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Vi Drill Bits - Technical Paper

Improvements in design and manufacture made to drills available from Vi

Executive summary

As part of our drive to continue delivering the highest standards of product quality to the Animal Health industry, Vi has recently undertaken a project to improve the efficacy of our entire drill bit range.

Working with several Veterinary Surgeons. The project focused on several technical features which required refinement, ensuring the entire range advanced and delivered optimal drilling performance and bone dissection results for users.

The major design features which contribute the most to thermal generation when drilling include; rake angle, margin width, body clearance (thinning) (1), all of which are integral to Vi's drill design, along with the improved four faceted point design and clearance faces to the cutting edges. See Fig. 1; Photo of typical Vi drill bit demonstrating point features and Fig. 2; showing the twist drill nomenclature (2).

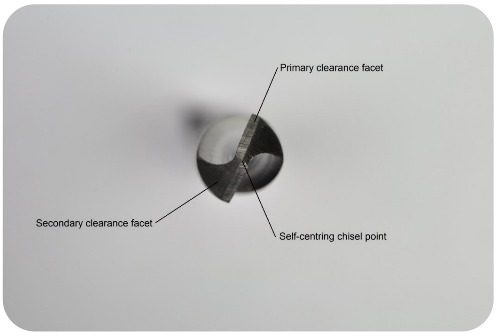

Fig. 1 Vi Drill Bit

Four-faceted drill points consist of separate cutting lips and secondary heel clearance facets.

Extending the secondary facets to the midway point of the chisel produces the apex (point) at the centre of the chisel's long axis, a self-centering point is produced, eliminating point drifting as you start to drill into softer material such as cortical bone.

A sharper drill point angle of 80° also requires less pressure to start the cutting process into bone; greatly reducing 'drill walking' on rounder surfaces such as bone (3) and facilitating accurate hole placement.

Cortical bone produces small chips when machined and normally a slow helix is required to remove this type of debris, however, in live bone stock, the chips are mixed with biological fluids and so require a faster helix.

Vi drills are now designed to use two flutes which produces the optimal cutting vs debris clearance characteristics required, all without contributing to thermal necrosis (4). The flutes are also developed to provide the ideal helical angle and thus clearing debris suitability, removing heat from the cutting edge with the swarf; in line with recommendations from academic studies (5).

The "helix angle" also has a large influence on the cutting force of the drill through the "rake angle", which is closely related; this in turn reduces heat generation at the cutting face (1 p. 623). This has been incorporated into our drills to offer the optimal combination of all these interrelated factors.

If no lip clearance is present, extreme pressure is required to make the drill cut and this would then generate excessive heat due to the increase in surface contact. However, too much lip clearance means the corners of the drill are unsupported thus making the drill vulnerable to corner breakage. Therefore, a fine balance is required and, in this instance, has been achieved, through intimate knowledge of drill manufacturing process.

The body clearance featured in Vi's drills provides a cutting edge along the full length of each flute, which improves the surface of the cut bone, improving bone healing and so reducing screw loosening. This creates the optimal surface finish of "no body thinning" (1 p. 622) whilst reducing the surface contact to just the margin width, reducing thermal generation. Margin width is kept to a minimum, providing just enough material to support the cutting edge along the flute.

In additional to the revision of several technical features, the raw material used for manufacture and certain steps in the manufacturing process, were also developed to improve effectiveness and longevity.

We use EN 1.4028 (X30Cr13) material (also referred to as ASTM F899:2011 - 420B); as recommended by ISO 9714-1 (6); which is stronger and harder than 1.4125 (AISI 440C) used by some manufacturers. This for reference is not included in the list of recommended materials.

EN 1.4028 is also shown to be suitable drill material for medical use in a study by Albertini (7) who compared the two materials in drill form and examined their effect on thermal generation. The temperatures recorded for both drill materials were well within the defined limits, with slight differences in the two batches which could be due to experimental variables.

The wear of each material was also examined in the same study (7) and 1.4028 was shown to be significantly more wear resistant. This can be attributed to the higher material property values for strength and hardness. EN 1.4028 material properties are very suitable for surgical drills, as the higher strength ensures that the drills will not break under normal use and load, with the higher hardness ensuring that cutting edges remain sharp without wear for considerable usage.

EN 1.4028 steel also has improved thermal diffusivity, carrying heat away from the cutting edge better than 1.4125.

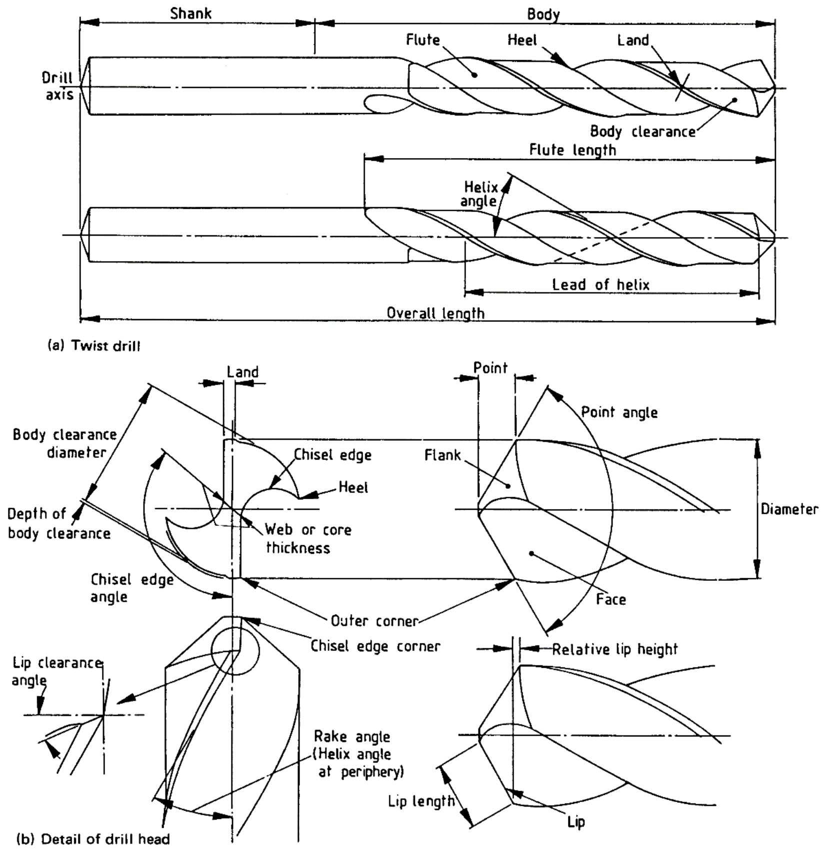

Fig. 2 Twist drill nomenclature

Stainless steel drill bits which are correctly manufactured will not corrode with correct care and application.

The benefits of various coatings are minimal to insignificant in the generation of heat which could contribute to thermal osteonecrosis, (8) (1) and if the correct base material is selected (EN1.4028) then coatings are superfluous and unnecessary.

To ensure compatibility with our comprehensive screw range, the overall drill length and flute lengths have been designed to optimise the compatibility and functionality across all screw sizes.

References & Bibliography

1. Study and improvement of surgical drill bit geometry for implant. Soriano, Josu, Garay, Ainhara, Aristimuño, Patxi, Arrazola, Pedro J,. 5-8, Lomdon : Springer, 9 01, 2014, The International Journal of Advanced Manufacturing Technology, Vol. 74, pp. 615-627. 1433-3015.
2. British Standard. BS 3531-5.5:1990 Implants for osteosynthesis — Part 5: Bone screws and auxiliary equipment — Section 5.5 Specification for taps and drills. London : BSI, 1990.
3. Cortical bone drilling and thermal osteonecrosis. Augustin, Goran, Zigman, Tomislav, Davila, Slavko, Udilljak, Toma, Staroveski, Tomislav, Brezak, Danko, Babic, Slaven,. 4, s.l. : Elsevier, 11 08, 2012, Clinical Biomechanics, Vol. 27, pp. 313-325.
4. A comparison of the thermal properties of 2- and 3-fluted drills and the effects on bone cell viability and screw pull-out strength in an ovine model,. Nicky Bertollo, Hadley R.M. Milne, Liam P. Ellis, Paul C. Stephens, Ronald M. Gillies, William R. Walsh,. 6, s.l. : Elsevier, July 01, 2010, Clinical Biomechanics, Vol. 25, pp. 613-617. 0268-0033.
5. Drilling in Bone: Modeling Heat Generation and Temperature Distribution. Davidson SH, James DF,. 3, s.l. : ASME, 06 10, 2003, Journal of Biomechanical Engineering, Vol. 125, pp. 305-314.
6. International Organization for Standardization. ISO 9714-1:2012 Orthopaedic drilling instruments — Part 1: Drill bits, taps and countersink cutters. Geneva : ISO copyright office, 2012.
7. Comparative study on AISI 440 and AISI 420B stainless steel for dental drill performance,. M. Albertini, M. Herrero-Climent, P. Lázaro, J.V. Rios, F.J. Gil,. s.l. : Materials Letters,, 2012, Vol. 79. ISSN 0167-577X.
8. Effects of bone drilling on local temperature and bone regeneration: an in vivo study. Karaca, Faruk, Aksakal, Bünyamin and Köm, Mustafa. 3, s.l. : Acta Orthop Traumatol Turc, 2014, Vol. 48. doi: 10.3944/AOTT.2014.3074.
9. Reducing temperature elevation of robotic bone drilling. Feldmann, Arne, Wandel, Jasmin. 12, s.l. : Elsevier, 12 01, 2016, Vol. 38, pp. 1495-1504.
10. Effects of Mechanical and Thermal Fatigue on. Harris, Benjamin H. and Kohles, Sean S.PhD. 6, s.l. : QUINTESSENCE PUBLISHING CO, INC, 2001, International Journal of Oral & Maxillofacial Implants, Vol. 16.
11. Influence of Orthopaedic Drilling Parameters on Surface Roughness and. Izanshah, R., et al. s.l. : Atlantis Press, 2016. 6th International Conference on Electronics, Mechanics, Culture and Medicine.
12. Modeling and experimentation of bone drilling forces,. JuEun Lee, B. Arda Gozen, O. Burak Ozdoganlar,. 6, s.l. : ScienceDirect, 2012, Journal of Biomechanics, Vol. 45. ISSN 0021-9290.
13. Optimization of cutting parameters on drill bit temperature in drilling by Taguchi method,. Ramazan Çakıroglu, Adem Acır,. 9, s.l. : sciencedirect, 2013, Vol. 46, pp. 3525-3531. ISSN 0263-2241.
14. MACHINING OF CORTICAL BONE: SURFACE TEXTURE, SURFACE INTEGRITY AND CUTTING FORCES. Yeager, C., Nazari, A. 1, s.l. : Taylor & Francis, 03 07, 2008, Machining Science and Technology, Vol. 12, pp. 100-118. 1091-0344.
15. Evaluation of the parameters affecting bone temperature during drilling using a three-dimensional dynamic elastoplastic finite element model. Chen, Yung-Chuan, Tu, Yuan-Kun, Zhuang, Jun-Yan, Tsai, Yi-Jung, Yen, Cheng-Yo, Hsiao, Chih-Kun. 11, London : Springer, 11 01, 2017, Medical & Biological Engineering & Computing,