophysiology, clinical significance and appearance on CTC with case examples and correlation with optical colonoscopy.
• Discuss optimal preparation and technique for maximizing detection of flat colorectal polyps on CTC.
Background

• Many flat serrated polyps were historically misclassified as benign hyperplastic polyps with no future malignant potential.
• It is now known that “hyperplastic polyps” comprise a varied group of lesions, all with a serrated epithelial morphology.
• A subset of these neoplasms (‘sessile serrated polyp’) are difficult to detect and have malignant potential via a pathway distinct from the traditional adenoma-carcinoma pathway.
• Recognition of the malignant potential of serrated neoplasms has made clear the need for removal.
• **CT colonography (CTC) can be a valuable tool in the detection of these important-to-recognize lesions.**
Flat polyps

• Flat is a morphologic descriptor.
  • A flat polyp is plaque-like lesion raised no more than 3 mm from the colonic mucosa. They are typically difficult to detect.
  • Many histologies can present as flat polyps, including serrated neoplasms.
  • Flat masses (≥3 cm) are termed “carpet lesions”
  • Despite claims otherwise, CTC can detect flat lesions, including flat serrated neoplasms, due to contrast coating of the lesions.

Left: Axial CTC image showing a subtle, flat polyp in the transverse colon. Note the overlying contrast (arrow).

Right: Optical colonoscopy correlate to the CTC-detected flat polyp which was a sessile serrated polyp at histology
Serrated neoplasms

• Newly recognized group of related polyps distinct from an adenomatous lineage (tubular, tubulovillous, villous).
• Some serrated subtypes may progress to cancer.
• Serrated lesions accounts for 20% of sporadic (non-familial) colorectal cancers.
• Screening population prevalence: 3% for non-diminutive (≥ 6 mm) serrated polyps.
Serrated polyps include a histologically varied group of lesions, all with epithelial infolding, i.e. a ‘serrated’ morphology:

**Hyperplastic polyp (HP)** – Majority of serrated lesions – 70-95%. No malignant potential

**Sessile serrated polyp (SSP)** also known as a ‘sessile serrated adenoma (SSA)’, *although not adenomatous in lineage (a misnomer)* – 5-25% of serrated lesions. These are clinically important serrated lesions.

**Traditional serrated adenoma (TSA)** – 2-9% of serrated lesions. These are also clinically important serrated lesions.
**Serrated polyps: Pathologic spectrum**

- SSPs and TSAs are the serrated subtypes with future malignant potential.
- True hyperplastic polyps are benign.
- Until recently, many institutions mistook SSPs to be HPs. Prior to 2008, any HP that is large (≥ 10mm) and right-sided is likely an SSP.
  - There are subtle changes in the architecture of the crypt bases that separate the two polyp subtypes. The distinction is crucial, as one is a cancer precursor.
- The genetic pathway to cancer for SSP and TSA differs from the traditional adenoma-carcinoma pathway.

Large field (left) and magnification views (right) showing the histopathological appearance of a sessile serrated polyp (H&E stain). There are dilated boot-shaped crypts that distinguish from a hyperplastic polyp.
Specific serrated neoplasms:

- **SSP**
  - One of the polyp precursors that can progress to cancer over time
  - Only a small percentage progress over 15-20 years.
  - Predominantly seen in the right colon (>90%)
  - Higher percentages of flat morphology (can be sessile, pedunculated, rarely carpet)
  - Typically larger than 10 mm on presentation
Sessile serrated polyps

Axial CTC (left), 3D reconstruction (left middle), and zoomed axial CTC (right middle) of an SSP in the ascending colon, which is almost completely flat. Without adherent contrast tagging, this lesion would not have been detectable. The right image shows the optical colonoscopy correlate, which demonstrates a mucin cap.
Axial CTC in prone (left), and supine (middle) positions demonstrate a pedunculated SSP in the right colon, which moves with change in position. SSPs with pedunculated morphology are less common, but do occur. Adherent contrast tagging again helps make the lesion more visible. Optical colonoscopy correlate (right) shows the characteristic mucin cap atop this SSP.
Sessile serrated polyps

Axial CTC (left) and optical colonoscopy correlate (right) of a second ascending colon SSP in the same patient, which is sessile in morphology.
Sessile serrated polyps

From left to right: Coronal and zoomed coronal CTC, 3D reconstruction and optical colonoscopy image of an SSP in the ascending colon tracking along a haustral fold. Contrast coating helps draw attention to the polyp, regardless of morphology.
Sessile serrated polyps

From left to right: Axial CTC, 3D reconstruction, translucency view, and optical colonoscopy image of a large, laterally spreading flat mass (carpet lesion) in the sigmoid colon, which was an SSP at pathology.
Specific serrated neoplasms:

- **TSA**
  - Rare lesion but has future malignant potential.
  - Seen throughout the colon without a right-sided predominance.
  - Typically large, but a subcentimeter presentation is not uncommon.
  - Can present with sessile (most common), flat, or pedunculated morphology.
  - Characteristic ‘frond-like’ appearance when very large.
Traditional serrated adenomas

Axial CTC (left) and 3D reconstruction (middle) of a sessile TSA in the sigmoid colon. The image on the right shows the optical colonoscopy correlate.
Traditional serrated adenomas

Axial CTC in prone and supine positions (left two images) show a large, mobile TSA with a characteristic frond-like appearance and contrast interdigitating between fronds. Corresponding translucency view (right middle) and optical colonoscopy correlate (right) are also shown.
Specific serrated neoplasms:

• **HP**
  • Benign lesion with no future malignant potential and therefore of little clinical significance.
  • Seen throughout the colon.
  • Usually small and flat.

Axial CTC (left) and corresponding optical colonoscopy image showing a 6mm hyperplastic polyp in the posterior rectum (note the rectal tube on the CTC image).
Alternative cancer pathway

• The genetic pathway to cancer for SSP and TSA differs from the traditional adenoma-carcinoma pathway...
For SSPs, mutations in the BRAF oncogene are found. The microvesicular HP subtype (MVHP) contains BRAF mutations and may be a precursor lesion. In this pathway, hypermethylation (CpG island methylator phenotype – CIMP) of the MLH1 gene leads to DNA mismatch repair and subsequent microsatellite instability (MSI). When CIMP does not target MLH1 early in the pathway, microsatellite stable cancers result. BRAF mutations may also lead directly to SSP without an MVHP precursor.

*Adapted from Sweetser et al. Clin Gastroenterol Hepatol 2013;11(7):760–767*
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TSAs may have either BRAF or KRAS mutations, but not both. The KRAS mutation pathway begets microsatellite stable (MSS) cancers. The goblet cell HP (GCHP) subtype may be a precursor to this lesion, or it may occur independently. Less is known about this pathway.

*Adapted from Sweetser et al. Clin Gastroenterol Hepatol 2013;11(7):760–767*
Imaging features

- A learning curve exists in detecting serrated polyps at CT colonography.
- Many are of flat morphology (>40%) which makes detection more difficult.
- Despite claims that CTC cannot detect these lesions due to the flat morphology and lack of optical cues used by colonoscopists, the phenomenon of adherent contrast tagging on polyps allows CTC detect these lesions.

This large flat polyp was actually detected at CTC, because of adherent contrast tagging, and sent for same day colonoscopy, which yielded an SSP.
Imaging features

- Adherent contrast tagging
  - Mucin produced by serrated polyps is adherent to the polyp surface. This provides a visual cue at optical colonoscopy.
  - Elements of the bowel prep adhere to the mucin elaborated by SSPs
    - It is theorized that barium sulfate (BaSO4) is the tagging agent.

Contrast tagging material admixed with the mucin cap sitting atop a sessile sigmoid polyp at optical colonoscopy.
Imaging features

Contrast coating improves detection at both 2D CTC (the white plaque draws attention to an area for closer scrutiny) and at 3D fly through (reconstruction is a combination of the contrast tag and flat polyp so they almost look sessile).

Axial 2d CTC wide field (left) and zoomed (middle) views of a very flat SSP in the cecum. On 3D reconstruction (right) the contrast coating gives the illusion of height.

Top: Contrast tagging material admixed with the mucin cap seen at optical colonoscopy sitting atop a serrated lesion in the sigmoid colon.
Bottom: CTC correlate. Note the contrast coat highlighting the lesion.
Once a contrast plaque is detected, it must be closely scrutinized for soft tissue undermining the plaque to confirm a flat polyp. If not present, then this represents tagged adherent stool.

Axial CTC image demonstrating a contrast plaque in the cecum (arrow) on polyp windows. Soft tissue window of the same image helps identify a soft tissue prominence underlying the contrast coating. The presence of this flat polyp was confirmed at optical colonoscopy and was an SSP at pathology.
Flat polyps: mimics and pitfalls

Tagged stool can mimic a flat colorectal lesion

• The absence of mucosal thickening underneath the contrast tag precludes a diagnosis of a flat polyp and confirms the presence of tagged stool.

• Scrutiny on both supine and prone views is needed: Adherent stool may change position or disappear whereas, for a true soft tissue polyp, the soft tissue thickening will persist on both views.
Tagged stool- polyp mimic

Here we see another plaque like area of adherent contrast on prone axial CTC and corresponding 3D reconstruction. Soft tissue windows do not demonstrate the soft tissue attenuation that would be seen underlying the contrast coat on a polyp, making this area suspicious for adherent stool. On the supine view, the plaque is gone, confirming our suspicion that this is not a true polyp, but rather tagged adherent stool.
Imaging features: Contrast tagging

CTC bowel preparation and adherent tagging on polyps

- Well documented in a specific CTC bowel prep which is characterized by a dry cathartic and dual tagging regimen (next slide).
- Whether it occurs in wet cathartic-based preps (i.e. polyethylene glycol) or single tagging preps with iodine alone is unknown.
- Good technique is paramount!
One day prior to CT colonography, patients undergo colonic preparation consisting of cathartics and stool tagging agents as follows:

**Liquid only diet** beginning at midnight.

<table>
<thead>
<tr>
<th>Time</th>
<th>Treatment</th>
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<tbody>
<tr>
<td>After midnight...</td>
<td>Liquid diet</td>
</tr>
<tr>
<td>11:00 am...</td>
<td>Bisacodyl</td>
</tr>
<tr>
<td>3:00 – 5:00 pm...</td>
<td>Magnesium citrate #1</td>
</tr>
<tr>
<td>6:00 – 8:00 pm...</td>
<td>Magnesium citrate #2 + BaSO4</td>
</tr>
<tr>
<td>9:00 – 11:00 pm...</td>
<td>Iohexol</td>
</tr>
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</table>

**Bisacodyl tablets** are taken in the late morning

In the afternoon, 2 doses of **magnesium citrate** are ingested, 3 hours apart.

After the second dose, 250 mL of 2.1% weight by volume **barium sulfate** (BaSO4) is taken. This tags any residual stool and coats serrated polyps.

**Iohexol** (iodinated contrast) is then taken to admix with any residual colonic fluid.
Improper or absent contrast tagging

- If the patient confusion the bowel prep sequence and ingests the iodinated contrast, iohexol, prior to the barium solution, the right colonic mucosa will have a thin film of contrast coating. The advantage of tagged adherent contrast is lost.

Axial CTC image in a patient who confused the order of oral contrast ingestion. There is a thin film of contrast circumferentially coating the right colon, obscuring evaluation for flat polyps.
Flat polyps: mimics and pitfalls

Pooled colonic fluid can obscure lesions

- Interrogation of the colon on both prone and supine views can help minimize this.
- Occasionally, a significant amount of contrast pooling is present. In these cases, completion of the study can be delayed for a few hours in order to allow the patient to more adequately evacuate.

Supine (left) and prone (right) axial CTC showing the same SSP along a haustral fold. In isolation, this polyp would be easily missed on the prone view alone as the adherent contrast coating isn’t visible.
# Serrated polyps: surveillance

**Consensus opinion on surveillance intervals after endoscopic resection of serrated lesions**

<table>
<thead>
<tr>
<th>Histology</th>
<th>Size</th>
<th>Number</th>
<th>Location</th>
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<tbody>
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<td>&lt;10 mm</td>
<td>Any</td>
<td>Rectosigmoid</td>
<td>10</td>
</tr>
<tr>
<td>HP</td>
<td>≤5 mm</td>
<td>≤3</td>
<td>Proximal to sigmoid</td>
<td>10</td>
</tr>
<tr>
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<td>Any</td>
<td>≥4</td>
<td>Proximal to sigmoid</td>
<td>5</td>
</tr>
<tr>
<td>HP</td>
<td>&gt;5 mm</td>
<td>≥1</td>
<td>Proximal to sigmoid</td>
<td>5</td>
</tr>
<tr>
<td>SSP or TSA</td>
<td>&lt;10 mm</td>
<td>&lt;3</td>
<td>Any</td>
<td>5</td>
</tr>
<tr>
<td>SSP or TSA</td>
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<td>1</td>
<td>Any</td>
<td>3</td>
</tr>
<tr>
<td>SSP or TSA</td>
<td>&lt;10 mm</td>
<td>≥3</td>
<td>Any</td>
<td>3</td>
</tr>
<tr>
<td>SSP</td>
<td>≥10 mm</td>
<td>≥2</td>
<td>Any</td>
<td>1-3</td>
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<tr>
<td>SSP w/ dysplasia</td>
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<td>Any</td>
<td></td>
<td>1-3</td>
</tr>
</tbody>
</table>

Flat lesions and masses include a spectrum of histologic entities including serrated neoplasms.

Serrated neoplasms of the colon and rectum represent a newly recognized subgroup of flat lesions that have the potential to transform into colorectal cancer, distinct from the traditional adenoma-carcinoma pathway.

Serrated neoplasms are comprised of sessile serrated polyps (SSP), traditional serrated adenomas (TSA) and hyperplastic polyps (HP). SSP and TSA hold potential future malignant potential.

The target serrated neoplasms for removal tend to be large (>1cm), flat, and proximal in location. They can be difficult to detect.

A learning curve exists in detecting flat serrated polyps and masses at CTC.

Oral contrast often coats the surface of flat colorectal neoplasms at CTC, which can aid in detection and may increase diagnostic confidence.

Summary


6. Kim DH, Matkowskyj KA, Pickhardt PJ. Serrated polyps are detected at CT colonography: clinical observations over the past decade and results from CTC-based screening of average risk adults. Abdom Radiol 2016;41:1445–1447.


18. Rex DK, Ahnen DJ, Baron JA, Batts KP. Serrated lesions of the colorectum: review and recommendations from an expert panel. The American journal of gastroenterology 2012;107(9):1315.
