Awake cardiac surgery was first performed in 1998 as coronary artery graft surgery by the Turkish cardiac surgeon Karagoz (1). Using only a thoracic epidural, 5 patients were able to have successful off-pump coronary bypass (OPCAB) surgery.

Minimal surgical access and operation techniques on the beating heart with no cardiopulmonary artery bypass and without full heparinization were the requirements for the first set of awake cardiac surgeries. This could only be realized by using high thoracic epidural anesthesia (hTEA) without a general anesthetic. Consequently, until recently, most awake cardiac surgeries using off-pump techniques have been described in low risk patients (2-16). However, there now exist small case series including valve replacements with awake high risk patients undergoing on-pump surgery with the use of the cardiopulmonary artery bypass (27-21).

Currently there are nearly 1,000 cases of awake cardiac surgery published, whereas 2,000-3,000 operations have been carried out worldwide. However there are only a few countries and centres in the world in which awake cardiac surgeries are performed, mainly India, Turkey, Czech Republic, Italy, and Poland.

Most of the published awake cardiac surgeries are case reports or observational studies, which simply describe the feasibility of this method. Only a few studies have control groups which compare awake cardiac surgery using hTEA alone, with a group using hTEA plus general anesthesia, as well as patients with general anesthesia only. These showed that there were no advantages to the group using awake cardiac surgery, in comparison to the group using hTEA together with additional general anesthesia (22-25).

Summing up the current data one can conclude that there are no major complications regarding the awake technique with the hTEA.

**High thoracic epidural anaesthesia and cardiac surgery**

The opinion regarding a hTEA in combination with general anesthesia is still controversial amongst cardiac anaesthesiologists (26-28). The existing studies are ambivalent: some studies (pro- and retrospective) show a reduction of postoperative morbidity (postoperative arrhythmias, pulmonary complications, renal failure) and an improvement in pain control allowing earlier extubation and hospital discharge (29-31). Others show no improvement in outcome (32).

There are also conflicting data of meta-analyses regarding this topic. While one showed reduced myocardial ischemia and mortality and a reduced need for ventilation with hTEA for cardiac surgery (33) other meta-analyses including more than 1,000 patients didn’t show any differences in the rate of the mortality or myocardial infarction (34, 35). However, patients undergoing cardiac surgery with a hTEA have a reduced the risk of postoperative supraventricular arrhythmias and respiratory complications (34, 35).

In all meta-analyses, there where no major complications regarding the thoracic epidural. In particular there were no epidural hematoma, which isn’t surprising, since the total number of patients included in the analyses was few. Nevertheless the possibility of developing an epidural hematoma, is the main cause for concern amongst the cardiac anesthesiologists.

Until now only very few epidural hematomas were described in cardiac surgical patients in the context of a TEA, with intraoperative heparinisation (36) or postoperatively catheter-related (37-40). The first risk calculation of blockade-induced hematoma with 95% was from 1:150,000 to 1:1,500 for epidurals (41), the latest published risk estimation was 1:12,000 (42).
Probably the actual number of epidural hematomas will be higher, however, so will be the actual number of performed but unpublished thoracic epidurals. The incidence of 1:12,000 is a similar hematoma-incidence which is described with epidurals in non cardiac surgery.

Nevertheless the question as to whether it is worth taking the risk of performing an epidural in cardiac surgery has to be justified (25, 26). Under the condition of an off-pump procedure with considerably less heparinisation in comparison to the usage of a cardiopulmonary artery bypass, a thoracic epidural seems to be justified. However there is no definitive evidence for that. The removal of the epidural catheter as well as postoperative anticoagulation remain unresolved problems in relation with the hTEA. If the catheter has to be removed then, according to the guidelines, the anticoagulation has to be stopped. This however puts the patient at risk of developing unacceptable coronary ischemia or a thromboembolic event.

**Patient selection for awake cardiac surgery**
Patients undergoing an awake cardiac surgery have to be extensively and properly informed about this anesthetic technique, potential adverse events and the pre- and intraoperative course. An awake on-pump procedure is not applicable to all kinds of coronary artery stenoses. Revascularization of the left circumflex artery requires Trendelenburg positioning and luxation of the heart and is therefore difficult to perform. In addition, patients with highly impaired left ventricular function depending on a certain cardiac sympathetic tone should be excluded from this new technique. Further exclusion criteria arise from common contraindications of epidural puncture, such as compromised coagulation, bleeding disorders and the use of any antiplatelet drugs (e.g. ticlopidine, clopidogrel etc.) within the last 10 days.

**Benefits of the awake cardiac surgery**
Benefits of awake cardiac surgeries may result from avoidance of endotracheal intubation and from the use of hTEA. To date selected patients with severe COPD or other comorbidities could be successfully operated in the awake technique (43-45). Comparative studies are however missing though in which it has been shown, that outcomes such as postoperative arrhythmias or the rate of pulmonary infection are increased in awake cases compared to hTEA plus general anesthesia. Safe and reliable hemodynamics intraoperatively, fast mobilization and even daily life activities a few hours after surgery, short-term ICU stay or even bypass of the ICU, shorter intrahospital stay are however, published and potential advantages of awake cardiac surgery (23, 46, 47, 48).

**Summary**
For over 10 years awake cardiac surgery has been performed and results published from a few specialist centres. This technique is mainly used in coronary artery graft surgery on the beating heart (OPCAB) based on the lower heparinisation and therefore the lower possible risk of an epidural hematoma.

The feasibility of this technique, albeit in the few specialist centres where it is performed, is no longer in question. However comparative studies with larger case numbers and valid conclusions, as to whether the technique of awake cardiac surgery is superior to hTEA in combination with general aneshtesia are still lacking.

Whether awake cardiac surgery will be performed more frequently, requires further critical evaluation. The patient-clientele has changed significantly over the years. Patients, who were operated awake ten years ago with one or two bypasses, are now treated interventionally by cardiologists without operation. Patients for bypass surgery nowadays are usually high risk patients with compromised myocardial function or patients with additional valve surgery. Furthermore diagnostic intraoperative transesophageal echocardiography belongs to the standard procedure these days and can’t be performed on the awake patient. Finally the feasibility of performing a cardiac surgery with the use of hTEA in patients with coronary artery disease and the modern anticoagulation concepts has to be considered critically and restrictively.
From that point of view awake cardiac surgery will remain an "outsider-method" now and in the future. However, there might be selected centres with experienced teams of anesthesiologists and cardiac surgeons, and clearly defined perioperative protocols, who will still perform this procedure successfully.

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