

Project Title: Development of Tagging Methods for Monkfish, *Lophius americanus*
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Abstract

The purpose of this project was to develop tagging marking methods for a data-storage-tagging (DST) study of monkfish *Lophius americanus*. Our goal was to develop procedures that maximize monkfish survival and retention of tags. We first tested and practiced options for tagging using dead monkfish, and then conducted holding-tank experiments to test tag retention and survival of tagged monkfish. We used Star-Oddi DST centi-TD loggers with an 8-cm streamer implanted subcutaneously using semi-sterile methods. Live monkfish were obtained from a commercial gillnetter. Mortality of both tagged and control fish was high (39-44%) and did not differ significantly for fish held for up to 6 weeks. Tag retention was 100% through 6 weeks, but 38% of incisions on tagged fish held 36-42 days (n=8) showed possible signs of opening by 6 weeks. Two of four tagged fish held for up to 6 months expelled their tag. We believe the streamer may have caused the incision to open and recommend that DSTs be completely enclosed if implanted subcutaneously. An external tag (e.g dart or t-bar) could be used to indicate the presence of the DST.

Introduction

Monkfish have been considered a poor subject for tagging because they lack scales and have a large unprotected abdomen, which makes them susceptible to injury and infection. Because of this, there has been very little tagging of monkfish in the northwest Atlantic. However, a congener (*Lophius piscatorius*) has been successfully tagged in the northeast Atlantic using conventional tags (Laurenson et al. 2005; J. Landa et al. 2001), suggesting that development of tagging methods for *L. americanus* is warranted. In this pilot project, we laid the groundwork for a tagging study of monkfish using data storage tags (DSTs) by developing capture, handling and tagging procedures intended to maximize monkfish survival and retention of tags.

Project Objectives

The purpose of this project was to develop capture, handling and tagging/marking methods for a data-storage-tagging (DST) study of monkfish *Lophius americanus*. Our goal was to develop procedures that maximize monkfish survival and retention of tags.

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Methods

The project was conducted in three phases: (1) development of tagging techniques using dead monkfish, (2) practicing tagging techniques on live monkfish, and (3) experimental studies to test survival and tag retention. The tag used was the Star-Oddi DST centi-TD logger, which is cylindrical and measures 15 mm (diameter) x 46 mm (length), weighs 19 g (12 g in water), and was fit with a 2-mm diameter streamer (~ 8 cm long) (Figure 1). This is a relatively large tag, and is capable of recording time, pressure and temperature to a depth of 3000 m for up to 5 years.

During the first phase of the project we used dead monkfish to develop and practice tagging methods. We explored options for tag location and developed semi-sterile surgical techniques for subcutaneous tag implantation. We tested several additional marking/tagging techniques (Petersen disks, dart and t-bar tags, injection of visco-elastic polymer on the white ventral surface of the jaw) that could serve as ancillary marks to increase detection probability of an internally-implanted DST.

The second phase of the project involved developing transport and handling techniques and testing our tagging methods on live monkfish. John Our retained 8 live monkfish (49-64 cm total length) from the last haul of his gillnet on May 11, 2006. The fish were placed in a holding tank with a constant flow of seawater (~10.5°C) and held for up to 24 hr before return to port where they were transferred to 2 10-gallon coolers equipped with chillers and airstones. Transport time from port to lab was approximately 1 hour. Upon arrival at the lab, the cooler water was dosed with Amquell to reduce the NH_3^+ which had reached 1.4-1.6 ppm ($\text{NH}_3^+ < 0.05$ is optimal), and the temperature was equilibrated with the tank temperature (9°C) over a period of about 1 hour. The fish were held in two 290-gallon tanks supplied in a semi-closed system maintained at approximately 9°C. Three of the fish were tagged after 1 day and the remaining 5 were tagged after 5 days. Two of the monkfish were in poor condition at the time of tagging.

The third phase of the project was a controlled experiment to test effects of tagging on survival of monkfish and to investigate tag retention. Thirty-four monkfish ranging in size from 40-78 cm were captured in gillnets on Dec. 11-15, 2006, and transported to the lab as described above except that time from capture to release in the lab was reduced to a maximum of 12 hr and Amquell was used in the on-board tank and transport coolers. The transport coolers were also dosed with Slime Coat at the recommended concentration. The fish were held for up to six weeks in two tanks (2600 gallon) supplied with ambient (5- 8 °C) running seawater. Eighteen monkfish were tagged 4-10 days after their arrival in the laboratory, the remaining 16 fish were left untagged to serve as controls. Nine tagged fish and 8 control fish were placed in each tank. We attempted to match controls and tagged fish for size and condition. We offered food (squid or capelin) daily; however, the food was rarely taken. The experiment was terminated 40 days after the final batch of monkfish was tagged. Remaining monkfish were euthanized, released or held for longer term observation. Survival curves of tagged and control fish were compared using Proc Lifetest (SAS System, Allison 1995)

The fish retained for longer term observation were transferred to two smaller tanks (290 gallon) each holding 2 tagged fish and 2 control fish. These fish were maintained for up to 4.5 additional months (6 months total) for further observation. We also used them for further experimentation, including retention of dart and t-bar tags and implanted DSTs with no streamer. The dart and t-bar tags were inserted at the base of the soft dorsal fin on the posterior portion of the tail on May 1, 2007. This experiment was terminated when all fish died due to a pump malfunction (179 days after tagging).

Our project deviated from the original statement of work in the following ways:

- (1) use of slightly larger fish to avoid the need for an exemption from minimum size limits
- (2) DSTs were implanted internally rather than attached externally
- (3) we conducted one 6-week experiment rather than two 3-week experiments. This was because the logistics of obtaining the fish were somewhat difficult and because we felt it would be more productive to observe the fish over a longer time, since tagging did not cause immediate mortality.
- (4) we did not use actual DST's, but used 'dummy' DST's that were the same shape, size and weight. We did this because battery use begins upon manufacture. With the funds saved by purchasing dummy tags, we purchased a few (13) actual tags at the end of the project for tag and release during November and December 2007.
- (5) we did not pursue dye-marking methods (PanJet needleless injector) after learning more about them because we felt the additional handling and injury would outweigh the potential benefits.
- (6) we did not conduct histological analysis of scar tissue, but evaluated the tag site macroscopically.

Data

We collected data on daily mortalities, condition of tagged and control animals, and tag retention or loss. We also provide descriptions of the methods developed for surgically implanting tags. Data will be submitted to the Northeast Consortium along with this report.

Results and Conclusions

Tagging Methodology

We qualitatively evaluated external tag attachment sites including the dorsal or ventral surface of the pectoral fin, the caudal fin and the dorsal fin and rejected these as either too obstructive (e.g. pectoral fins are used for 'walking' and 'digging' and the gill opening is directly beneath them) or inadequate (concern that tag would not be retained for long periods of time). We chose subcutaneous implantation on the dorsal surface of the tail (Figure 2) for the following reasons: (1) we felt there would be minimal interference with the animal's functioning (2) fishermen thought the tag would be highly visible there, (3) if the tag was not noticed and the tail cut for market, the tag would be recovered somewhere in the consumer chain, and (4) this location has sufficient loose skin to easily accommodate the tag.

Given the propensity of monkfish to develop skin lesions (this is a major obstacle to maintaining monkfish in captivity), we developed tagging protocols that were near-sterile. This included cold-sterilizing instruments between surgeries, cold-sterilizing tags, use of surgical gloves and a sterile drape over the fish, and cleansing the incision site with antiseptic before and after the surgery. A detailed description of the procedure is given in Appendix I. Fish to be tagged were placed on a towel wetted with a solution of Slime Coat and the gills irrigated either using a large hand syringe or a constant flow of sea water. A 1-1.5 cm incision was made through the skin and the tag inserted between the skin and muscle. The tag was tacked to the muscle through the 'bridle' that attached the streamer to the tag, and the incision was closed with a purse-string suture using dissolvable monofilament (Appendix I). Duration of the surgery averaged 6.5 minutes (minimum 4.3 min.; maximum 10.3 min) and depended in part on the activity level of the fish.

We experimented with external marking/tagging techniques (visco-elastic polymer injections, Peterson disc tags) to increase detection of DST-tagged fish, but concluded that the additional handling for the visco-elastic injections was not justified and the Peterson tags might entangle algae or other objects or lead to infection.

Tagging Experiments

During our preliminary holding study, tagged fish (n=8) survived for 3 to 31 days (Figure 3). Of these, only one showed signs of deterioration at the tag site (Figure 4); in the remaining 7 fish the tag site was clean and intact at the time of death. The cause of death in these 7 fish appeared due to capture- and holding-related stress as evidenced by extensive skin and muscle lesions (probably of fungal origin) and severe erosion of the caudal fin. Cause of death in the fish with tag loss is uncertain, but could have been a combination of stress due to the tag wound and cutaneous infection over other parts of the body. The development of lesions sometimes occurred very rapidly (noticeable changes within an hour).

In our 6-week controlled experiment, 39% of tagged fish had died by day 22 and 44% of control fish had died by day 12. The survival curves did not differ significantly ($P > 0.05$, Wilcoxon test, Allison 1995). No further mortalities occurred during the remainder of the 6-week experiment (Figure 3). The fish that died first were the ones in poorest condition at the time of tagging and they typically developed extensive lesions and erosion of the caudal fin. The number of days that tagged fish survived was not correlated with duration of the tagging surgery (Figure 5). One of the 7 tagged fish that died by day 22 showed signs of stress around the tag site (change in coloration of skin); the remainder appeared healthy at the tag site. However, of 8 fish that were held at least 36 days, 3 (38%) showed possible signs of the tag site opening (typically a small opening under the streamer). This was not noticeable until we euthanized the fish and examined the tagging site closely.

During the long-term holding study (4 controls and 4 tagged fish held up to 179 days), 2 tagged fish lost their tags (after 76 and 133 days). One tagged fish died 92 days after DST-tagging and showed a small (~ 2 mm) opening below the streamer at the site of the

incision. The tag site was clean and did not appear to be related to the cause of death. The fourth tag remained implanted without signs of deterioration at the tag site. All dart and t-bar tags remained in place when the experiment ended (24 days after tagging with dart and t-bar tags); however, one that was poorly implanted upon tagging was loose. The remaining tags were well-engaged in the pterigyphores.

We concluded that the protruding streamer was the likely cause of DST loss and implanted DSTs with no streamer in the 6 remaining fish on May 24, 2007. These fish were held an additional 18-24 days until they died due to problems with the water system. During that time, no tags were lost and there were no signs of the incision opening. However, retention needs to be tested for a longer period than we were able to hold these fish.

During the long-term holding experiment we adopted a new technique for feeding monkfish which was fairly successful. We impaled a dead capelin on the tip of a sharpened 3-ft dowel and gently inserted it head-first into the posterior portion of the monkfish's mouth, then removed the dowel, leaving the fish in the monkfish's mouth. The capelin's tail typically remained visible outside the monkfish's mouth. The capelin would be slowly drawn into the monkfish's mouth and swallowed. This type of feeding was not associated with a lunge and sudden opening of the mouth as is typical of monkfish feeding on live prey, nor could we detect the swallowing motion. After the prey was swallowed, the monkfish typically exhaled strongly several times.

Literature Cited

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Partnerships

The direct collaboration involved only one fisherman (John Our) who worked with us to provide healthy monkfish for tagging. Several others were shown the experiments in progress and provided helpful discussion. The fishermen were very interested and enthusiastic about this and future monkfish tagging projects.

Impacts and Applications

Interest in tagging studies of monkfish has been growing because of the need for information on stock structure, movements and age and growth of monkfish to support improved assessments. This is true not only for *L. americanus* in the northwest Atlantic,

but for other *Lophius* species around the world too. The monkfish Research Set-Aside program lists tagging as a priority. This study therefore will be of interest to scientists working on all seven species of *Lophius* and they will be the greatest beneficiaries of this project. Fishermen and managers will benefit if this project leads to funding for a full scale DST tagging study because such a tagging study would lead to a stronger foundation for the population assessment.

Related Projects

None

Presentations

Presenter: Anne Richards

Title: Data Storage Tagging Methods for Monkfish (Poster)

Northeast Consortium Annual Meeting Dec. 2006

Portsmouth, NH

Student Participation

None

Published Reports and Papers

None to date

Future Research

The results of this project can be used to guide a tag and release study of monkfish using data storage tags.

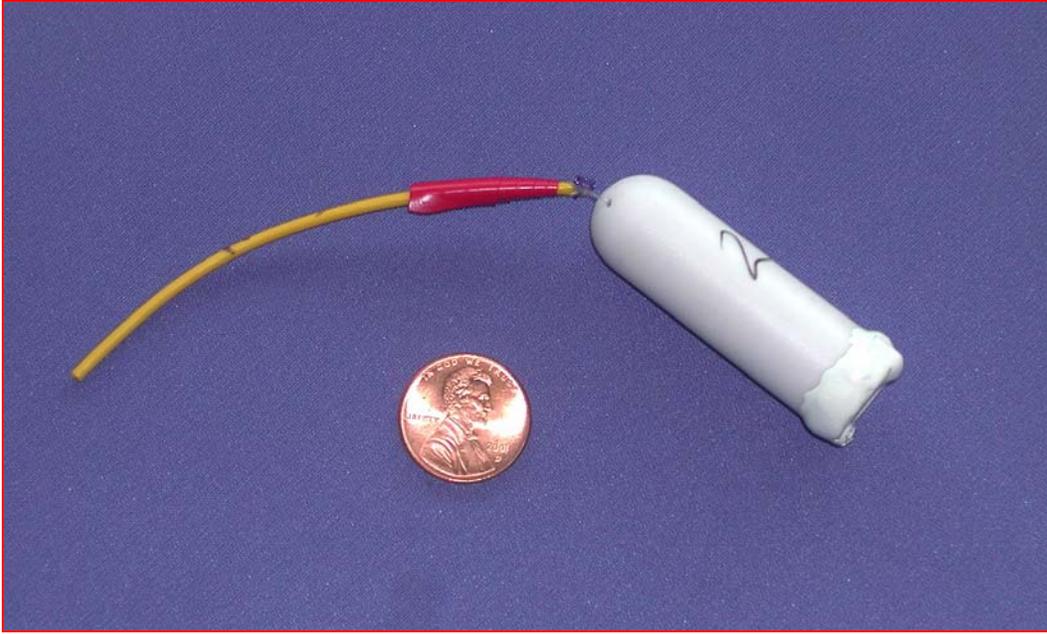


Figure 1. Star-Oddi DST centi-TD logger used in experiments.

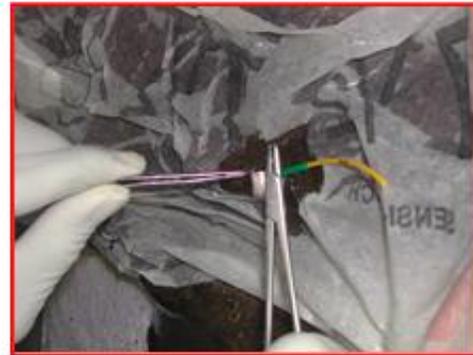
A.



B.



C.



D.



E.



Figure 2. Illustration of procedure for implanting tags. (A) Setup showing sterile drape, towel over eyes, syringe for ventilating gills, (B) Tag inserted into incision, (C) suturing incision closed, (D) implanted tag, (E) monkfish with implanted tag.

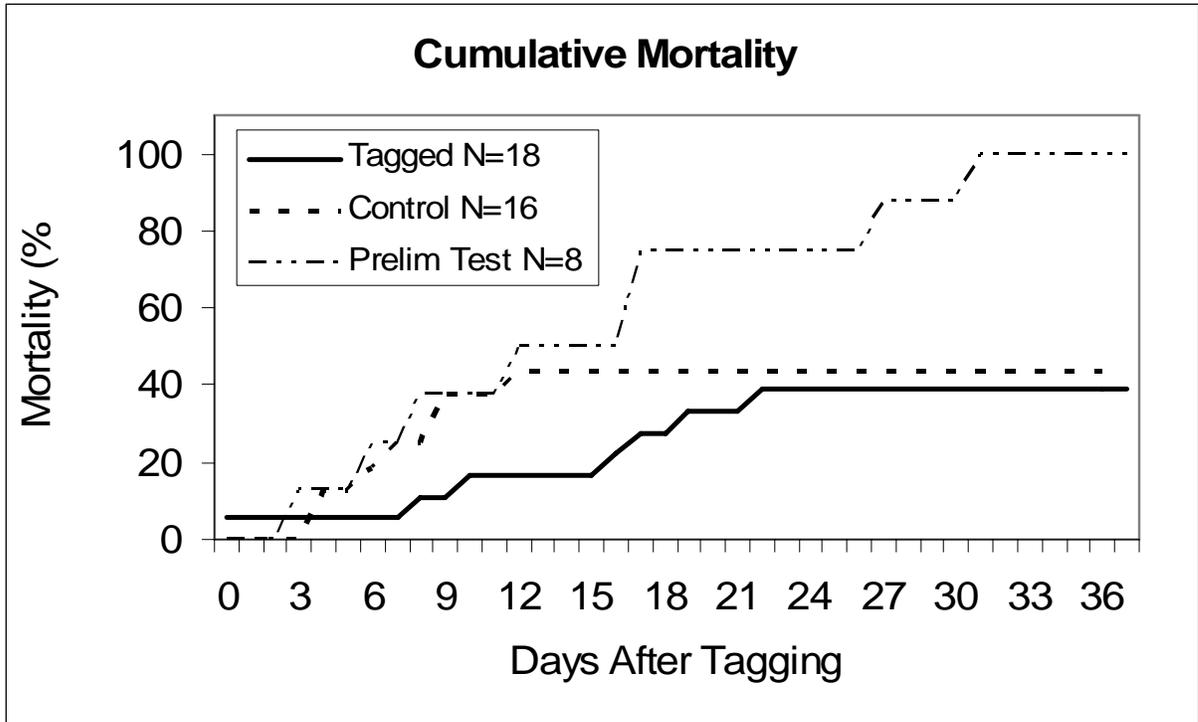


Figure 3. Cumulative mortality (%) in preliminary holding experiment, and during 6-week controlled experiment (tagged and control).

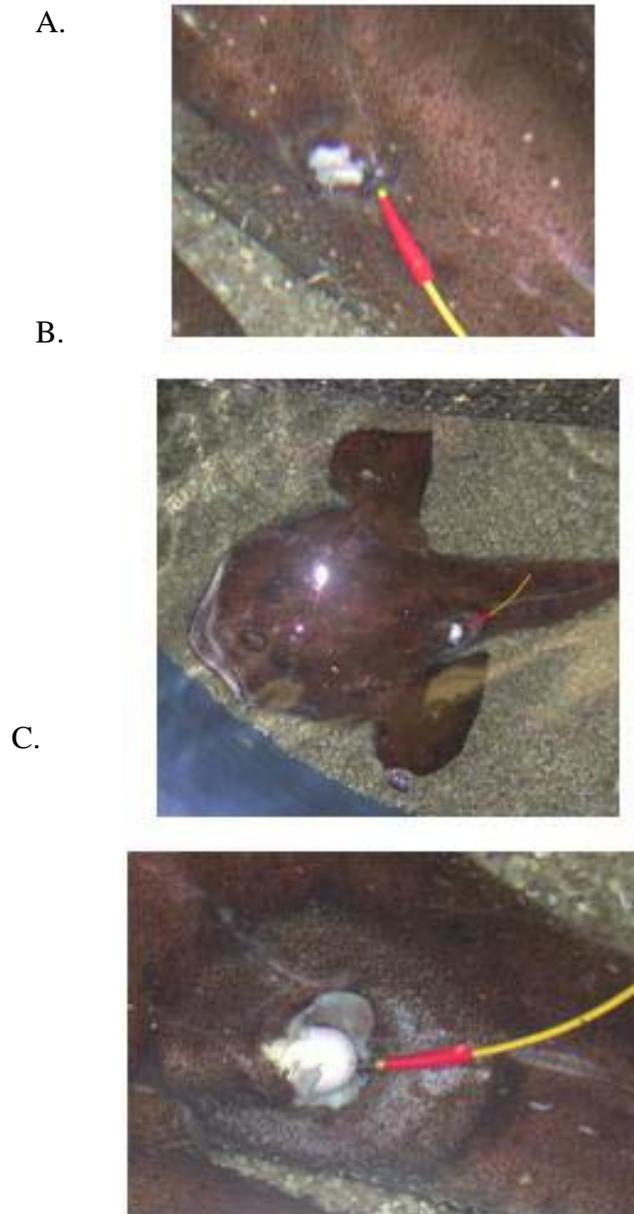


Figure 4. Monkfish from preliminary holding study showing tag loss in progress. (A) 3 days before death, (B) 1 day before death, (C) after death.

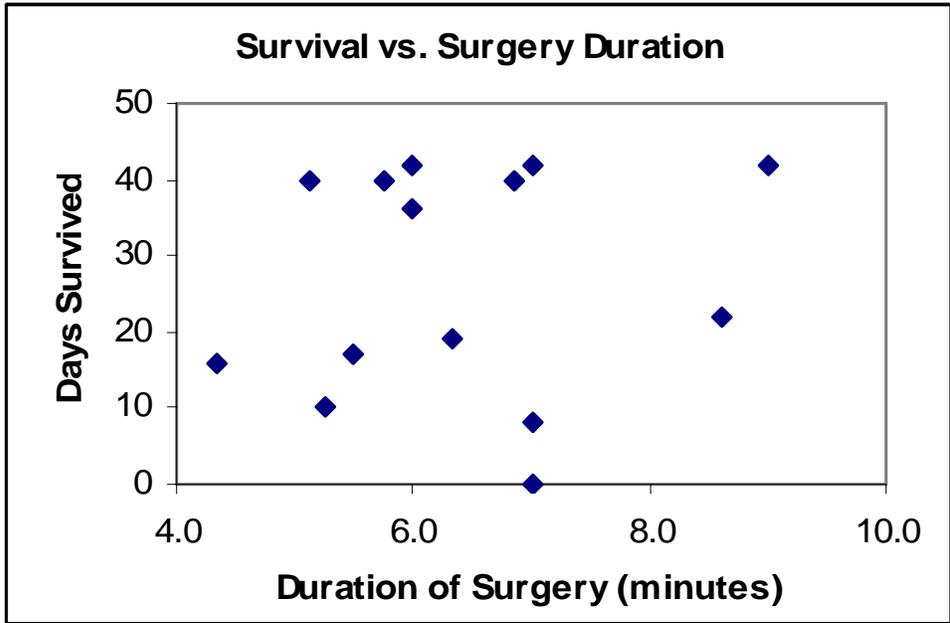


Figure 5. Survival vs. duration of surgery (6-week controlled experiment).

Appendix I

Monkfish Surgical Tag Implantation Surgical Description by Bridget Dunnigan MS DVM 4/12/06

Materials for Placing the Tag:

Scissors

- 1) Needle holder
- 2) Forceps
- 3) “swedged on” needle and suture

To make the incision:

- 1) Use the scissors to cut a ~ 1.2cm opening on the dorsal aspect of the tail, right of midline, at the level of the start of the second dorsal fin
- 2) Use the scissors to bluntly dissect a tunnel, up to the pre-measured mark on the scissors’ handle (equal to the length of the tag). To bluntly dissect using the scissors:
 - 1) With the scissor closed, make a ~0.5-1cm forward advancement between the skin and muscle layer,
 - 2) Then open the scissor so that the end is opened ~ 2cm, this will stretch the skin away from the muscle layer,
 - 3) Continue to advance the scissor and bluntly separate the skin from the underlying muscle, creating a tunnel for the tag to slide into.

Placement of the Tag:

- 1) Slide the tag into the created tunnel so that the tag is completely under the skin and the “indicator” portion is at the incision site.

Hold the Needle Holder in Your Dominant Hand:

- 1) Place your thumb and fourth finger (a.k.a. ring finger) in the finger loops.
- 2) Place your fingers #2 (index) and #3 on the shaft of the holder, and use these fingers to help direct your suture throws.
- 3) With the needle’s sharp end pointing up (curve upwards), use the end of the holder to grab the needle 2/3rds back from its sharp end.
- 4) Clamp the holder closed using your thumb and ring finger in the loops.

Tacking the Tag Down:

- 1) Take a ~4mm bite into the muscle layer at the incision site.
- 2) Using the forceps in your non-dominant hand to grab onto the end of needle as you use your thumb and ring finger to unclamp your holder.
- 3) Reposition your holder to re-clamp the needle and drag the suture through the muscle layer.
- 4) Slide the needle through the plastic loop attaching the indicator to the tag.

- 5) Again use the forceps to grab the needle while you reposition the holder to re-clamp the needle.
- 6) Drag the suture through the muscle and plastic loop until the end of the suture without the needle is at a length of ~7cm.
- 7) Tie the plastic loop to the muscle:
 - 1) With the long end of the suture in your non-dominant hand, place your holder in between the long end (needle end) and short end of the suture.
 - 2) Wrap the long end of the suture twice around the end of the holder.
 - 3) Use the end of the holder to clamp short end of the suture near the tip.
 - 4) Then with the short end of the suture clamped in the end of the holder and the long end of the suture in your non-dominant hand, slowing and evenly pull the two end of the suture and slide the knot down taught to the muscle layer.
- 5) Your right and left hand should have switched sides. (If you started with left hand was towards you and right away, as you pull the knot down your left hand should move away from you and your right towards you. Your hand position must alternate with each knot throw to create a secure square knot).
- 6) For the next knot throw:
 - 1) Again with the long end in your left hand, replace the holder in between the long and short end.
 - 2) Now wrap the long end of the suture only once around the end of the holder.
 - 3) Again use the end of the holder to clamp the short end of the suture.
 - 4) Again use a slow, even pull of the suture ends, making sure your hands are alternating positions from the last throw (see above).
 - 5) Make this throw slightly tighter than the first.
- 7) Continue this method for a total of 4 to 5 throws, slightly tighter each time.
- 8) Cut both ends of the suture leaving ~1-2mm of suture from the knot.

Closing the Incision with a Purse-string Suture:

- 1) Clamp the needle as describe above.
- 2) At the incision site start ~ 2mm out from the incision and take a bite of ~3mm of skin.
- 3) Used the forceps in your left hand to pull the needle through the skin, and then re-clamp the needle with the holder. Pull some of the suture through the skin.
- 4) Working around the incision in a counter-clock wise fashion, move ~4mm from your last suture and take another ~3mm bite of skin.
- 5) Continue this around the incision until you reach your first suture bite.
- 6) Pull on the needle end of the suture until the skin is synched up snug around the indicator, leaving ~7cm of suture material to tie a knot.
- 7) Use the above method (under “Tie the plastic loop to the muscle”) to tie a secure surgical knot to your purse-string suture.
- 8) Cut both ends of the suture leaving ~1-2mm of suture from the knot.