Current Practices in Ophthalmology
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Parul Ichhpujani
Manpreet Singh *Editors*

Ophthalmic Instruments and Surgical Tools

Current Practices in Ophthalmology

Series Editor

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Editors

Ophthalmic Instruments and Surgical Tools

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Foreword

It is with great pleasure that I write this foreword to the book, *Ophthalmic Instruments and Surgical Tools*, edited by Drs Parul Ichhpujani and Manpreet Singh, who I have known for several years to be highly motivated and enthusiastic young ophthalmic surgeons and teachers. I congratulate them for taking this initiative for filling a long felt gap on the availabilty of current information on ophthalmic surgical instruments, their uses, sterilization, and their upkeep. In the ever-changing world of the surgical techniques in ophthalmology, a description of surgical instruments has remained neglected in the past so many decades. The young ophthalmic surgeons, trainees, and students are often at a loss to find information on the instruments and equipment before they start using these. The editors have succeeded in filling this gap admirably well. The editors have complied a roster of young ophthalmic faculty members to contribute chapters on the surgical instruments and equipment used in a variety of surgical procedures in the anterior segment, vitreoretinal surgery, and the oculopastic and orbital surgery.

A dedicated text on the planned compilation, lucid description, pertinent uses, and intraoperative handling of the surgical instruments used in specialty ophthalmic surgeries is rare. Moreover, the photographs of instruments from various aspects provide a clearer image in the minds of readership for better understandings. This book will be a remarkable addition to the literature and of interest not only to the ophthalmologists under training but also to the nursing staff and undergraduate students.

The make, material, description, and sterilization of a surgical instrument are often overlooked and ignored entity. The surgical instruments are mostly "looked-at" and read by the students before exams with great difficulties in collecting the information and remembering afresh as an entirely new aspect. This book will go a long way in helping the readership in educating nursing staff, students, residents, fellows, and clinicians in practice.

Chandigarh, India — Amod Gupta

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Contents

1 Instrument Sterilization and Care 1
Manpreet Singh and Jagjit Malhotra

2 Ophthalmic Sutures and Needles 11
Parul Ichhpujani and Priya Goyal

3 Basics of Surgical Instruments 23
Manpreet Singh, Manpreet Kaur, Natasha Gautam, and Sonam Yangzes

4 Anterior Segment Surgery Instruments 31
Sahil Thakur, Natasha Gautam Seth, Monika Balyan, and Parul Ichhpujani

5 Instruments for Posterior Segment Surgery 51
Sahil Jain, Mohit Dogra, and Deeksha Katoch

6 General Instruments for Ophthalmic Plastic Surgeries 67
Manpreet Singh, Manpreet Kaur, Prerana Tahiliani, and Sonam Yangzes

7 Instruments for Lacrimal Surgeries 89
Manpreet Singh, Varshitha Hemanth, and Prerana Tahiliani

8 Nasal Endoscopic System 113
Manpreet Singh and Saurabh Kamal

9 Instruments Used in Eyelid Surgeries 121
Manpreet Singh, Varshitha Hemanth, and Prerana Tahiliani

10 Instruments for Enucleation and Evisceration 139
Manpreet Singh, Prerana Tahiliani, and Varshitha Hemanth

11 Instruments Used in Orbital Surgeries 153
Manpreet Singh and Manpreet Kaur

12 Common Instruments Used in Refractive Surgeries 161
Monika Balyan, Chintan Malhotra, and Arun K. Jain

13 Refractive Surgery: Basics of Laser Consoles and Ablation Profiles 175
Aditi Mehta Grewal, Sartaj Singh Grewal, Anchal Thakur, Amit Gupta, and Chintan Malhotra

14 Basic Operating Room Machines 185
Mohit Dogra, Manpreet Singh, and Parul Ichhpujani

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1 Instrument Sterilization and Care

Manpreet Singh and Jagjit Malhotra

The operation theatre equipment, machines, trolleys, and surgical instruments demand extra care as compared to other areas. The cleaning, disinfection, and sterilization of these items depend upon their role in the operation or surgery. Of these, the most frequently circulated and used items are the surgical instruments. Hence, proper cleaning, debridement, packing, and sterilization are of utmost importance before the use, repeat use, or storage of the instruments. Earle Spaulding (1968) from Philadelphia classified medical instruments, depending upon their use and risk of spreading infection. The instruments were grouped as critical, semi-critical, and noncritical devices (Table 1.1).

Table 1.1 Spaulding classification of instruments

Classification		Products	Cleaning process	Cleaning product
Critical	Enters inside sterile body cavities, bloodstream, or sterile tissue	Surgical instruments, implants, scalpel blades, needles, cannula, phacoemulsification handpieces	Sterilization	Sterilizing agent or process
Semi-critical	Comes in contact with non-sterile mucous membranes or non-intact skin	Endoscopes, the tip of applanation or indentation tonometer, the probe of contact/ immersion biometry, Schirmer's strips, fluorescein strips, etc.	Sterilization or high-level disinfection	Sterilizing agent or process/ disinfectant
Noncritical	Comes in contact with intact skin	Rulers, exophthalmometers, ultrasonography probes, blood-pressure cuffs	Low-level disinfection	Soap and water

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The conventional ophthalmic instruments are fine and mostly blood-free and have delicate ends which require careful handling during the complete sterilization cycle as compared to other surgical specialties. On the contrary, the instruments used in ophthalmic plastic surgery invariably get bloodstained. Blood contains hemoglobin and iron (Fe) which get lodged into micro-abrasions or cracks of the instrument coatings and invoke rusting. Careful soap and water cleaning removes most of the dirt, blood clots, and microorganisms. Cold water is preferred over hot to prevent the heat coagulation of proteins over the instrument surface, making it difficult to remove. Without cleaning, the disinfection and sterilization remain ineffective.

1.1 Stepwise Processing of the Used Instruments

1.1.1 Cleaning

Cleaning is the physical removal of visible dirt, blood, pus, lint fibers, or threads from the instruments. For fine and delicate ophthalmic instruments, the mechanical cleaning is preferred over the manual one to minimize the instrument damage and for efficient performance. Moreover, it prevents the infectious hazard to the instrument handlers and saves time in a busy operation theatre. Always use distilled water (DW) for cleaning—the normal saline and balanced salt solutions damage the instrument coatings and joints by corrosion. Adequate ventilation with temperature and humidity control is desirable requirements for the cleaning area.

Ultrasonic cleaning (Fig. 1.1) is the most efficient and effective technique to clean instruments. The sound waves of frequency ≥100 KHz pass against the

Fig. 1.1 An ultrasonic cleaner with a bowl-tray to contain the instruments to be cleaned. The arrow highlights the 'inlet' for the water or solution

water-dipped instruments. Fine-tipped and delicate micro-instruments are advisable for ultrasonic cleaning. For ultrasonic cleaning, the neutral pH solution should be used which improves calibration and reduces the surface tension. The fluid should be changed daily or whenever required in 1 day.

(a) Turn on the machine for 8–10 min to get rid of any microbubbles from the solution before placing instruments (150 °F).
(b) Grossly clean the larger instruments before placing it inside the wire basket of ultrasonicator.
(c) Open box lock joints and ratchets for better effect.
(d) To prevent cross-plating or cross-metalling, do not overload or mix dissimilar metals.
(e) After completion of the cycle, remove the instruments, rinse them, and air-dry them.

After cleaning, rinsing of all instruments with DW should be done to remove the surface "biofilm." Rinsing of cannulas, vitreous cutters, tubings, and metallic suction tips with DW and air is a must. The lubrication is the next desirable step which prevents further sticking of proteins and improves "life" of the instrument. The lubrication of instruments with the lumen is not advisable.

1.1.2 Drying

Now, the instruments are dried with a lint-free cloth and regular hair dryer before the packing. At this time, the instruments should be inspected under magnification for tip and tooth alignment of forceps, cutting edges of scissors, approximation of needle holders, and suture tying forceps. Fine cleanliness, corrosion, cracks, pits, burrs, nicks, etc. are other observed details.

1.1.3 Packing or Wrapping

Rigid containers made up of metal, plastic, or aluminum are used to store most of the ophthalmic instruments. Transparent pouches and sterilization wraps (synthetic or organic fabric) are used wherever necessary.

The synthetic disposable wrapping material is preferred over woven textiles (Fig. 1.2). Fabric or textile drape cloth (Fig. 1.2) should have a minimum of 140 threads/inch^2, and minimum residual soap is desirable after washing of cloth. This prevents the soap deposits on instruments after autoclaving. Paper, polyolefin, peel-pack rolls, or pouches are used for packing the small boxes or individual instruments before sterilization.

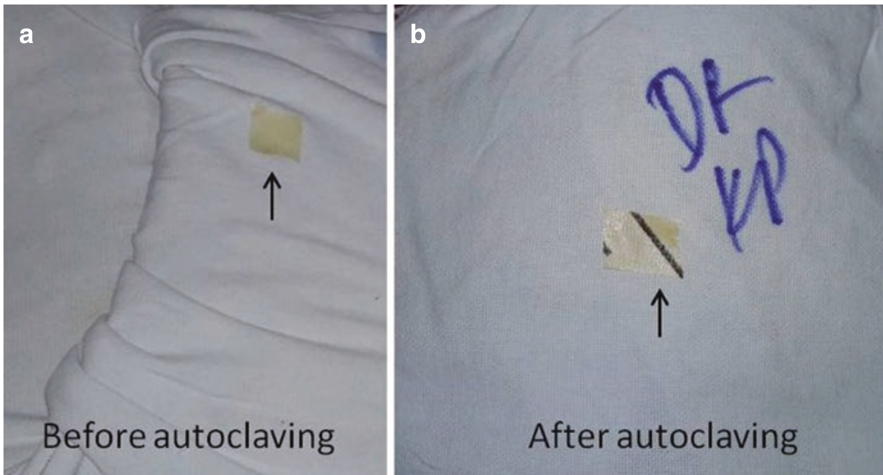

Fig. 1.2 (**a**) The arrow shows a blank sticker placed over the wrapped linen before autoclaving. (**b**) After autoclaving, the sticker shows a black stripe indicating the autoclaved lot

During packing or wrapping, the sterilization indicators (chemical or biological) are put inside the pouches for the assessment of sterilization adequacy. The storage plates should preferably have perforations for better steam penetration and effective drying during autoclaving. Always place heavier instruments at the bottom and lighter ones on top. The tip protectors should be used to safeguard the business-end tips of fine ophthalmic instruments. Approximately 1-inch space is kept around the boxes and plastic wrappers. The labeling of the package should clearly indicate the date of sterilization, lot number, contents, and initials of the sterilization processing person. The style of packaging must permit the presentation of the stored contents to the sterile area or trolley in a straightforward and aseptic manner.

1.1.4 Sterilization

The process of sterilization involves the complete destruction of all microorganisms and the spores. Disinfection means killing or destruction of microorganisms only. Various methods of sterilization include autoclaving, hot air oven, ethylene oxide (ETO) gas, plasma sterilization (hydrogen peroxide gas), and chemical agents like glutaraldehyde 2%. Out of these, autoclaving, ETO, and plasma are commonly used sterilization methods in ophthalmology. A simple test known as *Bowie-Dick test* is used to assess the penetration of steam till the middle of a test sack made up of cotton towels. An autoclave test tape indicator is placed in the center, and a test cycle is run—a uniform change (from beige to brown) of the tape indicates adequate penetration of steam. As also mentioned by the manufacturers, this is not the perfect test to guarantee sterilization. The salient features of the following methods have been summarized and compiled in Table 1.2.

Table 1.2 Techniques for sterilization

Technique	Merits	Demerits	Time and temperature	Ideal for
Autoclave (pressurized steam)	• Inexpensive • Highly effective • Rapid • Nontoxic	• Not suitable for oils, powder, ointment, etc. • Closed glass chambers • Rubber, plastic can melt	20–60 min 121–180 °C	• Operating metallic instruments • Surgical gowns, drapes, dressings
Hot air oven (dry heat)	• Non-corrosive • Inexpensive Nontoxic	• Less effective • Longer duration	60–80 min 340 °F	• Oils, powder, etc. • Metallic instruments • Open glass vials
Ethylene oxide (ETO)	• Heat-labile tubes • Plastic handle blades • Wires • Longer storage • Ready to use pack	• Toxic • Expensive • Caution for handlers (carcinogenic, explosive) • Long cycle time • Long aeration time	6–12 h	• Vitrectomy cutters • Phaco tubings • Optical-fiber light pipe • Silicone stents • Acrylic orbital implants • Conformers • Plastic eye shields • Cryoprobes
Plasma (hydrogen peroxide)	• Short cycle time • Ready to use • Plastic, heat-labile material • Wires • Longer storage	• Special packing needed • Expensive equipment	75–80 min	Same as of ETO
Chemical disinfectants	• Quick and ready method • Inexpensive	• Not for any intraocular instrument • Needs thorough wash for all items • Proper lumen rinsing before use • Toxic to mucosa and conjunctiva	3–4 h	• Nasal endoscope tips • Nasal packing forceps • Plastic, glass, airways, etc.

- *Autoclaves*: These (Fig. 1.3) use the compressed or pressurized steam as a sterilizing agent. It is an inexpensive, nontoxic, easy, expedient, and efficient method of sterilization. The packaged trays should be arranged for adequate steam surround and penetration. After switching on, the air inside autoclave is removed by

Fig. 1.3 The digital autoclave containing wrapped linen with the autoclave cycle parameters and timings recorded on a printed strip. The standard autoclave shows analogue gauges and meters with no record of previous cycles.

the vacuum pump and is replaced by the steam. The operating temperature and pressure are maintained and monitored externally by gauges. Total cycle time and other parameters should be according to the equipment manufacturer. Flash sterilizers are commonly used under emergency conditions, and items sterilized are recommended to be used immediately by most of the manufacturers.

- *Hot air oven*: This uses dry heat sterilization method. It is generally used to sterilize oil, ointment, powders, glass vials, and metal instruments. All items should be preferably dry. The items should be immediately used after cooling. Time taken for sterilization is generally more than an autoclave.
- *Ethylene oxide* (C_2H_4O): This is an alkalinizing agent toxic to the DNA of microbes. It is used mainly for the moisture and heat-sensitive devices. The concentration of gas, exposure time, temperature, and relative humidity are major functioning parameters. Proper documentation of each parameter is necessary for best efficiency and to avoid accidents. This method demands a lengthy aeration time (with filtered air) after every cycle for the removal of harmful residuals. This is done before opening the door of the machine. All sterilized items must be aerated properly before safe use as the residual contents can incite intraocular inflammation. Regular testing of the machine area is necessary to check for the gas exposure. The process is carried out at a temperature of 45–55 °C, relative humidity of 60%, and the pressure between 5 and 10 psi for 12–6 h, respectively.

- *Plasma sterilization*: Plasma sterilization (Fig. 1.4) uses hydrogen peroxide that is used in gas or vapor form. Plasma constitutes highly ionized gas composed of ionic particles (electrons, neutrons, etc.) produced by excitation of gas or vapors by radiofrequency or microwaves in a closed chamber under low-vacuum conditions. Plasma constitutes low-temperature sterilization in which polypropylene, polyolefin, and plastic have preferably used a packing or wrapping material. The cellulose content of paper and cloth absorbs the peroxide preventing its effective penetration.

Fig. 1.4 The plasma sterilizer with 'open door' showing the shelves to keep the wrapped items. Each cycle is printed on the stripe for record maintenance. Various options and cycle stage indicators

- *Chemical sterilization*: *Glutaraldehyde 2%* is an effective sterilizing agent available in liquid form. Heat-labile equipment, endoscopes, and metal instruments are commonly placed into this solution for minimum 3 h. These instruments are thoroughly washed or rinsed before use. The solution should be replaced after 2 weeks.

  Isopropyl alcohol (70%)—It is a low-cost disinfectant for ophthalmic lenses, tips of applanation or indentation tonometers, and other OPD or OT metallic instruments. It should be wiped dry before use and must be used with caution as it is highly inflammable. *Other chemical agents—Sodium hypochlorite*, *chlorhexidine*, and *10% povidone-iodine.*

  Formalin in the form of tablets, liquid, and aerosol is used for sterilization of many operation theatre items. The transparent, shelved, airtight box containing heat-sensitive equipment (wires, leads, endoscopes, fiber-optic light pipes, etc.) is generally used. The standard concentration used is 7 g/m^3. The shelves should preferably be perforated for better circulation of vapors. The box can be kept at room temperature. The sterilizing time is 12 h and the box should not be opened during this time. Eye protection wear is helpful from this potentially carcinogenic chemical. In many institutions, its use has been discontinued due to its potential carcinogenicity.

1.2 Effective Sterilization Monitoring

It is always indirectly indicated by a few mechanical, chemical, and biological indicators (Fig. 1.5). The mechanical indicators are intra-process temperature, pressure, and time as depicted by the gauges and necessary documentation on charts. The chemical indicators are commonly used for ETO, autoclaving, and dry heat sterilization. These are commonly placed in the middle of items or packs where the steam might take longest to reach. These are available as adhesive tapes placed outside the packs making it easier to distinguish between an autoclaved and unsterile pack.

Fig. 1.5 A steam indicator (chemical) tape with the arrows showing the site of chemical stripe. The space in between two lines is used to label the date, time and signature of nursing officer

Table 1.3 Storage times for material sterilized by different methods of sterilization

Technique	Storage time/shelf life
Autoclave (pressurized steam)	72 h {only in a controlled environment having a temperature (20 °C–24 °C) and humidity (less than 60%)}
Hot air oven (dry heat)	Vary according to article/equipment
Ethylene oxide (ETO)	3 Months
Plasma (hydrogen peroxide)	6 Months
Chemical disinfectants	Vary according to disinfectant used

The biological indicators measure the effectiveness of sterilization at closest to the direct assessment. *Bacillus subtilis* spores are heat-resistant endospores, but when killed by the pressurized steam of autoclave, it is presumed that all other microorganisms must have been destroyed. After completion of the autoclave cycle, the strips containing endospores are incubated for 7 days. If no growth is demonstrated, the then autoclaved lot is considered to be sterile. This delay of the result is a considerable disadvantage making the chemical indicators as the most used ones.

Nonetheless, a comprehensive "operation theatre employees orientation program," proper documentation of the sterilization process, monitoring of sterilization, and written instructions have a vital role in running an efficient operation theatre.

Note Whenever there is doubt about the sterility of any instrument, equipment, or surgeon's wear, consider it unsterile and proceed accordingly.

1.3 Storage of Sterile Instruments and Linen

Good storage condition is utmost important. Instruments should be placed at least 2½ feet above the ground level. Shelves or storage racks should be carbolized and completely dry. Adequate temperature and humidity should be maintained. Keep a check on the expiry date of sterile material on a daily basis. Table 1.3 shows storage times for material sterilized by different methods of sterilization.

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2 Ophthalmic Sutures and Needles

Parul Ichhpujani and Priya Goyal

2.1 Definition

"Surgical suture" is a medical device that helps to approximate and hold body tissues after a surgery or an injury.

A surgical suture in ophthalmology is used for desired apposition of wound edges, hanging back of tissues (recti or levator), fixation of detached structures (canthal tendons, bones), and lifting of tissues (eyelid, facial skin). Moreover, suturing closes or reduces the dead space, hence decreasing the chances of hematoma collection and infection.

2.2 Ideal Suture Material

The ideal suture should have the following characteristics:

- Sterile
- Resistant to infection
- Have minimal tissue reaction; be nonallergenic and noncarcinogenic
- Favorable absorption profile
- Easy to handle
- Hold securely when knotted; must not fray or cut after knot is tied
- High tensile strength
- May be used for multiple types of tissues or surgical procedures
- Cheap

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