Computer Assisted Surgery has developed into an important technology for humans and may do the same in horses. Especially the continuously increasing demands for absolute precision in implant placement and the increasing pressure in reference to the postoperative expectations by the owners may make this technique a valid option.

Basically, one distinguishes C-arm and CT guided systems. In both, a navigation system assists the surgeon to place the implants in the ideal spot decided upon on previously taken radiographs or a CT scan. Below, the different components of an integrated CAS System are described. There are several such systems available. Our personal experiences are based on initially the SurgiGATE system by Medivision followed by the VetGATE system developed by the Maurice Mueller Institute in Berne combined with the Arcadis Orbic 3-D C-arm from Siemens.

Arcadis Orbic3D:

The principal difference compared to conventional C-arms is the system’s isocentric design, coupled with a motorized orbital rotation and hardware and software components for 3D imaging. This system thus enables the exposure of a fixed number of fluoroscopy images at predetermined angle intervals during continuous, automatic orbital rotation through 190°(Figs. 1&2) simultaneously a high resolution isotropic data cube with edge length of approximately 12cm is calculated from these images in the isocenter.

The Arcadis Orbic 3-D can be used for 2D and 3D navigation. For the latter, however special software is necessary. For the equine patients the 3-D navigation is of major interest, because it allows the intraoperative use of cross sections of the bone during navigation and therefore the perpendicular orientation of the implants relative to the fracture plane. The selected images of the 2D or 3D evaluation respectively, can be transferred over to the VetGATE system for the actual navigation. To be able to do this, it is important, that the barrel of the C-arm is equipped with position markers to identify it within the working room.
Fig. 3: The VetGATE System (left) together with the Arcadis Orbic 3D equipment

**VetGATE System**

In the VetGATE system the camera and the navigation computer are mounted on the same cart (Fig. 4). The camera consists of only 2 lenses and has a slightly reduced precision (0.01mm), which is of no significance. The Siremobile Iso 3D is equipped with passive LED’s. Also the power drill, and the drill sleeves contain passive LED’s (Fig. 5). The advantage of the passive LED’s is the lack of cables, but the round reflecting balls cannot be steam sterilized. The software also contains several adaptations to the equine situation, which improve the application of CAS in this species (Fig. 6).

Fig 4: Camera with the computer

Fig 5: Passive LEDs with reflecting balls – no cables!
The Camera has to see the different marker sets in use all the time. One marker has to be mounted on the bone to be treated. This can be done with the help of a Schanz’ screw onto which the marker is attached. The instruments used, i.e. the power drill must be equipped with an additional marker. Together with the C-arm, the camera should identify 4 different markers. If that is not the case, navigation is impossible. A special device has been developed to calibrate the different instruments used, such as drill bits, tap etc (Abb. 7). Also the different programs available can be activated directly by the surgeon.

Once all systems are on “go” navigation may be started. The selected radiographs are transferred to the computer and shown on the monitor (Fig 8). The activities carried out with the different instruments can be directly followed on the screen, similar to arthroscopy. Additionally the moment the fracture plane is crossed can be seen and the length of the glide hole determined. This allows the surgeon to achieve maximum accuracy in implant placement. Initially the procedure takes somewhat longer than a non-navigated surgery, but with time and acquired experience the surgery time can be reduced to below regular and precision increased.

Fig. 6: Preplanning of the screw fixation  Fig. 7: Calibration device for different diameters

Fig. 8: The computer screen during the insertion of a 4.5mm screw into the navicular bone. Top right: Three different orthogonal views are shown. The green bar represents the preplanned width of the implant. The red bar represents the 3.2mm drill inserted into the 4.5mm glide hole to the mid-portion of the navicular bone immediately at the beginning of drilling the thread hole. The fourth picture represents the location of the instrument within space.
Assessment:

The equipment is presently still very expensive. Therefore it may be suited for specialty referral clinics only. The development proceeds rapidly. For the equine surgeon especially the precise implantation of lag screws is of major interest. With these technologies we are able to control exactly how we perform and possibly find reasons for an unexpected substandard performance of a patient.

Literature