ENDOSCOPIC RADIAL ARTERY HARVESTING

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Hardware and software requirements:
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Endoscopic Radial Artery Harvesting

Background

As the first so-called “alternative arterial conduit”, the radial artery was initially introduced by Carpentier and collaborators in 1972 and since then used at several sites in North America. Soon, after having been abandoned due to the concerns raised by the low patency rates at short-term, an upsurge in the use of the radial artery finally occurred in late Eighties, when conduit patency up to 15 to 18 years following grafting was demonstrated by Carpentier’s group. This resulted in a steadily progressive reintroduction of the radial artery in the clinical scenario, with several studies supporting its routine use.

The reports by Loop and collaborators first and then that by Lytle and collaborators provided the foundation for the next logical step, i.e. the exclusive use of arterial conduits to achieve complete revascularization. Finally, the advent of the T-graft or Y-graft has allowed complete revascularization with only two conduits. By attaching the free conduit (ITA* or radial artery) to the mid-portion of the in situ left ITA, it is as though 10 cm is added to the length (compared with aortic anastomosis) of the free conduit, which enables it to reach most areas on the heart with sequential anastomoses.

* Internal Thoracic Artery

Harvesting of the Radial Artery: Open Technique

The conventional (open) approach for Radial Artery (RA) harvesting has been extensively described elsewhere in the literature, albeit several technical aspects are worthy to be analyzed in order to better understand the differences (not only in terms of aesthetics) when compared to the endoscopic technique.

Briefly, the patient’s nondominant arm is prepped following adequate pre-operative assessment of collateral circulation (by means of an Allen test or other methods, e.g. Doppler ultrasound). The upper extremity is placed on an arm board perpendicular to the long axis of the operating table. A medially curved incision is made on the skin overlying the RA from a point 2 cm proximal to the styloid process of the radius to a point 2 cm distal to the elbow crease and 1 cm medial to the biceps tendon (Fig. 1).
Surgical Anatomy of the radial artery.

The subcutaneous tissue is divided either with scissors or cautery. The dissection can be initiated at either end depending on the surgeons’ preference, although most surgeons would start the dissection at the distal end. The deep fascia of the forearm is incised directly over the RA. The RA is harvested as a pedicle with minimal manipulation using sharp dissection, diathermy, or any other suitable vessel sealing system currently available. During harvesting, gentle retraction of the brachioradialis muscle is usually performed in order to further facilitate vessel exposure (Fig. 2).

Two nerves must be protected during RA dissection: first, the lateral antebrachial cutaneous nerve (LACN) lies superficial to the brachioradialis muscle and close to its medial border, making the nerve particularly prone to inadvertent injury if the skin incision is placed at this site. As a result of iatrogenic trauma, the patient will develop paresthesia and numbness of the radial aspect of the volar forearm. Second, please be well aware, that the superficial branch of the radial nerve (sRN) lies beneath the brachioradialis muscle in the proximal two-thirds of the forearm and runs parallel to the RA. Injury to the sRN will cause paresthesia and numbness of the thumb and the dorsum of the hand. Accordingly, the LACN should be spared by making sure, that no excessive lateral retraction is applied to the brachioradialis muscle.

Once the pedicle is free and systemic heparin has been administered, the artery is divided proximally and distally, and stored in a solution (usually containing heparinized arterial blood at room temperature, mixed with different anti-spastic drugs according to each center’s own protocol). Next, hemostasis of the operative field is achieved and the arm is closed in multiple layers. A closed-suction drain may be placed to prevent seroma or hematoma formation. The arm is then secured to the table alongside the body.

Surgical anatomy of nerves during radial artery harvesting.
Harvesting of the Radial Artery: Endoscopic Technique

Endoscopic Harvesting of the Radial Artery (ERAH) has only recently been introduced in the clinical scenario, whilst endoscopic removal of the great saphenous vein is a well established technique during coronary artery bypass surgery and proved to offer significant advantages in terms of wound complications, reduced pain and aesthetics while yielding remarkable results with respect to the histological analysis of the harvested conduits. As a result, great interest was aroused in ERAH with the aim of providing the same clinical benefits as in endoscopic vein harvesting, which can also be attributed to advances made in the development of specialized medical devices for endoscopic visualization of the conduits and vessel sealing systems for completion of harvesting.

The pre-operative evaluation criteria (e.g. negative Allen test, choice of non-dominant arm, etc.) previously described for the open approach, are similarly adopted for the endoscopic technique.

The main steps required to perform endoscopic harvesting of the radial artery are outlined below. For further technical details, please refer to the DVD enclosed.

Surgical Equipment

Albeit different approaches have been described so far, the technique outlined in this manual allows a simplified approach for endoscopic harvesting of the radial artery to be performed using only a few specialized endoscopic devices mainly consisting of three components:

- BISLERI Endoscopic Radial Artery Retractor plus 45°-Hopkins® II Telescope
- Vessel sealing system
- Artery dissector

Moreover, the technique, as described in the following chapters, can be performed by a single surgeon (or physician assistant) without the routine need for another assistant, as in many other endoscopic procedures. Finally, the reported technique can be easily adopted even by those who do not have a background in endoscopic vein harvesting, which is not necessarily required for ERAH.

BISLERI Endoscopic Radial Artery Retractor

Despite the excellent performance of the Endoscopic Vein Retractor already available on the market, the different anatomical features of the radial artery – mainly the fact, that the great saphenous vein runs in the subcutaneous tissue while the radial artery lies mostly beneath the brachioradialis muscle – made the development of a novel retractor necessary.
Endoscopic Radial Artery Harvesting

Special Features of the BISLERI Endoscopic Radial Artery Retractor:

- Stainless steel, resterilizable device
- Hopkins® II rod-lens 45°-endoscope for optimal visualization of the operative field
- Ergonomic handle
- Improved design of the distal tip (Fig. 4a) and the proximal (Fig. 4b) part.
- Improved smoke evacuation due to a specific channel (Fig. 5)
- Tunnel-shaped design (Fig. 6).

4a
Design of the distal tip.

4b
Design of the proximal part.

5
The additional channel can be used either connected to a suction device or to a CO2 insufflator.

6
The tunnel-shaped design of retractor is clearly visible.
**Vessel Sealing System**

ERAH can be performed either with the use of a more traditional approach (e.g., using endoscopic clip appliers and scissors) or a vessel sealing system. As previously outlined, the use of a vessel sealing system yields considerable advantages during ERAH mainly in terms of time-effectiveness and simplification of the procedure, since it is routinely the only other instrument used by the operating surgeon (beside the BISLERI retractor), thus avoiding the potential need of an additional assistant.

The choice of the most appropriate vessel sealing system relies on each surgeon’s preferences, and as such, it is not a matter of debate in the present manual. Conversely, the BISLERI retractor offers the added benefit that it can be combined with different vessel sealing systems: to date, the BISLERI retractor has been safely and effectively used in combination with the following devices:

- RoBi³ Forceps and Metzenbaum Scissors (KARL STORZ, Germany)
- EnSeal™ endoscopic forceps (SurgRx®, Ethicon Endo-Surgery, USA)
- Starion endoscopic forceps (Starion Instruments, USA)
- Harmonic Scalpel / Ultracision (Ethicon Endosurgery, USA)

Moreover, considering that the existing armamentarium will be expanded by additional similar (in terms of dimensions) new devices, the BISLERI retractor stands a good chance of being used in conjunction with such tools.

**Patient Selection**

Endoscopic Radial Artery Harvesting can be performed in virtually all patients scheduled for Coronary Artery Bypass Grafting (CABG) surgery and selected for use of the radial artery.

Nevertheless, a careful selection of such candidates is strongly recommended during the initial phase (i.e. at the beginning of the learning curve) of the ERAH program, in order to avoid unnecessary discouragement and frustration of those surgeons involved in the endoscopic approach. It is particularly advisable to avoid patients with overdeveloped forearm (muscles or fat) at the beginning, unless the surgeon has already a consistent background in endoscopic procedures (preferably in endoscopic vein harvesting). Once the surgeon has completed the learning curve (usually 20 cases are the average required to reach the “plateau phase”), more heterogeneous patients could be included in the ERAH program.
**Arm Preparation**

A schematic overview of the OR setting during endoscopic harvesting of the radial artery is depicted below (Fig. 7).

The upper extremity (usually the non-dominant arm) is prepped, draped and placed on an arm board perpendicular to the long axis of the operating table. The arm needs to be secured to the arm board (e.g. using adhesive tapes or towel clips) in order to provide an adequate setting for ERAH, especially in the initial steps. Moreover, a rolled pad below the wrist (allowing extension of the wrist) is fundamental to achieve a proper positioning of the forearm during ERAH, otherwise it will be extremely cumbersome to manoeuvre the BISLERI retractor and the vessel sealing system during the procedure (Fig. 7a).

Worthy of note, no tourniquet around the arm is used, as reported by other authors using different systems for ERAH: in fact, the pulsations of the radial artery can provide an important landmark especially in difficult cases when a clear and direct visualization of the radial artery cannot be achieved.

---

**Procedural Steps**

Operating room set-up and patient positioning during ERAH. It is of crucial importance that a rolled pad be placed below the wrist to establish a proper placement of the forearm, a preparatory measure that considerably facilitates maneuvering the BISLERI retractor and the vessel sealing system (a).
The very first step of ERAH is the exposure of the radial artery through an incision placed in the distal side, at the level of the wrist: this part of the procedure plays an essential role in preparation for the following “endoscopic” phase; therefore, the operating surgeon should exercise great care while performing this step to allow a simpler endoscopic step afterwards.

A 2- to 2.5-cm longitudinal incision of the volar surface of the forearm is performed beginning 1 cm proximal to the radial styloid prominence (Figs. 8, 9). The subcutaneous tissues are incised first. Next, the fascia between the brachioradialis and the flexor carpi radialis muscles is divided, and the radial artery is identified. Care is taken to separate the radial artery from the superficial radial nerve, which is one of the two nerves at risk during radial artery harvest.

The radial artery is harvested as a pedicled graft. According to our protocol, the RA is first dissected from the surrounding tissues under direct vision with the aid of a vessel sealing system (Fig. 10). In the next steps of the procedure the endoscopic instruments should be advanced into the forearm for at least 3–4 cm. It is therefore highly advisable that dissection under direct vision be extended as proximally as possible (i.e., 3–4 cm) while lifting the self-retaining retractor. If this preliminary measure does not produce the anticipated effect, endoscopic-guided dissection of the distal part of the radial artery can become extremely cumbersome.
Fascia Opening

Once enough space has been created, the BISLERI Radial Artery Retractor and the vessel sealing system are advanced (Fig. 11) which allows the fascia between the brachioradialis and the flexor carpi muscles to be divided up to the antecubital fossa (Fig. 12). It is important to keep to a dissection plane immediately above the fascia and thus prevent any muscular structure from being divided (in particular the brachioradialis muscle) in an attempt to improve visualization of the radial artery. In fact, even in difficult cases, the BISLERI retractor can be advanced below muscular structures and the “tunnel-shaped” design allows to continue ERAH with enough comfort for the surgeon.

Dissection of the Brachioradialis Side of the Radial Artery

The radial artery is then dissected off from side branches and the surrounding tissues on the brachioradialis side first (Fig. 13), otherwise the radial artery may become difficult to visualize as it can be obscured by the overlying brachioradialis muscle. Conversely, preserving the side branches and tissues on the flexor carpi radialis side pulls the radial artery towards the midline.
Step V

**Dissection of the Flexor Carpi Side of the Radial Artery**

Similarly to the brachioradialis side, the flexor carpi side of the radial artery is dissected free up to the antecubital fossa (Fig. 14).

At any stage, either on the brachioradialis or flexor carpi side of the radial artery an inadvertent injury of a side branch may occur. In most of such instances, the injury is minor albeit the endoscopic view seems to magnify the amount of bleeding. It is therefore recommended either to remove the BISLERI Radial Artery Retractor with the coupled vessel sealing system from the forearm and perform compression from the outside. After a few minutes, bleeding usually resolves spontaneously; nevertheless, in those instances, once the radial artery is outside the forearm, it should be assessed in order to rule out potentially leaking side branches.

Step VI

**Dissection of the Inferior Side of the Radial Artery**

As the final step in the dissection of the radial artery from surrounding tissues, any residual side branches on the inferior aspect are divided (Fig. 15).

Step VII

**Assessment of Residual Side Branches**

Once the dissection has been completed, the hook-shaped artery dissector is used to confirm the absence of any residual side branches (Fig. 16).

The flexor carpi side of the radial artery is dissected free.

Dissection of the radial artery from surrounding tissues is completed by dividing any residual side branches on the inferior aspect.

Absence of any residual side branches is confirmed by use of a hook-shaped artery dissector.
**Endoscopic Radial Artery Harvesting**

**Proximal Incision of the Forearm**

Finally, an additional 1.5-cm incision is performed near the antecubital space for proximal ligation (Fig. 17). A blunt tissue dissection is carried out under endoscopic control, using the tip of the dissector as a landmark (Figs. 18, 19). A tape is then looped around the radial artery and secured in a tourniquet, in case a residual side branch has been missed during final assessment (cf. step VII). This preventive step is to make sure that, once the radial artery has been divided distally following heparinization (prior to extraction from the forearm) division of any tissue remnant via the endoscopic route is still an available option. In such instance, the tourniquet can be snared down allowing to complete the residual tissue dissection.

**Division of the Radial Artery**

The radial artery is removed via the proximal incision (at the level of the antecubital fossa) and clipped at the distal end. The harvested graft is wrapped in prewarmed papaverine-soaked gauze outside the forearm, thus maintaining the radial artery perfused as much as possible. In case of need, the radial artery can be ligated proximally by means of an endoloop through the single, distal incision (Fig. 20).
Conclusions

The growing popularity of endoscopic venous conduit harvest for CABG has led to the modification of this technique in order to harvest the radial artery via the endoscopic approach as well. Such a procedure can be completed with the simple use of two instruments, the BISLERI Endoscopic Radial Artery Retractor and a vessel sealing system. The use of the endoscopic approach for radial artery harvesting offers several advantages when compared to the open technique in terms of less neurological complications, wound complications, wound infections, hematomas, and improved aesthetics\(^5,11\), findings similar to those reported previously by other authors. The advantages in terms of reduced neurological injuries are mostly related to the careful dissection of the distal part of the radial artery (which minimizes the trauma to the superficial branch of the radial nerve) and to the avoidance of manipulation to the lateral cutaneous antebrachial nerve (running along the brachioradialis nerve), due to the different route (below the brachioradialis muscle). Moreover, this technique allows reduced trauma and manipulation of the radial artery itself during harvesting, which is an important contributing factor to long-term conduit patency, i.e. preservation of the arterial wall and the endothelial morphology and function (Table 1).

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<tr>
<th>TISSUE DISSECTION</th>
<th>OPEN TECHNIQUE</th>
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<td>LONGER closure time</td>
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<tr>
<td>MORE prone to spasm</td>
<td>LESS prone to spasm</td>
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Table 1
Finally, the endoscopic technique provides ample patient satisfaction, especially in terms of length of the surgical incision when compared to the conventional approach. In patients with a normal postoperative course, the surgical scars are completely healed after 15 days with excellent aesthetic results. (Fig. 21)

The clinical experience with the BISLERI Endoscopic Radial Artery Retractor proved that this novel tool allowed endoscopic radial artery harvesting even in the most difficult cases (i.e. patients with a considerable amount of fat tissue in the subcutaneous layers or with a well-developed muscular forearm). Endoscopic radial artery harvesting can be performed concomitant to left internal mammary artery preparation, with a mean procedural time of 25–30 minutes, when performed by trained surgeons.

The BISLERI Endoscopic Radial Artery Retractor offers enhanced distension of the surrounding structures (due to the tunnel-shaped design of the device), improved positioning of the endoscopic instruments (once the vessel sealing system is inside the “tunnel”, virtually no conflict with surrounding tissues has been detected, moreover the vessel sealing system always sits parallel to the radial artery, which minimizes the risk of inadvertent injury to the vessel during harvesting), less smoke production (the additional channel allows either to connect a suction device or employ low-flow carbon dioxide insufflation to clear the operative field from any excessive smoke produced during the use of the vessel sealing system. Finally, the previously outlined design features of the device provide improved comfort for the surgeon during the endoscopic harvesting of the radial artery.

As an increasing number of novel technologies for vessel sealing are becoming available on the market, it is the surgeon's choice which preferred energy source or system will be used along with the BISLERI Endoscopic Radial Artery Retractor. In conclusion, this novel tool offers a unique improved design for endoscopic radial artery harvesting and is extremely cost-effective (in that it allows the combined use of reusable instruments with disposable devices), thus meeting a definite demand in the field of minimally invasive conduit harvesting.

Fifteen days after surgery, the scars are usually completely healed with excellent aesthetic results.
References


Recommended Instrument Set for Endoscopic Radial Artery Harvesting
Instruments for Endoscopic Radial Artery Harvesting

49205 FCZ  BISLERI Endoscopic Artery Retractor, for harvesting of the Arteria radialis, distal width 20 mm, working length 27.5 cm, with integrated U-shaped instrument guide and channel for smoke evacuation, with integrated routing of the fiber optic light cable inside the handle, autoclavable, for use with HOPKINS\textsuperscript{®} telescope 49205 FA, including cleaning adaptor 49205 FZ.

49205 FA  HOPKINS\textsuperscript{®} Forward Oblique Telescope 45\textdegree, diameter 5 mm, length 29 cm, autoclavable, fiber optic light transmission incorporated, color code: black.

Adaptor for Cleaning, for use with Endoscopic Vein Retractor, FREIBURG Model 49205 FB and BISLERI Endoscopic Artery Retractor 49205 FC.

49201 VR  Artery Dissector, blunt, distal end curved to right, size 3 mm, working length 41 cm.

49201 VL  Artery Dissector, blunt, distal end curved to left, size 3 mm, working length 41 cm.
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  - Outer sheath
  - Working insert
- Cleaning port
- Autoclavable

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28147 HH  **GILBERT Hand Holder,** for the fixation of the hand during carpal ligament release
Additional Surgical Instrumentation

220211 PLESTER Retractor,  
2x 2 teeth, length 11 cm

208000 Surgical Handle,  
Fig. 3, length 12.5 cm,  
for Blades 208010 – 19, 208210 – 19

208010 Blade,  
Fig. 10, non-sterile, package of 100

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length 16 cm

792071 TOENNIS Dissecting Scissors,  
fine model, straight, blunt/blunt,  
length 18 cm
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<table>
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<th>Part Number</th>
<th>Description</th>
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<tr>
<td>20 0430 01-020</td>
<td>TELE PACK™ Control Unit</td>
</tr>
<tr>
<td>20 2120 30</td>
<td>TELECAM® 1-Chip Camera Head with Parfocal-Zoom Lens, focal length f = 25 – 50 mm</td>
</tr>
<tr>
<td>400 A</td>
<td>Mains Cord</td>
</tr>
<tr>
<td>20 0410 32</td>
<td>PCMCIA Memory Card, 64 MB</td>
</tr>
<tr>
<td>536 MK</td>
<td>BNC-Connecting Cable, length 180 cm</td>
</tr>
<tr>
<td>547 S</td>
<td>S-Video (Y/C) Connecting Cable, length 180 cm</td>
</tr>
</tbody>
</table>

**TELE PACK™ Set, Color Systems PAL/NTSC**

<table>
<thead>
<tr>
<th>TELE PACK™ Set, Color Systems PAL/NTSC</th>
<th>TELE PACK™ Control Unit with Integrated Digital Image Processing Module</th>
<th>TELECAM® Parfocal Zoom Lens Camera Head</th>
<th>TELECAM® C-MOUNT Camera Head</th>
<th>C-MOUNT Lens, f = 30 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 0430 01-020 PAL 20 0431 01-020 NTSC</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>20 0430 02-020 PAL 20 0431 02-020 NTSC</td>
<td></td>
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<td></td>
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</table>

<table>
<thead>
<tr>
<th>TELE PACK™</th>
<th>Camera Head</th>
</tr>
</thead>
<tbody>
<tr>
<td>TELE PACK™ 20 0430 01-020 PAL 20 0431 01-020 NTSC</td>
<td>●</td>
</tr>
<tr>
<td>TELE PACK™ 20 0430 02-020 PAL 20 0431 02-020 NTSC</td>
<td>●</td>
</tr>
</tbody>
</table>
Genuine FULL HD (High Definition) is guaranteed by a maximum resolution and the consistent use of the native 16:9 aspect ratio throughout the entire image chain, from image capture, signal transmission to display.

HD-compatible endoscopic video camera systems must be equipped with three-CCD chips supporting the 16:9 input format and require that image capture is performed at a resolution of 1920 x 1080 pixels.

The benefits of FULL HD (High Definition) for medical applications are:

- 6 times higher input resolution of the camera delivers more detail and depth of field
- Using 16:9 format during image acquisition enlarges the field of view
- The 16:9/16:10 format of the widescreen monitor supports ergonomic viewing
- Enhanced color brilliance for optimal diagnosis
- Progressive scan technology provides a steady, flicker-free display and helps eliminate eyestrain and fatigue.

for use with IMAGE 1™ HD and standard one- and three-chip camera heads, max. resolution 1920 x 1080 Pixels, with integrated KARL STORZ-SCB® and integrated digital Image Processing Module, color systems PAL/NTSC, power supply 100 – 240 VAC, 50/60 Hz

consisting of:

- IMAGE 1 HUB™ HD Camera Control Unit SCB, with SDI module
- 400 A Mains Cord
- 400 B Mains Cord, US-version
- 3 x 536 MK BNC/BNC Video Cable, length 180 cm
- 547 S S-Video (Y/C) Connecting Cable, length 180 cm
- 20 2032 70 Special RGBS Connecting Cable, length 180 cm
- 2x 20 2210 70 Connecting Cable, for controlling peripheral units, length 180 cm
- 20 0400 89 DVI-D Connecting Cable, length 300 cm
- 20 0901 70 SCB Connecting Cable, length 100 cm
- 20 2002 31 U Keyboard, with US English character set

Specifications:

<table>
<thead>
<tr>
<th>Signal-to-noise Ratio</th>
<th>AGC</th>
<th>Video Output</th>
<th>Input</th>
</tr>
</thead>
</table>
| IMAGE 1 HUB™ HD       | Microprocessor-controlled | - Composite signal to BNC socket  
- S-Video signal to 4-pin Mini-DIN socket (2x)  
- RGBS signal to D-Sub socket  
- SDI signal to BNC socket (only) IMAGE 1 HUB™ HD with SDI module (2x)  
- HD signal to DVI-D socket (2x) | Keyboard for title generator, 5-pin DIN socket |

<table>
<thead>
<tr>
<th>Control Output /Input</th>
<th>Dimensions w x h x d (mm)</th>
<th>Weight (kg)</th>
<th>Power supply</th>
<th>Certified to:</th>
</tr>
</thead>
</table>
| - KARL STORZ-SCB® at 6-pin Mini-DIN socket (2x)  
- 3.5 mm stereo jack plug (ACC 1, ACC 2),  
- Serial port at RJ-11 | 305 x 89 x 335 | 2.95 | 100-240 VAC, 50/60 Hz | IEC 601-1, 601-2-18, CSA 22.2 No. 601, UL 2601-1 and CE acc. to MDD, protection class 1/CF |
Endoscopic Radial Artery Harvesting

IMAGE 1 HUB™ HD
HD Camera Head

22220055-3

22220055-3 50 Hz 60 Hz IMAGE 1™ H3-Z Three-Chip HD Camera Head

- max. resolution 1920 x 1080 pixels, progressive scan, soakable, gas-sterilizable, with integrated Parfocal Zoom Lens,
- focal length f = 15 – 31 mm (2x),
- 2 freely programmable camera head buttons

Specifications:

<table>
<thead>
<tr>
<th>IMAGE 1™ HD Camera Heads</th>
<th>H3-Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 Hz/60 Hz</td>
<td>22220055-3 (PAL/NTSC) (50/60 Hz)</td>
</tr>
<tr>
<td>Image Sensor</td>
<td>3x 1/3&quot; CCD chip</td>
</tr>
<tr>
<td>Pixel Output Signal H x V</td>
<td>1920 x 1080</td>
</tr>
<tr>
<td>Dimensions</td>
<td>Diameter 32-44 mm, length 114 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>246 g</td>
</tr>
<tr>
<td>Min. Sensitivity</td>
<td>F 1.4/1.17 Lux</td>
</tr>
<tr>
<td>Lens</td>
<td>Integrated Parfocal Zoom Lens, f = 15-31 mm</td>
</tr>
<tr>
<td>Grip Mechanism</td>
<td>Standard eyepiece adaptor</td>
</tr>
<tr>
<td>Cable</td>
<td>non-detachable</td>
</tr>
<tr>
<td>Cable Length</td>
<td>300 cm</td>
</tr>
</tbody>
</table>

Standard IMAGE 1™ camera heads may also be used with the IMAGE 1 HUB™ HD camera control unit.
### IMAGE 1 HUB™ HD HD Monitors

![HD Monitors Image](image1.png)

<table>
<thead>
<tr>
<th>KARL STORZ HD Flat Screens</th>
<th>24&quot;</th>
<th>26&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desktop with pedestal</td>
<td>9524 N</td>
<td>9524 NO</td>
</tr>
<tr>
<td>Wall mounted with VESA 100-adaption</td>
<td>9524 NB</td>
<td>9524 NBO</td>
</tr>
</tbody>
</table>

**Inputs:**
- SDI
- HD-SDI
- RGBS
- S-Video
- Composite
- SOG
- DVI-D
- Fiber Optic
- VGA

**Specifications:**

<table>
<thead>
<tr>
<th>KARL STORZ HD Flat Screens</th>
<th>24&quot;</th>
<th>26&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desktop with pedestal</td>
<td>9524 N/NO</td>
<td>9526 N/NO</td>
</tr>
<tr>
<td>Wall mounted with VESA 100-adaption</td>
<td>9524 NB/NBO</td>
<td>9526 NB/NBO</td>
</tr>
<tr>
<td>Brightness</td>
<td>400 cd/m²</td>
<td>500 cd/m²</td>
</tr>
<tr>
<td>Max. Viewing Angle</td>
<td>178° vertical</td>
<td>178° vertical</td>
</tr>
<tr>
<td>Pixel Distance</td>
<td>0.270 mm</td>
<td>0.287 mm</td>
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<tr>
<td>Reaction Time</td>
<td>5-12 ms</td>
<td>5-12 ms</td>
</tr>
<tr>
<td>Contrast Ratio</td>
<td>1000:1</td>
<td>800:1</td>
</tr>
<tr>
<td>Adaption</td>
<td>100 mm VESA</td>
<td>100 mm VESA</td>
</tr>
<tr>
<td>Weight</td>
<td>7.3 kg</td>
<td>8.2 kg</td>
</tr>
<tr>
<td>Rated Power</td>
<td>115 Watt</td>
<td>115 Watt</td>
</tr>
<tr>
<td>Operating Conditions</td>
<td>0-40 °C</td>
<td>0-40 °C</td>
</tr>
<tr>
<td>Storage</td>
<td>-20-60 °C</td>
<td>-20-60 °C</td>
</tr>
<tr>
<td>Rel. Humidity</td>
<td>20-85%, non-condensing</td>
<td>20-85%, non-condensing</td>
</tr>
<tr>
<td>Dimensions in w x h x d</td>
<td>597 x 401 x 100 mm</td>
<td>627 x 427 x 100 mm</td>
</tr>
<tr>
<td>Power Supply</td>
<td>100-240 VAC</td>
<td>100-240 VAC</td>
</tr>
<tr>
<td>Certified to</td>
<td>EN 60601-1, protection class IPX1</td>
<td>EN 60601-1, protection class IPX1</td>
</tr>
</tbody>
</table>
**IMAGE 1 HUB™ HD**
HD and TFT Flat Screens

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>9524 NO</td>
<td>24&quot; KARL STORZ HD Flat Screen</td>
<td>Desktop with pedestal, color systems PAL/NTSC, max. screen resolution 1920 x 1200, image format 16:10, power supply 100 – 240 VAC, 50/60 Hz</td>
</tr>
<tr>
<td>9524 N</td>
<td>24&quot; KARL STORZ HD Flat Screen</td>
<td>Desktop with pedestal, color systems PAL/NTSC, max. screen resolution 1920 x 1200, image format 16:10, power supply 100 – 240 VAC, 50/60 Hz</td>
</tr>
<tr>
<td>9526 NO</td>
<td>26&quot; KARL STORZ HD Flat Screen</td>
<td>Desktop with pedestal, color systems PAL/NTSC, max. screen resolution 1920 x 1200, image format 16:10, power supply 100 – 240 VAC, 50/60 Hz</td>
</tr>
<tr>
<td>9526 N</td>
<td>26&quot; KARL STORZ HD Flat Screen</td>
<td>Desktop with pedestal, color systems PAL/NTSC, max. screen resolution 1920 x 1200, image format 16:10, power supply 100 – 240 VAC, 50/60 Hz</td>
</tr>
</tbody>
</table>

**Wall mounted with VESA 100-adaption,**

**Color systems PAL/NTSC,**

**Max. screen resolution 1920 x 1200,**

**Image format 16:10,**

**Power supply 100 – 240 VAC, 50/60 Hz**

**Consisting of:**

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>9524 NBO</td>
<td>24&quot; HD Flat Screen</td>
<td></td>
</tr>
<tr>
<td>9419 NSF</td>
<td>Pedestal</td>
<td></td>
</tr>
<tr>
<td>9526 NBO</td>
<td>26&quot; HD Flat Screen</td>
<td></td>
</tr>
<tr>
<td>9526 NBO</td>
<td>Pedestal</td>
<td></td>
</tr>
</tbody>
</table>

**External 24VDC Power Supply 400 A Mains Cord**

**Signal cables:** S-Video, BNC, SXGA, DVI-D

**24" KARL STORZ HD Flat Screen**

**Desktop with pedestal,**

**Color systems PAL/NTSC,**

**Max. screen resolution 1920 x 1200,**

**Image format 16:10,**

**Power supply 100 – 240 VAC,**

**50/60 Hz**

**Consisting of:**

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<thead>
<tr>
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<th>Components</th>
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</thead>
<tbody>
<tr>
<td>9524 NGO</td>
<td>24&quot; HD Flat Screen</td>
<td></td>
</tr>
<tr>
<td>9523 PS</td>
<td>External 24VDC Power Supply</td>
<td></td>
</tr>
<tr>
<td>400 A</td>
<td>Mains Cord</td>
<td></td>
</tr>
</tbody>
</table>

**Signal cables:** S-Video, BNC, SXGA, DVI-D

**24" KARL STORZ HD Flat Screen**

**Wall mounted with VESA 100-adaption,**

**Color systems PAL/NTSC,**

**Max. screen resolution 1920 x 1200,**

**Image format 16:10,**

**Power supply 100 – 240 VAC, 50/60 Hz**

**Consisting of:**

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<tbody>
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</tr>
<tr>
<td>9523 PS</td>
<td>External 24VDC Power Supply</td>
<td></td>
</tr>
<tr>
<td>400 A</td>
<td>Mains Cord</td>
<td></td>
</tr>
</tbody>
</table>

**Signal cables:** S-Video, BNC, SXGA, DVI-D

**26" KARL STORZ HD Flat Screen**

**Wall mounted with VESA 100-adaption,**

**Color systems PAL/NTSC,**

**Max. screen resolution 1920 x 1200,**

**Image format 16:10,**

**Power supply 100 – 240 VAC, 50/60 Hz**

**Consisting of:**

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<thead>
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</tr>
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<td>400 A</td>
<td>Mains Cord</td>
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**Signal cables:** S-Video, BNC, SXGA, DVI-D

**26" KARL STORZ HD Flat Screen**

**Wall mounted with VESA 100-adaption,**

**Color systems PAL/NTSC,**

**Max. screen resolution 1920 x 1200,**

**Image format 16:10,**

**Power supply 100 – 240 VAC, 50/60 Hz**

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</tr>
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<td>9523 PS</td>
<td>External 24VDC Power Supply</td>
<td></td>
</tr>
<tr>
<td>400 A</td>
<td>Mains Cord</td>
<td></td>
</tr>
</tbody>
</table>

**Signal cables:** S-Video, BNC, SXGA, DVI-D
Cold Light Fountain XENON 300®

20133101-1 Cold Light Fountain XENON 300® with built-in antifog air-pump, and integrated KARL STORZ Communication Bus System® power supply:
100–125 VAC/220–240 VAC, 50/60 Hz
including:
400 A Mains Cord
610 AFT Silicone Tubing Set, autoclavable, length 250 cm
20 0901 70® Connecting Cord, length 100 cm

20133027 Spare Lamp Module XENON with heat sink, 300 watt, 15 volt

20133028 XENON Spare Lamp, only, 300 watt, 15 volt

Fiber Optic Light Cable

495 NA Fiber Optic Light Cable, with straight connector, diameter 3.5 mm, length 230 cm

495 ND Same, length 300 cm

Electronic ENDOFLATOR®

264305 08-1 Electronic ENDOFLATOR® Set® operating voltage: 100-240 VAC, 50/60 Hz
consisting of:
26 430520-1 Electronic Endoflator, with integrated SCB® Module
400 A Mains Cord
20 400143 Silicone tube, sterilizable
20 400030 Universal wrench
20 090170 SCB Connecting cable
Sterile filter, Package of 10 piece

Subject to the customer's application-specific requirements additional accessories are available on request.

Please note: For fully utilizing maximum insufflation capacity of the Electronic THERMOFLATOR® SCB® and the Electronic ENDOFLATOR® the use of KARL STORZ HiCap® Trocars is recommended. For additional information see catalog LAPAROSCOPY.
Data Management and Documentation
KARL STORZ AIDA® compact NEO (HD/SD)
Brilliance in documentation continues!

AIDA compact NEO from KARL STORZ combines all the required functions for integrated and precise documentation of endoscopic procedures and open surgeries in a single system.

Data Acquisition
Still images, video sequences and audio comments can be recorded easily during an examination or intervention on command by either pressing the on screen button, voice control, foot switch or pressing the camera head button. All captured images will be displayed on the right hand side as a “thumbnail” preview to ensure the still image has been generated.

The patient data can be entered by the on-screen keyboard or by a standard keyboard.

Flexible post editing and data storage
Captured still images or video files can be previewed before final storage or can be edited and deleted easily in the edit screen.

Reliable storage of data
- Digital saving of all image, video and audio files on DVD, CD-ROM, USB stick, external/internal hard-drive or to the central hospital storage possibilities over DICOM/HL7
- Buffering ensures data backup if saving is temporarily not possible
- Continuous availability of created image, video and sound material for procedure documentation and for research and teaching purposes.

Efficient data archiving
After a procedure has been completed, KARL STORZ AIDA® compact HD/SD saves all captured data efficiently on DVD, CD-ROM, USB stick, external hard-drive, internal hard-drive and/or the respective network on the FTP server. Furthermore the possibility exists to store the data directly on the PACS respective HIS server, over the interface package AIDA communication HL7/DICOM.

Data that could not be archived successfully remains in a special buffered procedure until it is finally saved. A two-line report header and a logo can be used by the user to meet his or her needs.

Multisession and Multipatient
Efficient data archiving is assured as several treatments can be saved on a DVD, CD-ROM or a USB stick.
Features and Benefits:
- Digital storage of still images with a resolution of 1920 x 1080 pixels, video sequences in 720p and audio files with AIDA compact NEO HD
- Optional interface package DICOM/HL7
- Sterile, ergonomic operation via touch screen, voice control, camera head buttons and/or foot switches
- Auto detection of the connected camera system on HD-SDI/SD-SDI input
- Efficient archiving on DVD, CD-ROM or USB stick, multi-session and multi-patient
- Network saving
- Automatic generation of standard reports
- Approved use of computers and monitors in the OR environment as per EN 60601-1
- Compatibility with the KARL STORZ Communication Bus (SCB) and with the KARL STORZ OR1™ AV NEO
- KARL STORZ AIDA® compact NEO HD/SD is an attractive, digital alternative to video printers, video recorders and dictaphones.

20040910 KARL STORZ AIDA® compact NEO SD
Communication, documentation system for digital storage of still images, video sequences and audio files, power supply 115/230 VAC, 50/60 Hz

20040911 KARL STORZ AIDA® compact NEO HD
Communication, documentation system for digital storage of still images, video sequences and audio files, power supply 115/230 VAC, 50/60 Hz

20040610 KARL STORZ AIDA® compact NEO SD,
documentation system for digital storage of still images, video sequences and audio files, power supply 115/230 VAC, 50/60 Hz

20040611 KARL STORZ AIDA® compact NEO HD,
documentation system for digital storage of still images, video sequences and audio files, power supply 115/230 VAC, 50/60 Hz

Specifications:

<table>
<thead>
<tr>
<th>Video Systems</th>
<th>Signal Inputs</th>
<th>Image Formats</th>
</tr>
</thead>
<tbody>
<tr>
<td>- PAL</td>
<td>- S-Video (Y/C)</td>
<td>- JPG</td>
</tr>
<tr>
<td>- NTSC</td>
<td>- Composite</td>
<td>- BMP</td>
</tr>
<tr>
<td></td>
<td>- RGBS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- SDI</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- HD-SDI</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- DVI</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Video Formats</th>
<th>Audio Formats</th>
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</thead>
<tbody>
<tr>
<td>- MPEG2</td>
<td>- WAV</td>
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<table>
<thead>
<tr>
<th>Storage Media</th>
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</thead>
<tbody>
<tr>
<td>- DVD+R</td>
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<td>- DVD+RW</td>
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<tr>
<td>- DVD-R</td>
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<td>- DVD-RW</td>
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<td>- CD-R</td>
</tr>
<tr>
<td>- CD-RW</td>
</tr>
<tr>
<td>- USB stick</td>
</tr>
</tbody>
</table>
AUTOCON® II 400

**20 5352 01-11x AUTOCON® II 400** consisting of:
- **20 5352 20-11x AUTOCON® II 400** with **KARL STORZ®**
  - Power supply 230 VAC, 50/60 Hz
  - 400 A Mains Cord
  - **20 090170 AUTOCON® II 400 Connecting Cable,** length 100 cm

**20 5352 01-115 AUTOCON® II 400 High-End,**
- Power supply 230 VAC, 50/60 Hz
- HF connecting sockets:
  - 2x bipolar standard, bipolar multifunction, unipolar 3-pin and Erbe, neutral electrode
  - 6.3 mm jack, system requirements:
- SCB R-UI Software Release 2009001-26,

**20 5352 20-115 AUTOCON® II 400**, with **KARL STORZ®**
- 400 A Mains Cord
- **20 090170 AUTOCON® II 400 Connecting Cable,** length 100 cm

Equipment Cart

**29005 LAP Equipment Cart,**
- Rides on 4 antistatic dual wheels, 2 equipped with locking brakes,
- 3 fixed shelves, one with handles, main switch at vertical beam, integrated cable conduits in vertical beams, drawer unit with lock, 3 horizontal cable conduits, one with cable winding, two with 4-times electrical sub-distributor,
- 1 set of non-sliding stands for units,
- 1 TFT-Monitor arm (VESA 75/100), 1 camera holder, 8 power cords (50 cm), 2 power cords (2 m), 2 equipment rails,
- 1 CO2-bottle holder, max. diameter 155 mm, Isolation transformer 230 VAC (50/60 Hz) with 8 sockets and earth potential and earth leakage monitor (2000 VA),

**Dimensions:**
- Videocart 730 x 1470 x 716 mm (w x h x d), shelf: 630 x 480 mm (w x d), caster diameter: 150 mm

**29005 SZ TFT-Monitor arm,** height and side adjustable, can be positioned at left/right side, rotatable and inclinable, turning radius approx. 180°, load capacity max. 14 kg, swivel length 600 mm, VESA 75/100-adaption, for mobile videocart, model 29005LAP/GU and 29003NE/NA
Notes:
Notes: