Fluorescence Visualization with VELscope

A practical guide to the clinical use of VELscope
1. Role of Fluorescence Visualization
2. Fluorescence Visualization & the Panoramic Radiograph
3. Principles of Fluorescence Visualization
5. Abnormal Tissue
   • Non-cancerous lesions
   • Dysplasia and Oral Cancer
6. Important things to remember about VELscope
Role of Direct Fluorescence Visualization with VELscope

1. Discovery (Screening)
   • General Practitioners

2. Biopsy Guidance
   • Oral Surgeons

3. Surgical Margin Delineation
   • ENT, Head & Neck Surgeons

4. Surveillance and Monitoring
   • GP’s & Specialists
Fluorescence Visualization with VELscope...

- Complements rather than replaces what can be seen with the naked eye and felt with fingers
- Is fundamentally different from white light reflectance
VELscope can show things that are not visible to the naked eye…
What is this?

VELscope

It may be “unfamiliar territory” initially…
Some things weren’t noticed are now readily apparent…
It all makes sense after understanding a few simple concepts…
VELscope...

- Helps discover abnormalities that might otherwise have been overlooked
- Is initially unfamiliar territory and thus requires training and experience to fully utilize
- Is best used as a survey tool to help rule out abnormalities requiring further investigation
- Is another means to visualize the disease process that complements rather than replaces the clinical impression
- Facilitates rather than provides a diagnosis
Oral Mucosa

Cell Layers

- Superficial
- Intermediate
- Basal

- Stratified Squamous Epithelium
- Basement Membrane
- Stroma
- Capillaries
- Matrix of Collagen Fibers
- Matrix of Collagen Fibers
Visual Reflectance

Shorter wavelengths like blue are more strongly absorbed by oral mucosa than longer wavelengths like red.
This is why oral tissue has a red or pink appearance
Fluorescence Visualization…

...is fundamentally different
Blue light excites natural fluorophores in both the epithelium and stroma which emit their own light, fluorescence, at longer wavelengths – green, yellow & red.

VELscope's proprietary filtering makes fluorescence visualization possible by blocking the blue reflectance and enhancing the fluorescence image.
Oral Mucosa looks predominantly green under fluorescence visualization...

*Buccal Mucosa*
Fluorescence Visualization

Cause and Effect:

- Chemistry
- Morphology
- Environment
- Scattering
- Absorption & Excitation
- Fluorescence
- Re-absorption & Scattering
Natural Fluorophores in oral mucosa excited by VELscope:

1. **Flavin adenine dinucleotide (FAD)**

   FAD is correlated with metabolic activity in cells...

   Increased metabolism associated with cell turnover and dysplasia causes the concentration of FAD to decrease and the resulting fluorescence to decrease.
Natural Fluorophores in oral mucosa excited by VELscope:

2. Collagen cross-links

Breakdown of the collagen matrix in the stroma increases as dysplasia and cancer progress, and is naturally associated with decreased numbers of collagen cross-links, and therefore decreased fluorescence.

Fluorescence Microscope Image of Collagen

Image courtesy of the British Columbia Research Centre, Cancer Imaging Department
Natural Fluorophores in oral mucosa excited by VELscope:

3. Keratin

Certain areas of the oral cavity are naturally keratinized squamous epithelium:

- Attached Gingiva
- Hard Palate

Other oral tissues can become keratinized (hyperkeratosis) and thus show increased fluorescence as a result of chronic irritation or as part of the disease process (e.g. leukoplakia)
Natural Fluorophores in oral mucosa excited by VELscope:

4. **Porphyrin**

*Porphyrin is associated with bacteria and fluoresces quite strongly in the red part of the spectrum*

*The presence of bacteria is thus characterized by the presence of a remarkable orange/red colour*

Some bacteria from a tonsillar crypt giving off an orange glow

Palatine Tonsil
Tissue components that decrease fluorescence

**Melanin**

Melanin pigmentation absorbs light resulting in a dark area under VELscope.

**Blood (hemoglobin)**

Blood strongly absorbs blue, green and yellow but not red light. Major effect is absorption light resulting in a dark appearance under VELscope.
Ideal time for Discovery & Intervention is in the Premalignant stages

Oral Cancer & Dysplastic Progression

Mild Dysplasia

Moderate Dysplasia

Severe Dysplasia

Carcinoma-In-Situ (CIS)

Squamous Cell Carcinoma (SCC)

Potentially Malignant Disease Stages
Oral Cancer & Dysplastic Progression

Blue Excitation Light

Abnormal epithelial tissue and underlying stromal disruption causes loss of fluorescence

Normal tissue produces fluorescence and appears as an apple-green glow

Epithelium

Basement Membrane

Stroma

Normal Stroma

Abnormal Epithelial Cells

Disruption of Stromal Collagen

Normal Epithelial Cells
Tissue Fluorescence and Dysplastic Progression

Breakdown of Collagen Matrix (prelude to invasion)
Collagen cross-links ↓
Fluorescence ↓

Micro-Vascularization (recruitment of new blood supply)
Blood absorption ↑
Fluorescence ↓

Metabolic Activity ↑
FAD ↓
Fluorescence ↓

Nuclear back-scattering ↑
Fluorophores excited ↓
Fluorescence ↓

Fluorescence intensity decreases with dysplastic progression.
A cancerous lesion looking dark compared to the adjacent normal tissue...
Generally speaking, healthy oral mucosa presents as a bright green colour due to a combination of predominantly green fluorescence from both the epithelial and stromal layers.
A brighter homogeneous green colour is usually indicative of healthy tissue…

Hard Palate
A brighter homogeneous green colour is usually indicative of healthy tissue…
A brighter homogeneous green colour is usually indicative of healthy tissue…

Buccal Mucosa
Different oral structures have their own particular appearance, or fluorescence pattern, just as they have their own unique appearance under white light...
Sometimes healthy tissue has a normal fluorescence pattern of both bright and dark areas …

**Fungiform Papillae**
Appear dark because of *blood perfusion*

**Filliform Papillae**
*Keratinized tips fluoresce brightly*

*Dorsal Surface of the Tongue*
Sometimes healthy tissue has a normal fluorescence pattern of both bright and dark areas …

Area of dense vascularization may appear symmetrically dark under VELscope

Floor of the Mouth

This is a high-risk area of dysplasia – unilateral presentation should increase suspicion of dysplasia or cancer
Sometimes healthy tissue has a normal fluorescence pattern of both bright and dark areas ...

**Blood Vessels**
Appear dark because of their blood content

**Reflection of the highly fluorescing teeth**

**Ventral Surface of the Tongue**
Sometimes healthy tissue has a normal fluorescence pattern of both bright and dark areas …

Blood Vessels
Appear dark because of their blood content

Labial Mucosa – Upper Lip
Sometimes healthy tissue has a normal fluorescence pattern of both bright and dark areas ...

\textbf{Blood Vessels}

\textit{Appear dark because of their blood content}

\textbf{Labial Mucosa – Lower Lip}
Attached Gingiva often appears dark due to its structural characteristics.

Unattached gingiva are brighter. Mucogingival junction is readily apparent.

Sometimes healthy tissue has a normal fluorescence pattern of both bright and dark areas ...
Sometimes healthy tissue has a normal fluorescence pattern of both bright and dark areas …

Anterior Tonsillar Pillar
Given this structure's appearance in white light it’s not that surprising…

The Anterior Tonsillar Pillar is naturally well-vascularized
Healthy tissue can have quite a remarkable appearance under VELscope.

Areas of dense vascularization and inflammatory cells appear dark.

Palatine Tonsil
The minor salivary gland openings on the hard palate can sometimes show up as dark spots.

*Minor salivary glands*
An orange/red color can often be observed due to porphyrin fluorescence from bacteria, especially on the tongue.
Melanin Pigmentation of the Attached Gingiva
Melanin Pigmentation of the Papillae

In addition to the orange fluorescence from the bacteria on the tongue, quite distinct melanin pigmentation of the papillae can be seen.
Irritation & Inflammation in the Mouth

• The oral environment is naturally subject to various forms of irritation and consequent inflammation.
• Certain areas of the mouth are more prone to this than others – in particular:
  • Lateral border and tip of the tongue
  • Buccal mucosa adjacent to occlusal surface
  • Hard Palate
Inflammation

- Blood vessel dilation associated with inflammation results in a higher blood content in the tissue.
- Other inflammatory components also affect the local tissue architecture and composition, resulting in a changed fluorescence pattern.
- The net result is a darkened area at the inflamed site due to the increased absorption of light.
It’s quite common for the lateral border and tip of the tongue to be inflamed due to chronic irritation and thus appear darker under VELscope.
Larger dark spots can sometimes be seen on the dorsal surface of the tongue. This is likely due to the patchy wearing down of the filliform papillae and a consequent loss of keratin fluorescence.
Although this isn’t always the case…

The corresponding areas on these tongues are comparatively bright.

It depends upon oral habits and the structure of the mouth.
The Buccal mucosa is quite often an area of chronic irritation and mild inflammation...

**Classical Linea Alba**

*Inflammation along bite line shows up as a dark area*

*Bright spots due to keratinization are also evident*
Chronic irritation of the Buccal mucosa from the teeth has in this case led to two pronounced dark patches.

*Diffuse borders of the darkened areas under VELscope – typical of an inflammatory response*

*Images courtesy of the University of Washington Oral Medicine Program*
The hard palate is quite a common area for irritation and local trauma.

The patient had been sucking on hard candies prior to the appointment.
Abnormal Oral Mucosa

• Look for tissue that has a reduction of normal green fluorescence compared to surrounding tissue of the same type

• Particular danger signs:
  • *Unilateral as opposed to bilateral presentation*
  • *Irregular and/or non-symmetrical shape*
  • *Well-demarcated borders*
  • *Abnormal patterns that appear “out of context”*
  • *Abnormal patterns that spread across different anatomical structures*
Bilateral Presentation is a good thing…

Both sides of the mouth are symmetric – generally a good sign that this is not a manifestation of disease.
Blanching

Using an instrument to blanch a dark area under VELscope can be a useful technique for indicating whether or not an abnormality has an inflammatory component.

*This particular area blanches completely.*

Treatment and subsequent follow-up after two weeks resulted in complete resolution.
This area did not blanch

This particular abnormality is an Ecchymosis
- it resolved within 2 weeks
Blanching

- Blanching can indicate that an abnormality has an inflammatory component
- Soft tissue hemorrhages such as an Ecchymosis may not blanch
- Cancerous or precancerous lesions typically have associated inflammation and some may partially blanch
- An abnormality that does not completely blanch under VELscope should be carefully followed so as to determine its cause and/or rule out dysplasia or oral cancer.
- An abnormality that does blanch but persists is of equal concern.
White Hairy Tongue
Inflamed Salivary Glands on the hard palate
Ecchymosis
(soft tissue hemorrhage)

This did not blanch but resolved in 2 weeks
Vascular Bed Abnormality

This is a benign, permanent condition that nevertheless should be monitored for change.
Amalgam Tattoo
Aphthous Ulcer

Erythematous border around central ulceration predictably looks dark
Fordyce Granules
Fibroma

Composed mostly of connective tissue with little vascularity - has a slightly brighter or neutral appearance under VELscope

Note the brighter appearance of this particular fibroma
Lymphoid Aggregate

Lymphoid nodule of tonsillar tissue appears dark under fluorescence because of high concentration of blood cells – note corresponding reddish area, apparent under white light
Erosive Lichen Planus

Not surprisingly, the inflammation around the central ulceration shows up as dark under VELscope.

Notice also that the keratinized (white) tissue and fibrin clot show up brighter compared to the surrounding inflammation.

Images courtesy of the University of Washington Oral Medicine Program
Verrucous Carcinoma

Extensive keratin production associated with verrucous carcinoma leads to an *increase* in fluorescence.
Mild & Severe Dysplasia

Mild Dysplasia

Moderate/Severe Dysplasia
Dysplasia on the Soft Palate

Biopsy confirmed moderate dysplasia

Notice the well delineated and irregular border

Images courtesy of the University of Washington Oral Medicine Program
Severe Dysplasia - Lateral border of Tongue

Biopsy Confirmed as Severe Dysplasia

Images courtesy of the British Columbia Oral Cancer Prevention Program
SCC on Hard Palate

SCC left lateral border of tongue, 2 yrs prior

Biopsy – SCC over entire area that showed fluorescence visualization loss

Images courtesy of the University of Washington Oral Medicine Program
Severe Dysplasia on Ventral Tongue

Chronic area of subtle leukoplakia on ventral tongue

Cytology: suggestive of advanced dysplasia

Images courtesy of the University of Washington Oral Medicine Program
Severe Dysplasia on Alveolar Ridge

Clinical Impression: Denture Trauma

Excisional Biopsy: Severe Dysplasia

Images courtesy of the University of Washington Oral Medicine Program
Dysplasia & Oral Cancer

Clinical Appearance

Loss of Fluorescence:
Region of CIS is now clearly visible

Images courtesy of the British Columbia Oral Cancer Prevention Program
Clinically occult lesion presents as an extended dark area under VELscope.

Biopsy confirmed carcinoma in situ.
Invasive Squamous Cell Carcinoma with Secondary Infection

Squamous Cell Carcinoma & Orange glow from bacteria

Biopsy site

Images courtesy of the University of Washington Oral Medicine Program
Some Important things to remember...

• VELscope is an adjunctive device: combine the information from what you see under VELscope with your white light visual & tactile exam.

• A comprehensive patient history can be the key to helping you understand what you see with VELscope… or with any other tool for that matter.

• Review some of the many resources available on the basics of oral cancer – knowing where it is most likely to occur, for example, can be very helpful in deciding how to follow up on a patient.
Some Important things to remember…

- Recognize normal and abnormal *patterns* of fluorescence – your brain is good at pattern recognition!

- Beware of a unilateral presentation as opposed to a bilateral one - this can help you decide what “doesn’t belong”.

- Be especially careful about a non-symmetrical lesion with an irregular and/or well-delineated border – this could be a danger sign.

- Excess blood in the tissue will nearly always look dark under VELscope.
Some Important things to remember…

- Try to use the underlying principles you’ve learned here to understand what you see with VELscope and how it relates to what you see under white light – you and your experiences are your own best teacher.

- As always, use your clinical judgment and common sense!
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