Femtosecond laser offers surgical precision and versatility, but at a higher price

FEMTOSSECONDS lasers are likely to replace mechanical microkeratomes for refractive surgical procedures, despite the markedly higher price associated with femtosecond-laser treatments that some believe is unethical for patients to pay for, according to a panel of specialists who spoke at the annual Congress of the D O C (German Ophthalmic Surgeons).

"Femtosecond lasers will replace mechanical microkeratomes wherever the surgeon has a free choice, much like the way better, newer generation microkeratomes took the place of the first developed microkeratomes. They are more exact, reproducible, and safer than conventional microkeratomes, with a broader spectrum of application. They also appeal more to patients than microkeratomes – a factor that is quite important," said Thomas Neuhann MD of the ALZ Surgical Centre in München, Germany.

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Thickness homogeneity introduces less aberration caused by flap cut. In fact, one recent study confirmed that early postoperative visual acuity was better in femtosecond than microkeratome patients who had refractive surgery. Microkeratome flaps cut for instance by the Zyoptix SP, a newer generation microkeratome, although much better than their predecessors, still cut deeper at the periphery and flatter at the centre, while the Intralase 60 Hz was homogenous throughout the extent of the flap, Dr Neuhann noted.

Dr Neuhann cut flaps using the FS60 H femtosecond laser in a first group of 331 patients achieving a narrow flap thickness range of 120-165 µm (SD 10 µm). By comparison, thickness reproducibility that was analysed in a study with O Conline (Heidelberg) in 1859 consecutive patients revealed much wider flap thickness ranges using different microkeratomes and 30 kHz Intralase. The Hansatome microkeratome (150 µm head) cut a mean of 121 µm (SD 20 µm) with a very wide spread of 64 to 194 µm (40 µm underneath the epithelium), the Zyoptix microkeratome (120 µm head) cut between 74 – 167 µm, and the 30 kHz Intralase cut flaps with a spread of 84-164 µm.

The femtosecond laser uses a suction ring for gross flap placement and specialised software for placement adjustments, which is as simple as a mouse click, Dr Neuhann said. Cut failures, regularly associated with potentially vision threatening complications and prolonged waiting times for reoperation (microkeratomes), rarely occur with the femtosecond laser. If a cut failure occurs, e.g. by loss of suction during the cut, the surgeon using femtosecond laser, can re-cut immediately without having to wait.

He noted that the flap edge profile/diameter of margin was freely selectable, allowing flatter angles in higher ablations for better edge apposition and steep angles for better protection against slippage.

Dr Neuhann observed that further technical refinement, such as reduced energy output, increased speed, improvement / refinement of coupling and automatic individual parameter optimisation are areas of improvement for femtosecond lasers. Some disadvantages of using femtosecond lasers include the duration of elevated pressure, temperature sensitivity (air conditioning required), and high costs, he noted.

**Worth an extra €1000?**

Considering the added expense of €600–€1000 more for femtosecond LASK than conventional LASK, however, there is evidence suggesting that the patient does not necessarily profit from better visual results. Femtosecond lasers offer patients no substantial advantage over the improved results obtained with new generation microkeratomes for safety and precision, according to Theo Seiler MD, IRO C, Zürich, Switzerland, who described the disadvantages of femtosecond lasers as the advocates diabolus in this discussion. Aftually the femtosecond laser is medically indicated in a minority of our patients, probably less than five per cent. Seducing patients to get femtosecond LASK as a standard procedure is at least an overkill, if not unethical, according to some," he said.

Recent studies seem to concur. A 100-patient investigation by Lim in 2006 showed that the femtosecond laser failed to have had significant superiority in clinical outcomes like contrast sensitivity and low contrast visual acuity, while in 2007, Patel revealed in over 100 patients that the method of flap creation did not affect the visual outcome.

Although flap thickness regularity is one of the main reasons surgeons choose femtosecond laser, an investigation by Talamo revealed that femtosecond-laser flaps were an average of 119±12µm while mechanical microkeratome flaps measured 130±19µm on average, which reduces variance only slightly, Dr Seiler said.

The virtual absence of cutting errors using femtosecond laser is strongly attractive to surgeons to reduce the error potential on the surgical end. The incidence of microkeratomes cutting errors, however, is far below one per cent in primary eyes with normal K as it is, he observed.

Meanwhile, other complications seem to have increased in femtosecond LASIK patients, Javaloy showed a 10 per cent increased incidence of diffuse lamellar keratitis with femtosecond-laser interventions versus less than one per cent with microkeratomes, and transient light sensitivity syndrome was 1.3 per cent in femtosecond laser patients (zero per cent with microkeratomes) according to Munoz.

Another increased complication in femtosecond LASIK patients who had no previous choroidal neovascularisation included macular haemorrhage, according to a study by Principe. Also, Chung noted mycobacteria infections in femtosecond LASIK patients, explained by the fact that surgeons must use instruments to lift the flap and irrigate the interface.

Contrary to Dr Neuhann's experience with high patient appeal for femtosecond LASK, recent evidence from Patel suggested that patient satisfaction showed no significant difference between the two methods. In fact, the investigation predicted a trend moving away from femtosecond laser due to failing patient enthusiasm. Dr Seiler corroborated low patient enthusiasm from his experience.

He said that based on the evidence available so far, femtosecond lasers were indicated for two case scenarios in particular that required the most precise instrument available. This includes eyes with no allowance for cutting errors (high/low Ks, or previous surgery) or eyes in which if flap thickness was an issue (thin corneas, high corrections). The latter cases, however, were more likely to be treated with phakic IOLs, he observed.

Two medical indications for femtosecond laser treatments seemed like a short list to Wiliam Culbertson MD from the Bascom Palmer Eye Institute in Miami, US. He told D O C listeners that femtosecond lasers represented the future of refractive surgery to perform procedures that included minimally invasive keratomeuliseus (MIKE) for thin, small diameter, custom shaped flaps; incisional keratotomy like astigmatic- and sub-surface astigmatic keratotomy (for instance to create corneal pockets for refractive inlays); limbal relaxing incisions; and presbyopia treatment (lens softening).

"Small flaps cut fewer sensory nerves, spare more collagen fibres and nerves than mechanical microkeratomes, and are thinner and planar. In addition, customised flaps are possible such as oval-shaped instead of round flaps, which preserve the peripheral vital lamellar fibers," Dr Culbertson pointed out.

Furthermore, Dr Culbertson sees a place for femtosecond lasers in therapeutic surgery, as well. For instance the laser can be used for cataract surgery (catacat incision, capsulorhexis, lens softening, LRI) and keratoplasty (penetrating and lamellar). The laser can create various special end-sheets that facilitate postoperative healing such as top-hat shaped PK, mushroom-shaped or zigzag PK, which may reduce the incidence of astigmatism and wound rupture as well as allow for easier visual rehabilitation he said. Where the side cut has been created by the femtosecond laser, the incision appears to have exhibited greater fibrosis and heal faster than incisions made with a metal trephine.

Dr Culbertson uses femtosecond laser regularly for the descemeto chorax created with femtosecond laser prior to Descemet stripping endothelial keratoplasty (DSERK) and for precisely localising and creating small diameter (3-5mm) corneal biopsies in patients with undiagnosed keratitis.

The femtosecond laser is so versatile because it uses spot and line spacing to create vertical and horizontal incisions in the cornea. Variables that are controlled through the specialised software include spot size (energy), spot separation, spot timing, depth of cut, diameter (length) of cut and direction (anulation) of the cut, Dr Culbertson said.

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