

How to Select and Procure Surgical Instrumentation for Rodent Surgical Research

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The field of surgical research has been growing rapidly with the development of new surgical and disease models. Advances in rodent transgenesis have increased the use of mice and rats in surgical models. An extremely important and often overlooked aspect of creating these models is the proper selection and implementation of surgical instruments. It is imperative to identify and select the appropriate instrumentation for the intended surgical procedure to be able to perform the procedure correctly. Other considerations when choosing surgical instruments are their ergonomic properties while making sure that instruments are of adequate quality, meet longevity requirements, and are affordable to meet increasingly smaller surgical budgets. Inappropriate instrumentation selection increases the risk of incorrect tissue handling and surgical complications.

Most research facilities do not have a rodent surgical instruments procurement specialist on site. Moreover, most personnel performing rodent surgeries do not have the same level of surgical training as human or veterinary surgeons. Therefore, identifying the most appropriate instruments, considering the number of instrument companies, quality and size, can be overwhelming.

This article describes several points that should be considered when selecting surgical instruments to optimize procedural outcome, thus decreasing non-experimental surgical variables, risk of morbidity and mortality, and expense in the long term.

Instrument Function

Surgical instruments are often designed for one or two principal functions, and if one chooses to use a particular instrument for purposes other than for which it was intended, then damage to the instrument or other tools could be the result. For example, the function of a microsurgical needle holder (Figure 1A) is to grasp, hold, and maneuver microsurgical needles. Using these microsurgical needle holders to grasp larger needles can damage the instrument. Another example of inappropriate use of an instrument is using microsurgical needle holders to handle the suture (a common mistake). Using the needle holder to handle the suture weakens the suture material, which can result in suture tearing during suturing or after the surgical procedure has been completed, leading to wound dehiscence. Therefore, there are specific microsurgical suture holders also referred to as tie forceps that are made for this purpose and they should be utilized to grasp suture when necessary. These microsurgical suture holders (Figure 1B) are more delicate than microsurgical needle holders and do not damage suture material to the level that needle holders do. There are resources available that describe the specific function and use of various instruments.¹⁻⁶



Figure 1: Comparison of Harvard Apparatus A) microsurgical needle holders and B) microsurgical suture holders (tie forceps).

Appropriate Instruments

It can be difficult to know what instruments are needed for each procedure. Therefore, it is advantageous to have 'standard kits' assembled and on hand that will cover various and common surgeries. Deciding what instruments should be in these kits can be a daunting task. Therefore there are many pre-packaged surgical kits available for purchase for mice and rat surgeries. Many individuals who perform rodent surgery do not have the depth of knowledge about specific surgical instrumentation. They end up purchasing these kits and perform many varied procedures with one kit that was designed for a very specific purpose. For example, there may be kits assembled that are standard for the collection of biopsy samples, but people purchase them and utilize them for all types of surgery, whether it is gastrointestinal or cardiac surgery. Using these kits indiscriminately could lead to excessive wear of the instruments and rough tissue handling. There are many experimental surgeries performed in mice and rats that are not performed in larger species, so finding a reference on which instruments to include in these kits can be difficult, and the instruments needed are much different than those found in standard mouse and rat surgical kits.

Furthermore there are many different ways to name the same instrument. This leads to further confusion in selecting instruments for individuals without a strong surgical background.

There are hundreds of companies that sell surgical instruments. The task of knowing brand names is challenging. Many of these companies offer different

grades and sizes of instruments, which further adds to the confusion. Hoyt et al¹ has provided an excellent review of microsurgical instrumentation and suture material. These should be reviewed by anyone thinking about performing rodent surgery, and in particular microsurgery, whether novice or expert. There are workshops offered in the United States and the Netherlands that provide an overview of the surgical instrumentation required for specific surgical procedures. Another option is to contact an expert in this field to assist with the selection of a rodent surgical kit. A good starting point and resource for this information is the Global Surgical Research Consortium - The Surgical Knowledge Exchange SubGroup on LinkedIn (www.linkedin.com/groups?gid=4489620&trk=myg_ugrp_ovr [1]).

When selecting surgical instruments it is important to consider:

Instrument Size and Length

Utilizing instruments that are of inappropriate size will not allow for optimal surgical technique. For example, using needle holders that are too large (Figure 2) will hinder appropriate grasping of a microsurgical needle because such needles may be too small and will slip. Furthermore, grasping with inappropriate needle holders will change the shape of the delicate rodent needle, which increases tissue drag tissue trauma. Instruments that are too long will decrease surgical precision and exaggerate each motion in an already restricted environment.



Figure 2: Comparison of Harvard Apparatus A) microsurgical needle holders appropriate for microsurgery to B) needle holders not appropriate for microsurgery.

Size of the instrument should be matched to the surgeon's hand size. Ringed instruments that have rings that are too large will tend to slip and rings that are too small will restrict blood flow and lead to finger fatigue. All of these factors have an impact on surgical technique.

Hoyt explains that microsurgical instruments should be long enough so that their non-operating ends rest on the webbing between the thumb and index finger.¹ This allows for optimal control of the instrument while minimizing fatigue and trembling.

Instrument Shape

Microsurgical instruments are available in flat (Figure 3A) or half-round handles (Figure 3B). The advantage of half-round handles is that it allows manipulation and rotation of the instrument in its own axis with minimal movement of the fingers

thereby decreasing risk of repetitive strain injury.



Figure 3: Comparison of Harvard Apparatus A) forceps with round flat handle to B) forceps with half-round forceps.

Weight of the Instrument

It is important that instruments are of appropriate weight. Titanium instruments are lighter than stainless steel instruments, which decreases the chance of hand fatigue/strain. However, if the instrument is too light it might be difficult to control. Selection of one material over the other will depend on the surgeon's preference. The authors recommend starting with stainless steel for beginner and novice rodent surgeons.

Glare of Surgical Instrument

Certain metal finishes are too reflective of the surgical lights and over a long period of time can lead to eye strain, especially when working under a microscope or with surgical loupes. Therefore, if possible, one should select instruments that are made of less reflective surfaces, like "brushed" metal. The glare of surgical instruments can decrease visual acuity and lead to eye fatigue, both of which can affect surgical precision. Many manufacturers offer instruments with a sandblasted matte finish ("brushed" metal). Another technique includes polishing with a coarser compound and third option includes blue anodizing of titanium instruments.⁷

Cost/Investment/Expense and Quality of Instrument

Balancing the budget and acquiring high quality surgical instruments continues to be a challenge. As rodent surgical procedures are becoming more specialized and complex, the need for more specialized instrumentation increases. Microsurgical instruments can be costly and easily damaged when not properly taken care of.

Germany, the United States of America, and Pakistan are the leading manufacturers and providers of surgical instrumentation. The quality of surgical instrument differs significantly depending where these instruments are manufactured.⁸ German and U.S. manufacturers in general use the highest quality of stainless steel for the production of surgical instruments and perform rigorous quality checks before they are sent to market. The Pakistani surgical instrument market has grown tremendously within the last decades, but many surgical Pakistani manufacturers do not incorporate rigorous quality checks, often use lower quality stainless steel, and are manufactured by manual street laborers.⁸ Personnel without surgical background often select these instruments, because they are significantly less costly. However, in the long term these costs may be higher because the instruments have to be replaced more often, but more importantly it is difficult to perform precise and gentle surgical procedures because the instruments do not

perform as well. It is difficult to grasp tissues gently when the forceps tips do not align properly and tissues are re-grasped because they slip. This becomes even more of a concern when performing microsurgical techniques in rodents. Therefore, it is important to consider the instrument quality before the purchase. The higher upfront cost of high-quality instrumentation can be easily justified if the goal is to perform high-quality surgery and replacing instruments less often.

Quality control should also be performed at your institution when the instruments arrive. It is important to assess and examine instruments for corrosion and appropriate alignment. One should ensure that ratchets work correctly, scissors cut cleanly without tearing, check for machining burrs, surface imperfections, and protruding guide pins, all of which can potentially injure tissues but also puncture gloves. Depending on the biosecurity level, a ripped glove could expose surgical personnel to harmful pathogens.⁹ Debris may collect within imperfect areas of the instrument and it has been suggested that even after the sterilization process, prion agents may survive in these imperfections.¹⁰

Items that will help you identify trustworthy surgical suppliers:

1. Manufacturer's mark should be visible on each instrument.
2. Manufacturer should stand by their instruments and replace them if they are found damaged (as listed above) upon receipt.

Use of Instruments

Usage frequency will have an impact on instrument durability. In rodent surgery, where bead sterilizers are commonly used between surgeries, this sterilization procedure makes instruments brittle and dull over time. For example, microsurgical scissors that are repeatedly sterilized using a glass bead sterilizer can lead to jagged incisions and require repeated cuts because of their dullness. Instruments must be assessed on a regular basis and replaced when necessary, however when bead sterilizers are utilized special attention must be given and the frequency of inspection increased. Proper care of instruments, such as adequate use of cleaning detergents, ultrasonic cleaners, and consistent lubrication will greatly extend the life of your instruments and help preserve your investment.

Summary

When selecting surgical instrumentation and especially microsurgical instrumentation, selection should not be made solely on price. Quality and appropriateness of surgical instrumentation will have a significant effect on the surgical technique. Therefore, surgeons should consider spending on purchasing rodent surgical instrumentation as an investment.

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