

Medical Technology

Surgical Power Tools: Reliable Helpers in Routine Clinical Practice

Applications – State-of-the-art – Outlook

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It is hard to imagine modern operating rooms without surgical power tools. This White Paper examines the range of applications of these reliable helpers, considers the essential characteristics of power tools, and explores where they might be headed in the future.

Hospital applications

Many surgical procedures these days rely on power tools. They have become essential routine equipment in most hospitals and private practices. Numerous disciplines from orthopedics and arthroscopy to ENT, gynecology, and urology rely on surgical power tools. Most often they are used to resect tissue, shape bone and place implants. Depending on the application and use, power tools differ in their







system architecture and nomenclature. The following table provides examples of power tool applications, including system architecture, in various specialties.

Benefits for physicians and patients

A good power tool offers benefits for both medical team and patients:

- 1 Shorter treatment time and length of hospital stay
- 2 Increased patient safety
- 3 Reduced invasiveness
- 4 Better esthetic outcomes



Discipline	Procedure (examples)	Handpiece designation	Architecture and special characteristics
ENT	 Adenoidectomy / polypectomy	Shaver / debrider	Console with user interface, control and interconnection between pump, foot pedal and handpiece. The motor is usually integrated in the handpiece. The handpiece contains a suction and irrigation channel with ports for the suction and irrigation pump, respectively.
Gynecology	 Resection of intrauterine polyps and leiomyomas	Morcellator	Console with user interface, controller, and interconnection between pump, foot pedal and handpiece. As a rule, there is only a suction channel and no irrigation channel. The console is supplied with reusable or single-use handpieces (sterilized or ready for processing).
Arthroscopy	 Resection of soft tissue and bone	Arthroscopy shaver	Console with user interface, control and interconnection between pump, foot pedal and handpiece. The motor is usually integrated in the handpiece. Incorporated in the handpiece is a suction channel with adjustable flow rate. The irrigation pump is not normally integrated into the control console.
Orthopedics	 Bone shaping	Power Tool	Handpiece with integrated, usually battery-operated motor and with various instruments mounted via appropriate attachments (e.g., sagittal saw, Jacobs chuck for drill bits, K-wire).
Dentistry	 Root canal and bone drilling, implant placement and removal	Straight and angled handpiece	Console with user interface, controller, and interconnection between pump, foot pedal, and straight and angled handpiece. The handpiece comprises a separate motor and attachment, usually offset by 30°. There is a whole range of angled handpieces for various applications differing in speed, maximum torque and drive type.
Neuro and spine surgery	 Craniotomy, bone shaping around the spinal canal	High-speed handpiece	Console with user interface, controller, and interconnection between foot pedal and handpiece. The handpiece comprises a separate motor and attachment, usually offset by 30°. Handpieces for neuro and spine surgery work with speeds up to 100,000 rpm, removing bone tissue with high precision.

Requirements and quality characteristics

As with surgical procedures in general, surgical power tools require a high degree of precision and reliability. For healthcare professionals in surgery user friendliness and performance rest in part on the following features:

The following additional features are particularly important for other stakeholders in surgery, such as hospital and support staff:



- 1** Ergonomic low weight handpiece
- 2** High degree of controllability thanks to low lag time and responsive interaction between the foot pedal and tool
- 3** Minimal backlash between handpiece and tool
- 4** Minimal heat build-up in the motor
- 5** Smooth running motor

- 1** Robustness and excellent suitability for processing with common cleaning and sterilization techniques
- 2** Minimal maintenance effort and good service by the manufacturer
- 3** Wide range of possible applications – e.g., tool reuse in multiple procedures
- 4** Attractive cost-benefit ratio
- 5** User-friendly console interface



The solutions seasoned development teams can deliver

Engineers have recognized these requirements and responded to them with a wide range of solutions. For example, specialized teams of developers already make it possible to design sophisticated power tools for many different applications. Engineers break down these requirements into a number of technical challenges, including speed control, torque control, processing, system integration, user interface, and connectivity. Successful implementation of product development projects requires in-depth knowledge of and experience in mechatronics, electronics and software engineering.

Speed control

Power tools in ENT, gynecology and arthroscopy commonly resect soft tissue with shavers oscillating at frequencies of 300 to 10,000 rpm. High-precision applications in bone surgery, on the other hand, require drilling speeds in the 0 to 80,000 rpm range.

Torque control

In orthopedics and implant dentistry, where high torque is needed even at low speeds, a torque of 0 to 80 Ncm is common and required, for example, for tapping threads and screwing in implants.

Cleaning and processing

Handpieces are generally designed to withstand several hundred cycles of the common processing modalities employed in hospitals and private practices, such as Sterrad®, autoclave and thermal washer disinfectant. Hygiene and patient safety rest on the ability of tool processing.

System integration

The controller unit and handpiece work exceptionally well together and are matched to each other already in the development stage. The console automatically detects the connected handpiece and uses this information to set the appropriate torque and speed for the application, providing an additional safety function.

User interface

Ergonomic operation is at the core of the user interface. The console graphics display and the function keys on the handpiece allow intuitive and function-optimized operation in all applications, something that is absolutely vital in critical situations.

Connectivity

Power tools can be connected to the local network or Wi Fi. Data acquired can be processed directly while complying with regulations for data protection and cybersecurity. Connection to existing manufacturer-specific OR systems is also possible.

Creating a successful product – industrialization & approval

Successfully launching a power tool involves not only challenging development work, but also professional industrialization. In particular, this includes expertise in core activities such as supply chain management, manufacturing and quality control.

- 1 Supply chain management:** The control console alone may contain components from up to 50 qualified suppliers worldwide. Securing and maintaining reliable supply chains requires the production partner to have the necessary expertise and professional infrastructure, along with a trained team and a modern warehouse management system.
- 2 Production:** Handpiece and console assembly and mounting require a high degree of attention to detail and experience. This is especially needed in identifying the most efficient workflow, thereby allowing the process to be scaled up quickly. Important conditions for this include the availability of qualified specialist staff in production, the number of ESD workstations, good supplier relationships, and availability of materials. The design transfer process is carried out under the direction of a team of production technicians and engineers highly experienced in technical matters.
- 3 Quality control:** Like all medical devices, surgical power tools must meet the most stringent quality requirements. To ensure patient safety, each component must pass all tests. Numerous parameters are tested, such as the seals on the handpiece, correct torque generation by the motor, and motor control functionality. The entire manufacturing process as well as the products themselves must demonstrate compliance with the stringent requirements of the Medical Device Regulation.

“One-stop shop” concept

Development, manufacturing and service by a single partner offers many benefits:

- Close cooperation between the development and production engineering teams, especially during prototyping
- Problems in production can already be anticipated and avoided during development
- Faster implementation of design and functional changes
- Intrinsic interest of the development team in realizing production-ready products
- Reduced effort to coordinate developers, producers, and distributors, saving time and money



Future developments

Technological progress also continues to gain momentum in everyday clinical practice including system efficiency and reliability. Technical advances in miniaturization allow even less invasive procedures, resulting in better treatment outcomes and shorter recovery times for patients. Surgical power tools of the future will also address the need for flexibility and versatility in the field of application - for example, through modular systems, intelligent data processing, and networking in the OR suite. In addition, surgical power tools are playing an increasingly important role in the rapidly growing field of surgical robotics.



Conclusion

Meeting the requirements of surgical power tools is a complex undertaking. On the technical side, current trends in robotics and data acquisition are creating new opportunities that will require expertise and resources in development. At the same time, manufacturing and approval processes for power tools are challenging for many manufacturers, not least owing to the strict approval regulations. Cooperating with an OEM partner leaves companies free to focus on marketing complete systems. This allows outsourcing for those parts of the tools requiring in-depth expertise, such as handpieces and control systems.



Outsourcing as our USP

As a full solution provider, Brütsch Elektronik AG offers you all-in-one expertise and professional project management from a single source. We develop and manufacture your products and also handle the service and after-sales support.

Please contact us if you want us to support you as outsourcing partner for your surgical power tool projects.

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