Chapter 5

Temporary Support of the Circulation

The primary function of the heart – to pump blood – sustains all other organs in the body. Impairment of this function over a long period of time, or even brief complete loss of cardiac output, may result in damage that leaves the patient with a permanent disability, regardless of ultimate cardiac recovery. In contrast with the broken leg, which can be rested in plaster for 6 weeks awaiting repair and return of function, the heart must continue to work immediately after major injury or cardiac surgery. Thus, measures to enhance, complement or substitute the pumping activity of the heart are encountered frequently in both the medical and surgical practice of cardiology.

Temporary support of the circulation broadly falls into two categories – pharmacological and mechanical.

Pharmacological Support

Pharmacological support embraces a large and growing number of drugs that act directly upon the heart or vascular system. *Inotropic agents* enhance contractility of the heart muscle, albeit at the cost of increased oxygen consumption by the heart itself. They usually are administered by continuous intravenous infusion, titrating the dose to the patients requirements. The commonly used catecholamines (adrenaline, dopamine, dobutamine, isoprenaline) all cause undesirable side-effects of vasoconstriction or tachycardia at very high doses, and for this reason they are often used in combination with each other or a vasodilator drug. The more recently introduced phosphodiesterase inhibitors may be pharmacologically synergistic with the action of the catecholamines and also promote vasodilatation.
The rationale for vasodilatation in the treatment of cardiac failure is to reduce the resistance against which the heart must pump. It should be carefully balanced against critical pressure requirements for perfusion of the cerebral, renal and myocardial circulations. This so-called ‘afterload reduction’ may be effected by a number of agents that vary in their mechanisms and duration of action as well as in the mode of their administration. Some, such as nitroglycerine or epoprostenol, are particularly effective in the coronary or pulmonary circulations, for example, and may convey added benefit for the management of coronary insufficiency or pulmonary vasoconstriction.

As a general rule, cardiotonic drugs are given for several days or longer, while the heart recovers, and the drugs are then gradually withdrawn as the heart demonstrates improved function by maintaining the circulation at the same or lower filling pressures. When the requirement for pharmacological support increases, it may be due to metabolic derangements (typically acidosis) which render the drugs less effective. But more often this situation indicates progressive damage or failure of the heart muscle.

**Mechanical Support**

Mechanical support of the circulation ranges from simple compression of the heart (external or internal cardiac massage) to extremely complex pumping devices completely replacing the heart’s function. In contrast with inotropic agents, mechanical support does not increase the oxygen consumption of or work done by the heart and, in theory, should optimise its recovery. In practice, however, most techniques of mechanical circulatory support are highly invasive and are accompanied by a significant incidence of complications. Their use is thus reserved for specific indications (such as emergency resuscitation or open heart surgery) or when pharmacological interventions have proved inadequate.

Cardiac massage constitutes the most primitive type of circulatory support. It is used to treat the acute and unanticipated loss of cardiac output, for example during a sudden arrhythmia or during blood loss from abrupt haemorrhage. If perfusion to the brain and coronary circulation can be maintained while measures are taken to remedy whatever precipitated the cardiac decompensation, the outlook may be quite favourable even after 30 or 60 minutes of cardiopulmonary resuscitation. This interval may also permit the organisation of more sophisticated mechanical assistance for problems that cannot be readily reversed. The size of the patient’s pupils is observed as an indication of cerebral perfusion (although this sign may be altered by drugs), while the ECG, and particularly the ability to defibrillate the heart, give an indication of blood flow to the cardiac muscle.

The deliberate interruption of cardiac function is a planned event in most open heart operations, in order to achieve satisfactory and safe operating conditions. During this time the circulation is taken over by the ‘heart–lung machine’.