UVA Emergency Medicine | Protocol 302930

Snakebite Envenomation Ultrasound Study

Investigator Training

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~20 min

What Is This Study?

The short version

We're trying to describe what snakebite envenomation looks like on ultrasound. That's it.

Patients presenting with a snakebite get serial point-of-care ultrasounds of the bite site during their ED visit. We watch how the soft tissue changes over time and document what we see. Their clinical care is not changed in any way.

There's no intervention, no placebo, no randomization. We're observing and documenting.

PROTOCOL #

302930

STUDY TYPE

Prospective observational cohort

SETTING

UVA Emergency Department

SPECIES

Crotaline — copperhead & rattlesnake

IMAGING

EFOV (Extended Field-of-View) ultrasound

SCANS

T0 then hourly up to 6 hours

CHANGE MANAGEMENT?

Never.

DATA PLATFORM

REDCap

Who Can Be Enrolled

✓ CAN ENROLL

- Suspected or confirmed North American crotaline snakebite (copperhead or rattlesnake)
- Any age — pediatric and adult
- Presentation within 24 hours of the bite
- English or Spanish speaking
- Able to provide informed consent (or assent with parental/guardian permission)
- Willing and able to comply with study procedures
- Includes patients later determined to have a dry bite — they still get T0 scan and are included in descriptive analysis

✕ CANNOT ENROLL

- Refusal of consent or assent
- Antivenom administered BEFORE the initial research ultrasound — if antivenom was given before T0, do not enroll
- Presentation more than 24 hours after bite
- Hemodynamic instability preventing imaging — stabilize first, then reassess if still within 24 hrs

How to Enroll a Patient

1

Identify the patient

Snakebite comes in via triage or a provider flags it. You don't need to be the treating physician — anyone on the study team can initiate enrollment.

2

Check eligibility

Crotaline bite? Within 24 hrs? Antivenom not yet given? Able to consent? No hemodynamic instability? If all yes — proceed.

3

Approach and get consent

Consent before anything else — before the ultrasound, before writing anything down about this patient for the study. See the consent slide.

4

Open REDCap, create enrollment record

Log time of consent, assign study ID, complete enrollment form. Study ID links all data — never patient name or MRN.

5

Perform T0 EFOV ultrasound

Must occur BEFORE any antivenom. This is the baseline and the most important timepoint. Mark the probe placement site on the skin. See ultrasound slides.

6

Set hourly reminders — T1 through T6

Hourly scans for up to 6 hours while patient remains in the ED. Use the skin mark for consistent probe placement. Stop when patient is discharged or admitted.

Consent & Assent — What You Actually Need to Do

ADULTS (≥18)

Use the IRB-approved consent form (English or Spanish). Key points to cover: observational only, ultrasound won't change their care, they can stop any time, ~6 hours of scans during their ED stay, no follow-up visits, no payment. Let them ask questions. Get a signature. Give them a copy.

Signature section requires:

Participant signature + date
Person obtaining consent + date
Copy given to participant — log in REDCap
For minors: parent/guardian signature + date
PI contact if questions: Dr. Charlton (434) 924-5185

ADOLESCENTS 12–17 → Parent/guardian consent first, then verbal assent from patient using Age 12–17 script

Read or paraphrase the script directly — don't hand it over. If they seem hesitant, don't push. Ask the 4 comprehension questions at the end. If the patient can't answer after rephrasing, reconsider assent — confusion means it's not valid. Document in REDCap.

YOUNG CHILDREN 7–11 → Parent/guardian consent first, then verbal assent from child using Age 7–11 script

Simpler language. If the child says no, looks away, cries, or shakes their head — stop. That's a veto. Spanish versions of both scripts are available. Ask the 4 comprehension questions; the child can point or give one-word answers.

Under 7: no formal assent required, but stop if the child is visibly distressed. Consent must be obtained before the first ultrasound — no exceptions, no retroactive consent.

Verbal Assent Script — Ages 12–17

Read or paraphrase directly to the patient after parent/guardian signs. Do not hand it to them to read alone.

VERBAL ASSENT SCRIPT | Ages 12–17 | Protocol 302930 | Reading level: 6th grade

Opening:
"We want to talk with you about being in a research study. A research study is when doctors collect information to learn more about injuries and how to take care of them. Please ask me questions any time. You do not have to be in this study if you don't want to."

Purpose:
"We are doing this study to find out if ultrasound — a machine that uses sound waves to make pictures of the inside of your body — can help doctors better understand what happens to your body after a snakebite."

What they'll do:
"Let a doctor use an ultrasound to take pictures where you were bitten. It feels like a gentle touch on your skin — does not hurt, no radiation. Pictures taken a few times over ~6 hours while you're already here being treated."

Key assurances:
"Your parents said it is okay — but you can still say No. You can stop at any time. You will not receive any payment."

Comprehension Check

Ask at the end. If the patient can't answer after rephrasing, reconsider assent — confusion means it is not valid.

1. What is the purpose of the study?
2. What do you have to do to be in the study?
3. What are the risks?
4. What are the benefits?

Verbal assent obtained? [ ] Yes [ ] No
If No → do not enroll. Document and move on.
Log in REDCap: assent script used — Ages 12–17.

The script has 'No' embedded throughout — reinforce it. If the patient hesitates or seems reluctant, do not push. Stop and document.

Verbal Assent Script — Ages 7–11

Simpler language (2nd grade level). Read directly to the child after parent/guardian signs.

VERBAL ASSENT SCRIPT | Ages 7–11 | Protocol 302930 | Reading level: 2nd grade

Opening:
"We want to talk to you about a study. A study is when doctors try to learn new things. We want to learn things that can help kids who get bitten by snakes. You can ask me questions any time. You don't have to be in the study — it is your choice."

Treatment assurance:
"Doctors will still take care of your snakebite. This is true even if you say no to the study."

The ultrasound:
"A doctor will put a small wand on your skin near where the snake bit you. It will take pictures inside your body. It does not hurt. It feels like a gentle touch. We will take pictures a few times over about 6 hours while you are already here getting help."

Their choice:
"Your mom, dad, or guardian said it is okay — but you can still say no. It is your choice. You can stop any time. Just tell us and we will stop."

Comprehension Check

Ask at the end. Use simple language — the child can point or give one-word answers. If they seem confused about what they agreed to, stop and talk to the PI before enrolling.

1. What is the purpose of the study?
2. What do you have to do to be in the study?
3. What are the risks?
4. What are the benefits?

Verbal assent obtained? [ ] Yes [ ] No
If child says No or is visibly upset → stop. Do not enroll.
Log in REDCap: assent script used — Ages 7–11.

Spanish versions of both assent scripts are available. If the child objects nonverbally (turning away, crying, shaking head), treat this as a refusal — do not enroll.

Ultrasound Protocol — What You're Looking At

Crotaline venom causes local tissue injury. EFOV ultrasound tracks its progression objectively.

What you will see on the screen

Envenomation produces predictable changes in soft tissue that appear on ultrasound:

- Subcutaneous fat becomes heterogeneous and thicker — interstitial fluid shifts between fat lobules producing a hypoechoic 'cobblestone' pattern
- The deep fascia may appear thickened, hyperechoic, or separated from the SQ layer by fluid
- Tendon sheaths may fill with fluid, visible as anechoic halos around tendons
- In severe cases, muscle echogenicity increases

We track how these findings evolve hourly. The anatomy diagram on the next slide shows exactly what layer you're measuring.

The Required Views

① Bite site — Longitudinal (EFOV)

Baseline SQ appearance; EFOV sweep along limb

② Bite site — Transverse

Thickness measurement, edema depth

③ Adjacent soft tissue (proximal + distal)

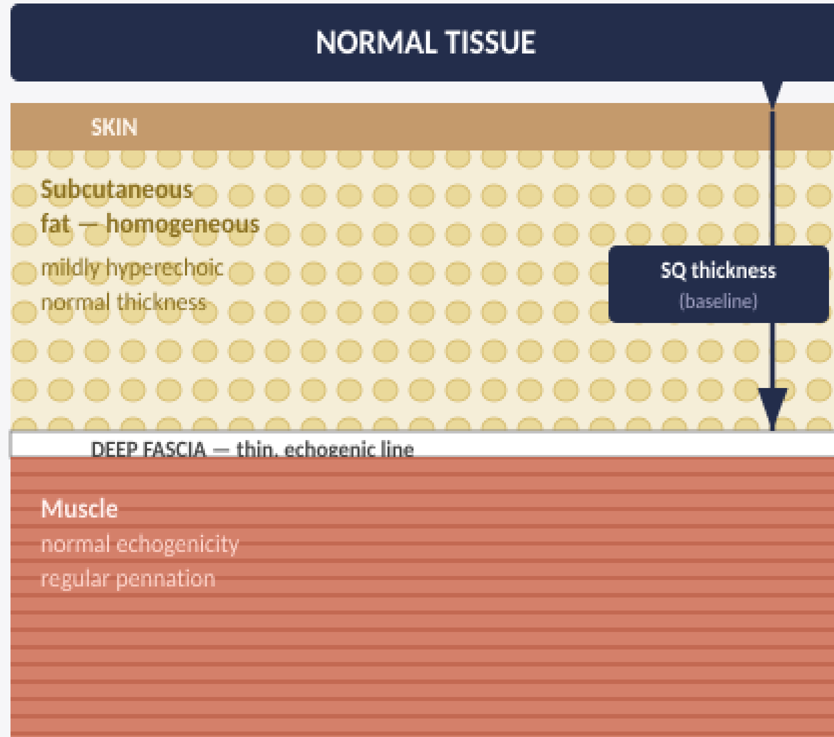
Edema boundary mapping

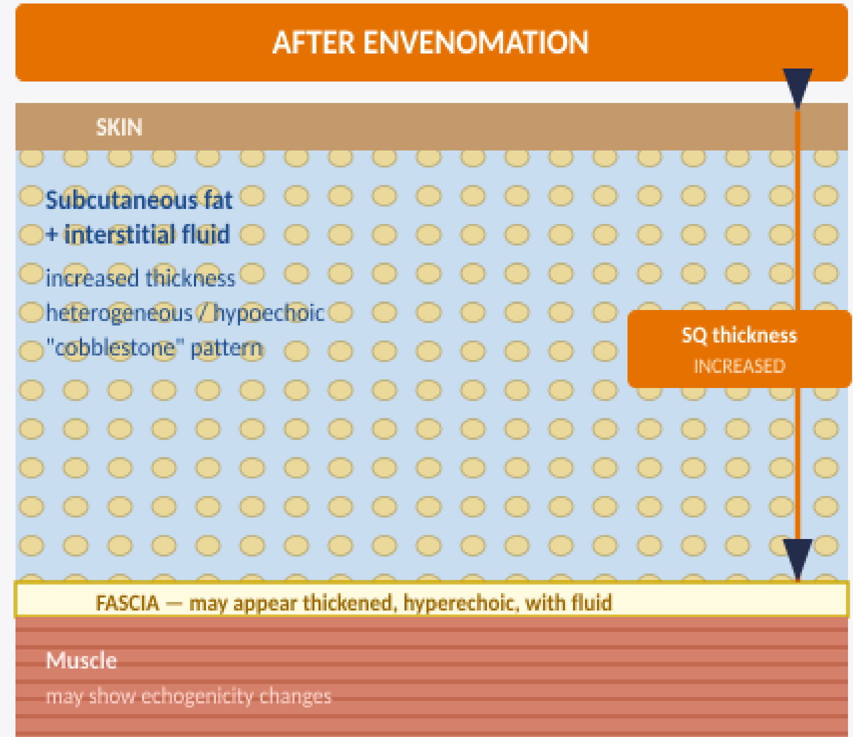
④ Contralateral comparison site

Internal control — required every timepoint

What You're Measuring — Tissue Layer Anatomy

Normal vs. envenomated tissue: this is what your screen shows





Delta SQ = bite side thickness minus contralateral side thickness

This is your primary measurement — always measure contralateral at the same anatomical level

Machine Setup & Probe Selection

Before you touch the patient

Probe & Preset

Probe:
Linear high-frequency transducer — 7–15 MHz. Soft tissue scan only. Do not use the phased array or curvilinear.

Preset:
"Soft tissue" or "MSK" preset. Dedicated small parts preset also works.

Frequency:
Start at the highest frequency your probe supports. Drop to ~9–10 MHz if you need more penetration depth for larger extremities.

Depth:
Start at 4 cm. Adjust until the fascia between SQ tissue and muscle is visible in the bottom quarter of the image. Don't stop at the SQ layer.

Gain:
Adjust for even brightness — SQ fat should appear mildly hyperechoic. Correct before measuring.

EFOV & Image Settings

EFOV mode:
Required for all longitudinal scans. Activate EFOV, place probe at the skin mark, then sweep slowly and steadily proximally (~1–2 cm/sec). Keep consistent pressure and angle — any lift, tilt, or speed change creates a visible seam. If stitching fails, reset EFOV and restart from the skin mark. See the EFOV diagram slide.

Patient ID on machine:
Study ID only (format: SB-###). Do NOT enter patient name, MRN, or DOB.

Exam label:
Label as "Snakebite Study" or "Research" — not the clinical complaint.

Harmonics: ON. **Split screen:** OFF.

EFOV Sweep Technique

How to build the panoramic image — and what to do when it fails

EFOV (Extended Field-of-View) Sweep

Activate EFOV mode → place probe at skin mark → sweep slowly and steadily toward proximal

Speed: ~1–2 cm/sec. Consistent pressure. Do not lift or tilt — any break creates a stitch artifact.

⚠ If EFOV fails:

- You'll see a visible "seam" or jump in the panoramic image
- Stop. Reset EFOV.
- Return probe to skin mark. Restart sweep.
- If it keeps failing: save standard long-axis clip, note it as EFOV-failed in REDCap

Probe Technique & Patient Positioning

How to hold the probe and position the patient

Probe pressure — critical

Use minimal probe pressure. Edematous tissue compresses easily — heavy pressure artificially reduces subcutaneous thickness, distorts fluid collections, and produces false negatives. The probe should rest on the skin with only the weight of the transducer plus gel. If you see the skin deforming, you're pressing too hard. Use a generous gel layer if you can't get contact — do not compensate with pressure.

Probe orientation

Longitudinal views: indicator points proximally (toward the body). Transverse views: indicator toward the radial/thumb side. Keep this consistent at every timepoint so images are comparable.

Fanning technique

Don't grab one static image. Rock the probe 10–15° in each direction to sweep the full volume of the affected area. Save a clip that captures the full sweep.

Positioning the patient

Goal: bite site accessible, dependent where possible (edema settles dependently — imaging dependent tissue gives you the most to measure).

Upper extremity bites: Supine or sitting. Affected arm resting neutrally at the side or on an armboard at heart level. Do not elevate for the scan.

Lower extremity bites: Supine, limb flat on bed. Foot/ankle — flex the knee slightly to relax the fascia.

Probe placement marking — critical for serial scans

At T0, mark the skin at the edge of the probe with a surgical marker to document starting position. Use this mark to align the probe at every subsequent hourly scan. Consistent placement is what makes serial measurements comparable.

View ① — Bite Site: Longitudinal

First view at every timepoint

How to do it

1. Identify the puncture marks. If there are two fang marks, center the probe between them in long axis (probe indicator pointing proximally).

2. Start with the probe directly over the bite site. Slowly fan through the subcutaneous tissue — rock the probe 10–15° medially then laterally.

3. Note the echogenicity of the subcutaneous fat. Normal fat is mildly hyperechoic and homogeneous. Envenomated tissue becomes heterogeneous, with hypoechoic stranding from interstitial fluid.

4. Identify and document the fascial plane between subcutaneous tissue and muscle. It should appear as a bright hyperechoic line. Note if it appears thickened, disrupted, or if there is fluid immediately deep to it.

5. Save a clip of at least 5 seconds that includes the full sweep. Save one still at the point of maximum abnormality.

What You're Looking For

Normal SQ

Mildly hyperechoic, homogeneous fat lobules separated by thin hyperechoic fibrous septa

Edema

Hypoechoic fluid between fat lobules — 'cobblestone' pattern. Increased SQ thickness vs. contralateral.

Tendon-sheath fluid tracking

Anechoic fluid within tendon sheaths — visible as a hypoechoic halo around the tendon

Fascial plane separation

Fluid or hypoechoic material along the deep fascia — appears as separation of the fascial layer from adjacent tissue

View ② — Bite Site: Transverse + Primary Measurements

This is where you get the numbers

How to do it

1. Rotate the probe 90° from the longitudinal position.

2. Sweep 2–3 cm proximally and 2–3 cm distally from the bite site to find the point of maximum swelling — where the subcutaneous layer is thickest and most heterogeneous.

3. Freeze the image at the point of maximum swelling.

4. MEASURE subcutaneous thickness: place the first caliper at the skin surface (just deep to the echogenic skin line) and the second caliper at the superficial surface of the deep fascia. Record in mm.

5. Save the still image with calipers and measurements on screen.

Measurement tip

The skin line is echogenic — proximal caliper goes just deep to it, not on the surface. Including the skin inflates the number.

Measurement Protocol

SQ thickness at bite (mm)

Skin-to-fascia at point of maximum swelling, transverse view. Record at every timepoint (T0–T6).

SQ thickness contralateral (mm)

Same anatomical level, unaffected limb. Same depth setting and probe orientation.

Delta SQ (mm)

Bite minus contralateral. Primary derived data point — log in REDCap at every timepoint.

Muscle echogenicity

Scan the muscle belly in transverse. Compare echogenicity to the contralateral side. Document yes/no change.

View ③ — Adjacent Tissue & Edema Boundary

How far has it spread?

Purpose

Tracking the proximal spread of edema over serial timepoints is one of the most clinically relevant data points in this study. A bite at the hand with edema reaching the elbow at 4 hours tells a very different story from one that stays at the wrist. This view maps that boundary.

How to Do It

1. From the bite site, walk the probe proximally in long axis until subcutaneous tissue looks normal — homogeneous, hyperechoic, thickness matching the unaffected limb.

2. That transition point is the proximal edema boundary. Note distance from bite in cm.

3. Repeat distally.

4. Document estimated distances (cm proximal and distal) as text in REDCap. No image required.

What to Document

- Estimated proximal spread: X cm from puncture site
- Estimated distal spread: X cm from puncture site
- If spread is crossing a joint, document which joint (e.g., 'crossing wrist into forearm')
- At each hourly timepoint: explicitly note whether the boundary has MOVED, STABLE, or IMPROVED vs. prior scan — this progression is the key secondary outcome

View ④ — Contralateral Comparison Site

Your internal control — do not skip this

Why this matters

Subcutaneous tissue thickness varies significantly between individuals, anatomical sites, and even between limb positions. There's no population-level normal value for "SQ thickness at the dorsal forearm" that you can compare against.

The contralateral limb is the patient's own baseline. The difference between affected and unaffected sides (ΔSQ) is a much more meaningful number than the absolute SQ thickness on either side alone.

This view is required at every timepoint. Do not skip it even if the patient looks obviously swollen.

How to do it

Image the exact same anatomical location on the unaffected limb — same level above/below a joint, same surface (dorsal/volar/medial/lateral). Use the same probe orientation (transverse). Apply the same gel, same pressure. Measure SQ thickness at the same depth setting. Label the image clearly as 'CONTRALATERAL' before saving.

Common Mistakes

- Imaging a different anatomical level on the contralateral side
- Applying more pressure on one side — this directly affects SQ thickness
- Skipping the contralateral view at any timepoint
- Not labeling the image as contralateral
- Using a different probe orientation on each side

Scan Timing — When to Scan and When to Stop

T0 then hourly for up to 6 hours

Timepoints are anchored to T0 (the baseline scan), not to time of presentation or consent. Log the actual clock time of every scan — this matters for the analysis. Scans are hourly (T0, T1, T2, T3, T4, T5, T6) while the patient remains in the ED, up to 6 hours.

T0

At enrollment

Must occur BEFORE any antivenom is given - antivenom before T0 is an exclusion criterion.

Target: within 30 min of consent, hard limit 1 hour. Mark the probe placement site on the skin before starting. This is the baseline - get it even if conditions are imperfect.

T1-T5

Hourly scans

Target: every 60 minutes ± 20 minutes from T0. Use the skin mark for probe alignment at each timepoint. Do not skip a scan because the patient 'looks the same' - documenting stability is data.

If you miss a window: document why, scan as soon as possible, label it 'T2-late' (etc.) in REDCap notes.

T6

6 hours post-T0

Final scheduled scan. Only perform if patient is still in the ED.

Do NOT go to the floor or ICU to complete study scans. If admitted or discharged before any timepoint, document the clock time of disposition and close the REDCap form - those cases contribute the timepoints that were completed.

Image Acquisition Standards

What to save and how to label it — images will be re-read for interobserver reliability

Interobserver reliability is a secondary outcome of this study. A subset of your images will be reviewed by a second reader blinded to the first interpretation. This means your images must be complete, clearly labeled, and self-explanatory to someone who wasn't in the room. Poor labeling or missing stills make secondary review impossible.

View	Save a Clip?	Save a Still?	Special requirements
① **Bite site — Longitudinal**	Yes — EFOV sweep ≥5 sec	Yes — at max abnormality	Show full SQ layer to fascia; EFOV stitch must be clean
② **Bite site — Transverse**	Yes — sweep proximal/distal	Yes — with calipers on screen	Calipers must be visible and labeled in the saved still
③ **Adjacent tissue**	Yes — walking scan proximally	Optional	Clip must capture transition from abnormal to normal tissue
④ **Contralateral site**	No	Yes — with calipers	Label CONTRALATERAL; same depth setting as affected side

File naming: [StudyID]_[T0–T6]_[ViewAbbrev] — e.g., SB-007_T0_BiteLong | SB-007_T0_BiteTransverse | SB-007_T3_Contralateral | No PHI in filenames

REDCap Data Entry — What Goes In and What Doesn't

What to Enter in REDCap

At enrollment

- Study ID, date/time of consent, who obtained consent
- Bite date/time, anatomical site, suspected species (copperhead vs. rattlesnake)

At each hourly scan (T0–T6)

- Timepoint (T0/T1/T2...) and clock time
- SQ thickness at bite (mm) and contralateral (mm); ΔSQ
- SQ echogenicity: normal / heterogeneous / hyperechoic / hypoechoic
- Fascial plane separation: present / absent
- Tendon-sheath fluid tracking: present / absent
- Muscle echogenicity change: yes / no
- Edema boundary: cm proximal and distal from bite
- Image quality: 1=excellent 2=adequate 3=limited

Clinical data (from chart)

Vital signs, swelling measurements, CBC, fibrinogen, INR, antivenom (yes/no, time, vials), disposition

What NOT to Enter

- Patient name, MRN, or any identifiers — study ID only
- Ultrasound findings in the clinical chart as 'study data'
- Clinical decisions or recommendations based on study scans

Protocol Deviations

Log any deviation in the REDCap notes field and notify the PI. This includes: consent obtained after T0 scan (do not enroll), missed timepoint window, wrong probe used, patient withdrew mid-protocol.

Don't try to hide deviations. Document them. They happen.

Common Scenarios — What to Do

Q: Patient arrives hemodynamically unstable

Don't approach for consent. Stabilize. Once stable and if <24 hrs since bite — reassess eligibility. A legally authorized representative can consent if patient lacks capacity.

Q: Antivenom was given before you got there

Do NOT enroll. Antivenom administered before the initial research ultrasound is an exclusion criterion. Document it and move on.

Q: Patient gets antivenom after T0 but before T2

Continue the study. Document the exact time antivenom was given in REDCap. This is important study data. The hourly scans continue normally.

Q: Patient is being admitted before a scheduled scan

Attempt the scan before they leave the ED if timing allows. If not, document disposition time and close the form. Do not go to the floor or ICU.

Q: Parent consents but the child says no

Do not enroll. Adolescent verbal assent is required and it is a real veto — parent consent alone is not sufficient. Document and move on.

Q: Image quality is poor (obese limb, movement, cast nearby)

Rate quality 3 (limited) in REDCap. Document why. Save what you can. A limited scan is still data. Do not skip the timepoint.

What the REDCap Forms Look Like — Enrollment

Complete at time of consent, before T0 scan

REDCap › Snakebite Study 302930 › Enrollment Form

Study ID *

SB-____

Date of consent *

MM / DD / YYYY

Time of consent *

HH : MM (24-hr clock)

Who obtained consent *

____

Date of bite *

MM / DD / YYYY

Time of bite *

HH : MM (approximate OK)

Anatomical bite site *

[ ] Hand/wrist [ ] Forearm [ ] Arm [ ] Foot/ankle [ ] Leg [ ] Other: ___

Suspected species *

[ ] Copperhead [ ] Rattlesnake [ ] Unknown

Pediatric patient?

[ ] Yes — assent script: [ ] 7–11 [ ] 12–17 [ ] No

English or Spanish?

[ ] English [ ] Spanish

Dry bite at presentation?

[ ] Yes [ ] No [ ] Unknown (enroll regardless)

Screen failure?

[ ] No — enrolled [ ] Yes — reason: ____________

Do not proceed if screen failure

* Required fields | Complete this form before the T0 scan begins | If screen failure, stop here — do not proceed to ultrasound

What the REDCap Forms Look Like — Ultrasound Scan

Complete one form per timepoint (T0 through T6)

REDCap › Snakebite Study 302930 › Ultrasound Scan Form [repeat per timepoint]

Timepoint * [ ] T0 [ ] T1 [ ] T2 [ ] T3 [ ] T4 [ ] T5 [ ] T6 Scan time (clock): _________ Image quality: [ ] 1-Excellent [ ] 2-Adequate [ ] 3-Limited

MEASUREMENTS

SQ thickness at bite site (mm) *

Long axis: ___ mm Short axis: ___ mm

SQ thickness contralateral (mm) *

Long axis: ___ mm Short axis: ___ mm

ΔSQ — bite minus contralateral (mm) *

___ mm (auto-calculated if using REDCap formula)

Edema boundary from bite site *

___ cm proximal ___ cm distal

QUALITATIVE FINDINGS

Field	Options
SQ echogenicity *	[ ] Normal [ ] Heterogeneous [ ] Hyperechoic [ ] Hypoechoic
Fascial plane separation *	[ ] Present [ ] Absent
Tendon-sheath fluid tracking *	[ ] Present [ ] Absent
Muscle echogenicity change *	[ ] Yes [ ] No
Image quality *	[ ] 1-Excellent [ ] 2-Adequate [ ] 3-Limited

Notes / deviations at this timepoint:

Complete within 30 min of each scan | * Required fields | Save and proceed to next timepoint, or close form if patient discharged/admitted

Contacts & Rules Worth Memorizing

Who to Call

ELIGIBILITY / PROTOCOL QUESTIONS

Dr. Nathan Charlton (PI)

Add to your phone contacts now

ULTRASOUND TECHNIQUE QUESTIONS

Dr. Kongkatong

Image quality, findings interpretation

IRB / CONSENT FORM ISSUES

Mya Sherman

Consent form versions, regulatory questions

CRCONNECT / SYSTEM ACCESS

CRConnectSupport@uvahealth.org

Investigator Agreement, login issues

Rules Worth Memorizing

- Consent before any study activity — no exceptions, no retroactive consent
- This study does not change clinical management. If you see something concerning clinically, tell the treating team. That's a separate clinical act.
- Study ID only in REDCap and on images. Never patient name or MRN.
- Child says no → you stop. Parent consent does not override adolescent assent refusal.
- Minimal probe pressure. Edematous tissue compresses easily.
- Contralateral view at every timepoint — it is not optional.
- Protocol deviation → document it in REDCap and tell the PI. Don't hide it.
- If you're not sure about eligibility or findings → call Dr. Charlton before you act.