Tufts UNIVERSITY | School of Dental Medicine

Ad-Hoc Operative Calibration Committee
Department of Comprehensive Care

Caries Detection and Assessment

Caries detection by clinical examination has been recognized as a problem for decades due to the lack of objectivity. As many systems surge to avoid the problem, it also created confusion when communicated among dentists/ dental faculty and researchers. It is essential to maintain consistency in the examination and have a uniform system in our clinical practice.

According to the International Consensus Workshop on Caries Clinical Trials (ICW-CCT), there is a difference between caries detection, caries assessment, and caries diagnosis.

Caries lesion detection implies an objective method of determining whether the disease is present by observing changes in enamel, dentine, and cementum, which are consistent with having been caused by the carious process.
Caries lesion assessment aims to characterize the lesions once detected as active or inactive/arrested, using parameters such as color, size, and surface integrity, relationship to plaque stagnation.
Caries diagnosis should imply the human professional summation of all the signs and symptoms of the disease to identify of the past or present occurrence of the caries[1].

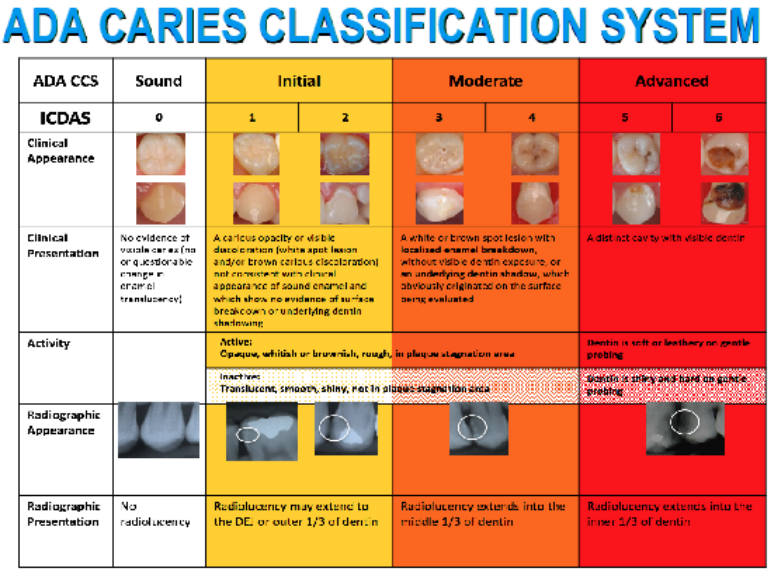
To detect, assess, and diagnose caries, we will need an appropriate examination to identify visual changes of color, translucency, and structure tooth by tooth to determine a successful treatment plan. This protocol aims to establish guidelines for the TUSDM faculty and students for a more consistent clinical examination for caries detection.

Background:

Clinical examination for caries detection. Classification Systems.

Because the caries lesion has different forms of clinical presentation during the disease process, clinicians need a classification system that supports appropriate treatment decisions using available nonsurgical and surgical approaches. Classifying lesion location, site of origin, extent, and if possible, activity should be part of all dental evaluations to facilitate risk assessment and treatment recommendations
The International Caries Detection and Assessment System (ICDAS) developed a classification system to address inconsistency during the different stages of the caries process and was modified by the American Dental Association (ADA) Caries

Classification System (CCS). TUSDM Comprehensive Care Department utilize an adapted version of the ADA CCS maintaining the same criteria. The visual and tactile examination of each accessible surface should be completed to determine if each surface is sound, or, if a caries lesion is present, then the lesion site of origin, surfaces involved, extent, and activity should be noted. For each severity level (initial, moderate, and advanced), there are descriptors for clinical appearance and the corresponding presence of infected dentin/cavitation to classify caries lesions and help with clinical decisions regarding treatment.



Images provided by Dr. Andrea Ferreira Zandona. Tufts University

What to do before the examination:

Clean and dry:

Due to the expectancy that caries occurs under the biofilm, the first step should be to remove the bulk of the plaque by instructing the patient to brush their teeth manually or by the professional use of the handpiece with water and the use of dental floss to remove it from the interproximal areas. Sometimes, the simple brushing technique is not enough to remove plaque in its totality, and often we find some on the smooth and occlusal surface. In that case, the side of a probe can be used by gently resting the probe and pulling the plaque with no pressure[3,4].

Saliva is another factor that often disguises enamel alterations. During the exam, we should consider the enamel refractive index and how it will affect the clinician's perception of color and texture of the enamel with or without the saliva. *The refractive index* ***(n)*** is an essential parameter in light propagation through biological tissues, including teeth. The ***n*** of the tissue can serve as an indicator of its scattering properties, as scattering itself is the result of local *n* variation [5,6]. Sound enamel is translucent and has a refractive index of 1.6.[5,6] When the enamel is wet, the index is reduced to n=1.3

because the enamel pores fill with water. When the enamel is demineralized, the refractive index is reduced from the normal value as the enamel porosity absorb more water[4-6]. that subtle reduction of the value when the surface is wet makes it more challenging to detect by the clinician's eye[4-6]. Thus, it is essential to avoid the excess of saliva by isolating the quadrants with cotton rolls. It is also recommended to air dry for 5 seconds the surface before the examination. On the other hand, when a caries lesion has extended to the dentin and creates a gray shadow under the enamel, a wet surface makes it easier for detection. For an accurate detection of the caries lesions in their different stages of progression, the clinicians should examine the surfaces when they are wet, to facilitate the detection of those lesions that reached the dentin and show gray shadows and examine again after 5 seconds of air-drying per surface with the air syringe to facilitate the detection of those lesions that are in the enamel[4].

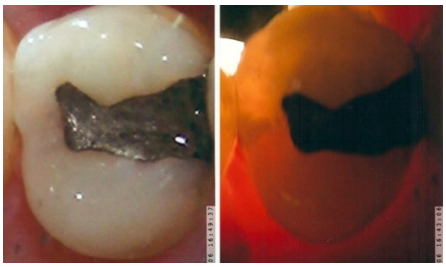
Methods to support the clinical examination:

Radiograph examination A throughout clinical evaluation includes radiograph examination. Radiographs with the bitewing technique are highly sensitive for detecting approximal caries that cannot be inspected visually, estimating the depth of the lesion and monitoring the disease's progression. However, limitations in revealing the early stages of the disease have been reported[10,12]. The contribution of the radiographs to detect lesions on the occlusal surface seems to be minimal[13]. Identification of initial lesions is the optimum time to instigate preventive options to interrupt the progression of the mineral loss [11]. When an occlusal lesion is detected on a bitewing radiograph, the lesion may have already reached the middle third of dentine, which has advanced beyond the scope of remineralization interventions [15]. Radiographs cannot assess the activity of the lesions (unless taken at regular intervals under the same angles) and often cannot determine between non-cavitated and cavitated lesions [16]. Cavitation should be established before undertaking any operative intervention.

T*emporary elective tooth separation technique* (TETST) will allow direct visual access of the approximal surfaces. This process, which consists of placing a small elastomeric band between the teeth around the contact areas for 2-7 days and removed in a second visit, allows the clinician to detect the presence or not of a caries lesion in the mesial and distal surfaces[7,19]. Anytime that there is a question about actvity and caviation status of a proximal lesions TETST should be attempted. In dental school environment when appointments are almost 3hrs long, in some cases, it might be possible to create enough separation by placing the elastomeric band at the beginning of the appointment and removing it at the end to assess the surface for cavitation.

A well-illuminated area is critical to enhancing any optical changes in the tooth structure. Performing transillumination with the dental mirror by reflecting the light onto the different surfaces can inform the operator about shadows and their sources. The use of loupes for magnification can help the clinician as well.

Fiber-optic transillumination (FOTI) is based on the phenomenon of light scattering to increase the contrast between normal and carious enamel. The transillumination method may support treatment decision-making, but it cannot monitor dental caries lesions as occurs with the bitewing radiographs[17]. TUSDM has a focus light specific for transillumination system (Microlux) available in the dispensary to use in our clinics.



High intensity white light from a fiber optic handpiece should be used with dimmed room lighting when possible and without the use of the operating light. The light source should be of the smallest possible diameter (0.3-0.5mm)

For posterior proximal caries:

- Light probe position should be above the gingival margin of the tooth
- Light source should be directly perpendicular to the approximal area to prevent direct observation of the beam of light and allow diffraction between demineralized and sound tooth structure
- The tooth should be illuminated both from the bucal and lingual aspects and observed from the occlusal surface.
- Proximal caries will produce a dark shadow on the occlusal marginal ridge

For anterior proximal caries:

- Light probe position also above the gingival margin
- Light source should be shine on buccal surface[23] and observed from the lingual surface

Quantitative Light-induced Fluorescence (QLF) is another method based on fluorescence. When a lesion is present, an increase in light scattering makes the lesion appear as dark spots on a bright green background. QLF has become a reliable diagnostic aid for the detection and monitoring of early enamel demineralization due to the capability to records the loss of fluorescence images and quantifies them with respect to adjacent healthy tissue[18]. The prcinciple of QLF is incorporated in the 3Shape Trios 4 scanners available at TUSDM.

Gomez et al [17]

What and Where to look for:

What:

The first clinically visible alterations of the "sound" dental enamel appear as changes in luster, color, or texture. These changes occur due to the increased porosity of the subsurface enamel layer.
Once we detect the changes and determine whether there is the presence of a caries lesion or not (caries lesion detection), we need to determine the severity a (*initial (A), moderate (B), or advanced (C) caries lesion*) of the lesion
and assess its' activity status (Active or arrested)

Where :

When performing the examination, we should look for lesions in the areas that are more susceptible to develop carious lesions considering patient age. Overall, the areas more susceptible to decay are the pits and fissures, and that is true especially in younger patients. Within the fissures also exist a different susceptibility that depends on the anatomy of their entrance (U-type, V-type, I-type, and Bottle-type fissures). The first sign of demineralization will show at the entrance, where the biofilm will lay. The narrower it is (I-type and bottle -type), the more difficult it is for the bristles of the brushes to penetrate to remove the biofilm, and the more susceptible it is. The clinician needs to assess the detail of the pit and fissures to determine the more vulnerable areas [4]. The initial stages of caries in the enamel will appear as a white spot lesion at the entrance of the fissures[4]. The use of a sharp explorer in initial lesions on the aperture of the fissure to feel a catch can irreversibly damage the tooth. The sharp instrument will create a microcavity where it was none, making more susceptible the area to the disease; for that reason, the use of an explorer to assess the fissures is not recommended. Adolescents and young adults will have proximal surfaces at higher risk and older adults will have exposed root surfaces at higher risk.

Caries lesions on the exposed root will show changes in color ad glossiness, but the texture (softness) seems to be the best indicative marker to detect an active lesion. A dark but

hard surface over time is a good indicator that the lesion is arresting. The indicated instrument for assessing this area should be a ball ended probe.

Assessment Caries Extension:

It is essential to determine the extension (initial, moderate, or advanced) and if the caries is active or not to develop an appropriate treatment plan.

Initial Caries Lesions

As net mineral loss occurs during the caries process, there is an increase in enamel pore-volume. The gaps between the prismatic crystals of the enamel become larger, allowing the fluids to penetrate. When these micron gaps are filled with fluid, the affected area has a similar refractive index to the enamel itself (1.33), making the detection harder, because the clinician's eye perceives it as sound enamel. These very initial lesions can only be identified when you dry the enamel for around 5 seconds on each surface with the three ways syringe.

As the caries lesion progresses and the loss of mineral from the lesion causes the gaps between the prisms to become large enough to be air-filled (air refractive index = 1.0), the lesion becomes visible clinically as a whitish area. In other words, when the light hits the surface of the porous caries lesion, it refracted differently from the sound enamel [3]. If the lesion's progression is arrested or significantly slowed down, then the lesions may take up color from the oral environment and become more brownish [20].

Moderate Caries Lesions

When the demineralization progresses further, the gaps between the crystals become so large that the structure becomes fragile and vulnerable to mechanical forces. The enamel surface starts to break down, causing micro cavitation. As the lesion extends to involve the dentin, it becomes darker in color, which creates a shadow that can be seen through the surface enamel[21]. This shadow can be seen in the presence or absence of enamel breakdown.

Advanced Caries Lesions

At some point, when the depth and width of carious dentin undermines the top layer of fragile enamel, the surface caves in creating a cavity which exposes the dentin [22].

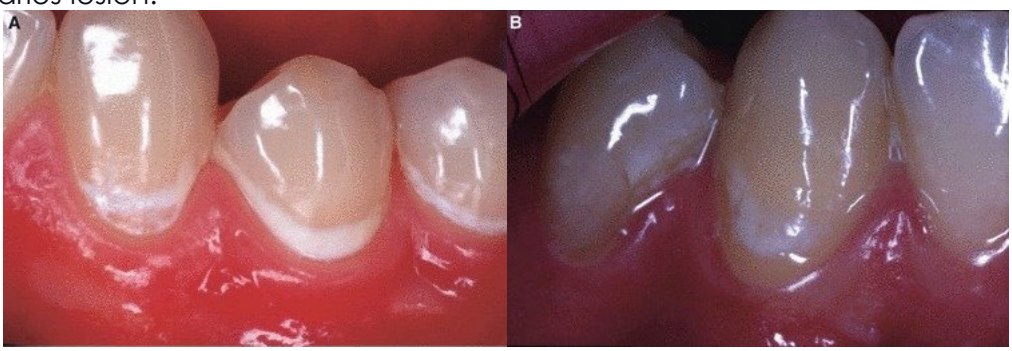
Assessing Caries Activity:

Assessment of the caries activity is a value factor to identify and to monitor caries progression and the need or not of surgical intervention. Clinical evaluation of caries lesion activity at the time of examination consists of identifying the enamel and dentin characteristics and location that has been exposed to bacteria acid and evaluated the factors that could determine the level of activity such as the age of the patient,

diet, and caries risk. Sometimes caries activity is not apparent and difficult to assess. Caries activity should be considered clinically and radiographically.

When evaluating a caries lesion, we should keep in mind the following factors:

- **Surface and location of the caries lesion:** A lesions closer to the gingival margin are more likely to be active than the lesion located further away from the gingival margin. An occlusal lesion in a partially erupted tooth could also be considered active.
- **Biofilm (Plaque) stagnation:** The presence of biofilm can determine lesion activity. "Nyvad criteria" is a system that has shown to have a good predictivity on the caries activity in the enamel on the presence or not of biofilm. This system is performed without prior professional biofilm removal. According to this criterion, active enamel caries appears whitish, mate, and chalky and feel rough to the gentle use of the probing and have biofilm stagnation. On the other hand, inactive enamel lesions appear shiny, glossy, and smooth to the probing, often stained black or brown and no biofilm is present[25-27].
- **Surface appearance and tactile feeling of the enamel: Active enamel lesions are whitish, chalky and feel rough** [5]. Inactive enamel lesions appear shiny, glossy, and smooth. As mentioned before, a sharp instrument can create a microcavity where it was none if a probe is used to determine enamel softness, the use of an explorer to assess enamel hardness is not recommended.
- **Surface appearance and tactile feeling of the dentin:** When the dentin is exposed due to cavitation a probe can be used to assess softness. If the dentin is soft, the demineralization is presently occurring (active); if the area is tactilely hard, the lesion is "arrested" and already remineralized (inactive). Affected dentin is often stained or discolored, not a reason for surgical removal if the dentin has remineralized.
- **Periodontal health and Gingival status:** A caries lesion in a patient with active periodontal disease and gingival inflammation could be considered an active caries lesion.



(A) Active white spot lesions are in plaque stagnation areas and are often covered with plaque. They are chalky white in appearance and feel slightly rough upon gentle probing. (B) Inactive white spot lesions are clean and glossy and can remain stable over decades if cleaned properly.

- **Patient age, eruption status:** A lesion on a recently (or erupting) tooth is more likely to be active as well as a lesions on a recently exposed root surface. For instance, a lesion in a 1st molar in a 6-year-old is more likely to be active than in 18 years old.

- **Evidence of lesion activity over time:** Changes (or lack thereof) in the radiolucency, or clinical characteristics over time can also help assess lesion activity and can impact clinical treatment decisions. An arrested, remineralized, non-cavitated lesion (white or brown) does not indicate active caries disease and doesn't need treatment for caries management[25-27].

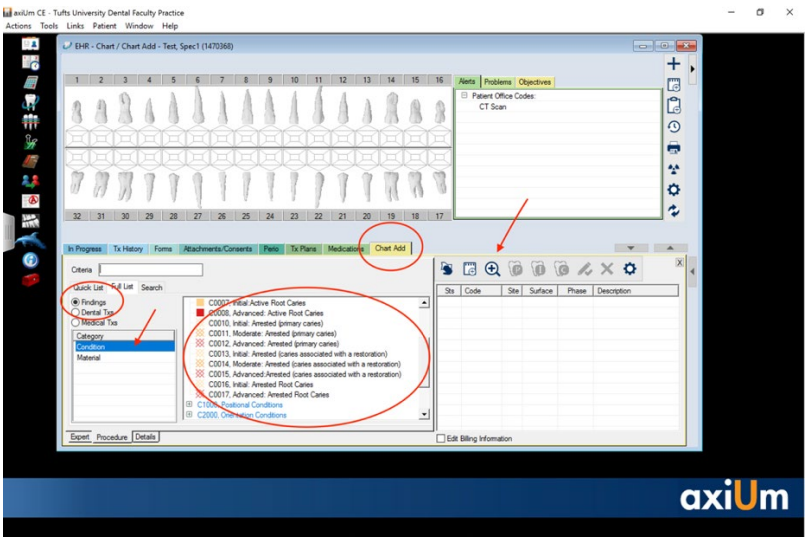
Characteristics of active and inactive caries lesions

Activity assessment factor	Caries lesion activity assessment descriptors	
	Likely to be inactive/ arrested	**Likely to be active**
Location of the lesion	Lesion is NOT in a biofilm/plaque stagnation area	Lesion is in a biofilm/plaque stagnation area (pit/fissure, approximal, gingival)
Biofilm/Plaque over the lesion	Not thick or sticky	Thick and/or sticky
Surface appearance	Shiny. color: brown, black	Matte/opaque/loss of luster. color: white-yellow
Tactile feeling	Smooth, enamel/ hard dentin	Rough enamel/soft dentin
Gingival status (if the lesion is located near the gingiva)	No inflammation, no bleeding on probing	Inflammation, bleeding on probing

Ekstrand KR, Zero DT, Martignon S, Pitts NB. Lesion activity assessment. Monogr Oral Sci 2009;21:63–90 (See Chaps. 4.1 and 4.3 for addional information on caries activity assessment)

Charting

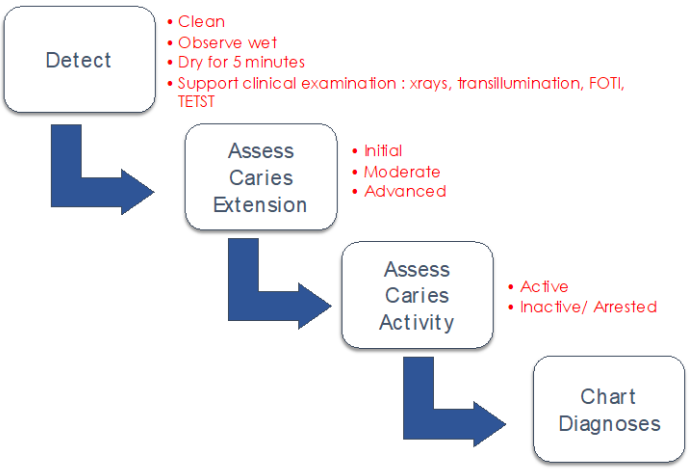
During the Comprehensive and Periodical exam, TUSDM clinical guidelines require recording of the findings of caries lesion severity and activity in the dental chart.



TUFTS Clinical Examination for Caries Detection and Assessment Protocol

The examination for caries detection and assessment requires teeth to be clean and dry.

- Students should instruct the patient to brush their teeth and floss.
- Control saliva with cotton rolls isolation
- A dental mirror is needed, the three-way syringes to dry teeth, and a probe when necessary. A sharp explorer is contraindicated.
- Loupes and a well-illuminated area are strongly recommended
- Each tooth is then examined following a logical, predetermined sequence not to miss any surfaces.
- Examine the surfaces when they are wet to detect lesions that reached the dentin and show gray shadows.
- Examine again after 5 seconds of air-drying per surface with the air syringe to facilitate the detection of those lesions that are in the enamel.
- Clinical exam should be aided by digital radiographs. The use of FOTL and QLF are highly recommended for those cases where radiographs present limitation for the diagnoses (i.e., initial lesions)
- When approximal lesion is present and can be identified in the bitewings as a lesion reaching or slightly passing the DEJ but the cavitation status cannot be assessed the use of TETST is indicated. The elastomeric band will be placed at the beginning of the session and removed 2 hours to 7 days later. Time will be determined case by case and considering other clinical and patient factors.
- Record all the findings following the ADA-CCS classification in the dental chart, treatment plan should follow the guidelines for clinical intervention.



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