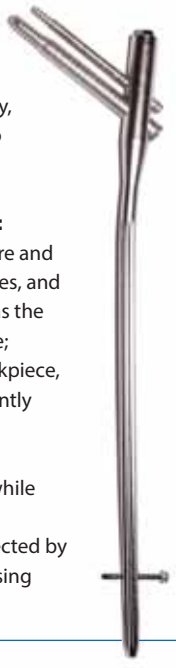
Deep-hole drilling in medical devices

Dr. Damiano Soprana, General Manager at GeneralMeccanica discusses how a market-niche machining process can create precise, high-quality, and reliable workpieces on hard-machining materials

Gundrilling is defined as a machining process that produces deep holes with length to diameter ratios greater than 10, but this ratio can grow up to 150. It is now employed to create workpieces of a wide range of materials, going from plastics, to metals, to carbon composites. Furthermore, it is used to make small and precise holes (i.e. 4mm hole diameter, 480mm total length, H8 hole tolerance) in hard machining materials (e.g., AISI 316, ISO 5832-1, 1.4441, 17-4 PH, AISI 420, Ti-6Al-4V) as required by the medical and biomedical fields to create specific devices, such as cannulated surgical nails and cannulated instruments. Cannulated instruments have elevated strength and hardness, high cutting resistance, and poor heat conductivity; all properties that result in a reduced drillability.

These machining processes have recently become more widely available due to the development and optimization of sophisticated technologies – essential to obtain the best precisions in small diameter holes, an improved drill life, higher productivity, and lower costs – this requires even higher rotational speeds and a correct balance of even higher pressures. The medical field is more demanding than others in terms of precision, reliability, repeatability, and quality, requiring a deep know-how and an ability to harness the newest technologies.



Gundrilling presents many complexities:

- the chip evacuation process becomes more and more important as the hole depth increases, and it is affected by several parameters, such as the coolant volume flow rate and the pressure;
- as drilling progresses deeper into the workpiece, the chip thickness increases. This significantly increases the drilling force required;
- the coolant hole configuration must be optimized to give the best performance while minimizing hydraulic pressure losses;
- the deep-hole long drill shaft can be deflected by lateral bending forces and vibrations, causing misalignments in machine spindles, intermediate supports, and pilot bushings, that compromise the hole straightness.

When gundrilling is applied to materials such as those required in the medical field, other factors need to be considered:

- the load transmitted from the boring-bar to the workpiece is stronger due to the materials' hardness, this drastic increase in the cutting load could rapidly degrade the overall cutting performance;
- the low heat conductivity of some particular steels and the high cutting force generated by drilling hard materials increase the heat generated at the drill tip, reducing significantly its durability and compromising its performance.

After deep-hole creation, it is mandatory to make detailed measurements to guarantee high precision and design tolerances that are more and more stringent. For this reason, specific measurement devices and solid measuring procedures are required.

GeneralMeccanica has been developing knowledge and experience with this particular machining process for more than 15 years. Our expertise is directed to meeting the unique demands of the medical field in the manufacture of trauma products using turning and milling technologies.

References

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