CONTROLLED HYPOTENSION TO MINIMIZE BLOOD LOSS OF ANAEMIC JEHOVAH’S WITNESS PATIENT UNDERGOING TOTAL HIP AND SHOULDER REPLACEMENT

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SUMMARY

A Jehovah’s Witness with disabling rheumatoid arthritis, and a normocytic, normochromic anaemia, underwent on separate occasions a staged total hip and a shoulder replacement. Controlled hypotension with therapeutic doses of sodium nitroprusside was used to minimize blood loss, and haemodilution with crystalloid fluids was used to maintain normal cardiac output.

SUMMARY

Induced or controlled hypotension was introduced in the 1950’s to produce optimal operating conditions during plastic surgery (Enderby, 1961) and certain neurosurgical procedures (Aserman, 1953) and subsequently to decrease intraoperative blood loss during major surgical procedures (Larson, 1964). Sodium nitroprusside has established itself as the agent of choice for controlled hypotension during major surgical procedures (Larson, 1964). Sodium nitroprusside has established itself as the agent of choice for controlled hypotension due to its potency and low frequency of tachyphylaxis, and its low toxic:therapeutic ratio (Palmer and Lasseter, 1975). Pre-existing anaemia is considered a contraindication to controlled hypotension because of the decrease in arterial oxygen carrying capacity (Lindop, 1975) but this case report illustrates the successful use of haemodilution with crystalloid fluids, and controlled hypotension to minimize blood loss, to undertake staged hip and shoulder replacement in an anaemic Jehovah’s Witness.

CASE REPORT

A 52-yr-old female Jehovah’s Witness was admitted for elective total hip replacement in May 1980. She had a 17-yr history of progressively disabling rheumatoid arthritis involving her wrists, shoulders, hips and knees.

In 1978 the patient underwent successful bilateral total knee replacement, blood loss being controlled by a tourniquet. She had no symptoms or signs of cerebrovascular disease, ischaemic heart disease, pulmonary or renal disease. She had a normocytic, normochromic anaemia (haemoglobin 9.6 g dm$^{-1}$) which was unresponsive to oral iron therapy, secondary to the chronic rheumatoid disease. A devout Jehovah’s Witness, she refused transfusion of homologous blood or any blood products and she also declined autologous blood transfusion. Her entrophen and indomethacin medication was discontinued 1 week before operation. Coagulation screen, bleeding time and platelet count were normal.

Anaesthetic technique

Procedure 1: total hip replacement

The patient weighed 60 kg and received diazepam 10 mg by mouth 90 min before surgery. Anaesthesia was induced with sodium thiopentone 5 mg kg$^{-1}$ and suxamethonium 1 mg kg$^{-1}$ was given i.v. to facilitate endotracheal intubation. Ventilation was controlled using a Bain non-rebreathing system (tidal volume 12 ml kg$^{-1}$ and respiratory rate 12 b.p.m). Anaesthesia was maintained with nitrous oxide 4 litre in oxygen 2 litre min$^{-1}$ and morphine i.v. Pancuronium i.v. was used to maintain neuromuscular blockade.

An intra-arterial cannula was inserted to the radial artery to permit the continuous measurement of arterial pressure and blood sampling for blood-gas analysis. Central venous pressure (c.v.p.) was monitored via the right internal jugular vein and the electrocardiogram (e.c.g.) (V5 lead position) displayed on an oscilloscope. An indwelling Foley catheter, and an oesophageal stethoscope and temperature probe were inserted.

Baseline arterial pressure was 130/90 mm Hg and c.v.p. 8 cm H$_2$O. Sodium nitroprusside solution

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0.01% (50 mg in 500 ml of 5% dextrose in water solution) was infused through a separate i.v. line via an Imed infusion pump. A rate of 1–3 μg kg⁻¹ min⁻¹ was used to maintain a mean arterial pressure of 70 mm Hg from skin incision to surgical closure. The total dose of sodium nitroprusside infused was 8 mg (80 ml of 0.01% solution) or 0.13 mg/kg body weight. To prevent wide fluctuations in arterial pressure, 0.5% halothane was occasionally added to the inspired gas mixture. Arterial blood-gas analysis was performed every 30 min to assess acid-base status and adequacy of ventilation. With a FiO₂ 0.33, PaO₂ values ranging from 13.7 to 17.3 kPa were recorded while PaCO₂ and HCO₃⁻ ranged from 3.7 to 4.0 kPa and 22–24 mmol litre⁻¹ respectively.

Lactated Ringer's solution was infused at a rate of 10–15 ml h⁻¹ per kg to maintain c.v.p. 8–12 cm H₂O and to ensure a urine output greater than 1 ml h⁻¹ per kg. Operative blood loss was assessed by weighing sponges, measuring suction drainage, and estimating blood loss on drapes. During the 2.5-h procedure, the estimated intraoperative blood loss was 600 ml. A total of 3800 ml of crystalloid fluid was infused. Following the withdrawal of sodium nitroprusside the patient became, and remained, normotensive.

The postoperative course was uneventful although haemoglobin decreased to 6.9 gm dl⁻¹ on the 2nd day after operation. Before discharge, haemoglobin had increased to 8.1 gm dl⁻¹.

Procedure 2: total shoulder replacement

The patient was readmitted in November 1980 for elective total shoulder replacement. She had been taking oral iron for 6 months following her total hip replacement and, on admission, haemoglobin was 9.9 gm dl⁻¹ (a normocytic normochromic anaemia). A similar anaesthetic technique was used: haemodilution with lactated Ringer's solution at 10–15 ml h⁻¹ per kg with c.v.p. monitoring and controlled hypotension using 0.01% sodium nitroprusside solution to maintain a mean arterial pressure of 70 mm Hg. The total dose of sodium nitroprusside infused was 10 mg (102 ml of 0.01% solution) or 0.16 mg kg⁻¹ body weight. Arterial blood-gas analyses were performed every 30 min during controlled hypotension to assure PaO₂ > 13.3 kPa, adequate pulmonary ventilation and to detect unexplained metabolic acidosis. Blood loss was estimated as 900 ml during an otherwise uneventful 4-h procedure. Recovery was uneventful and on oral iron medication haemoglobin was 7.6 gm dl⁻¹ before discharge.

Published reports of average blood loss for total hip replacement have ranged from 1086 ml (Sculco and Ranawat, 1975) to 2250 ml (Davis, Jennings and Harris, 1974). The use of controlled hypotension to decrease intraoperative blood loss during total hip replacement is established. Thompson and colleagues (1978) showed a decrease in blood loss from 1183 ml (±172) in normotensive patients to 326 ml (±41) in a group of patients subjected to controlled hypotension with nitroprusside. Vazeery and Lunde (1979) reported a mean blood loss of 212 ml in a hypotensive group compared with 1038 ml in normotensive controls. The combination of surgical expertise in securing haemostasis and sodium nitroprusside-induced hypotension resulted in blood losses of 600 and 900 ml during the two major orthopaedic procedures described above.

Despite the reported benefits of decreases in blood loss, decreases in the number of blood transfusions and shorter operating time, controversy concerning the use of controlled hypotension for surgical procedures has persisted for many years. Reports have been published recently concerning the safety of controlled hypotension for total hip replacement. No untoward effects from hypotension induced with sodium nitroprusside were noted on postoperative brain, liver or kidney function in patients undergoing total hip replacement while alveolar gas exchange and myocardial function were preserved (Thompson et al., 1978). Cardiac index increased by 20% in patients treated with sodium nitroprusside and undergoing total hip replacement (Lawson et al., 1976). The increase in cardiac output was achieved through decreased peripheral vascular resistance, with only minor changes in heart rate. Acid–base status was normal, as was urine output, during the period of hypotension.

Sodium nitroprusside was chosen as the hypotensive agent for these orthopaedic procedures because of its rapid onset of action, its rapid reversibility, its high potency, its specific action on arteriolar vessels and its lack of effect on cardiac and other smooth muscle (Palmer and Lasseter, 1975). Sodium nitroprusside maintains a stable cardiac output and cerebral blood flow by producing a proportional decrease in perfusion pressure and peripheral vascular resistance (Stoyka and Schutz, 1975).

The major concern relating to sodium nitroprusside is the danger of cyanide (CN) toxicity. Nitroprusside is metabolized into cyanide via a direct
non-enzymatic reaction with oxyhaemoglobin and the resulting cyanide is detoxified by the hepatic rhodanase system to thiocyanate with the aid of thiocyanate (Tinker and Michenfelder, 1976). Avoidance of cyanide toxicity is a matter of strict adherence to dosage limits. Patients can tolerate up to 8 \( \mu g \) kg\(^{-1}\) min\(^{-1}\) or 0.5 mg h\(^{-1}\) per kg without evidence of cyanide toxicity for up to 48 h (Michtenfelder and Tinker, 1977) and so far there have been no clinical or experimental reports of cyanide toxicity when the dose of sodium nitroprusside infused was less than 8 \( \mu g \) kg\(^{-1}\) h\(^{-1}\).

In the two procedures reported here, sodium nitroprusside was infused via a separate i.v. cannula and a calibrated infusion pump maintained a dosage of 1–3 \( \mu g \) kg\(^{-1}\) min\(^{-1}\). No tachyphylaxis developed during the infusion and arterial blood-gas analyses did not show evidence of unexplained metabolic acidosis, an early indication of toxicity (Greiss, Tremblay and Davies, 1976).

The total dose of sodium nitroprusside infused during the total knee replacement was 8 mg (0.13 \( mg \) kg\(^{-1}\)) and during the total shoulder replacement 10 mg (0.16 \( mg \) kg\(^{-1}\)). These total doses were considerably less than the 0.6–mg kg\(^{-1}\) h\(^{-1}\) dose (Du Cailar et al., 1978) or the 1.5-mg kg\(^{-1}\) dose recommended for short-term infusions (Vesey, Cole and Simpson, 1976). Serum cyanide concentrations were not measured in these two orthopaedic operations because of the small therapeutic dose of nitroprusside used and because no untoward effects followed the infusion.

Pre-existing anaemia is considered a relative contraindication to the use of induced hypotension because of its effect of decreasing arterial oxygen content. Since sodium nitroprusside produces a proportional decrease in perfusion pressure and peripheral vascular resistance (Stoyka and Schutz, 1975) tissue blood flow remains unchanged. Thus, provided arterial oxygen saturation is maintained and haemoglobin concentration is not markedly decreased, the available tissue oxygen should be sufficient to maintain normal cellular function.

The use of a triple-lumen, flow-directed Swan–Ganz catheter to measure cardiac output during surgery in association with the controlled hypotension would have been advantageous and had the patient had evidence of ischaemic or valvular heart disease, or of chronic obstructive lung disease, a Swan–Ganz catheter would have been inserted. As the patient had no cardiac or pulmonary disease, changes in central venous pressure would reason-
HYPOTENSION CONTROLEE POUR LIMITER LES PERTES SANGUINES CHEZ UN TEMOIN DE JEHOVAH ANEMIQUE DEVANT SUBIR UNE PROTHESE TOTALE DE HANCHE ET D'EPAULE

RESUME
Un Témoin de Jehovah, porteur d'une polyarthrite rhumatoïde invalidante et d'une anémie normochrome, normocytaire, a subi de façon séparée les pose de prothèses totales de hanche et d'épaule réglées. Une hypotension contrôlée avec des doses thérapeutiques de nitroprussiate de sodium a été utilisée pour minimiser le saignement et une hémodilution avec des solutés cristalloïdes a été utilisée pour préserver un débit cardiaque normal.

KONTROLLIERTE HYPOTENSION ZUR VERRINGERUNG DES BLUTVERLUSTES BEI EINEM ANÄMISCHEN ZEUGEN-JEHOVA-PATIENTEN, DER SICH EINER TOTALEN HÜFT- UND SCHULTERENDOPROTHÈSE-OPERATION UNTERZIEHEN MÜSTE

ZUSAMMENFASSUNG

HIPOTENSION CONTROLADA PARA REDUCIR A UN MÍNIMO LA PERDIDA DE SANGRE EN UN TESTIGO DE JEHOVA ANEMICO SOMETIDO A REEMPLAZAMIENTO TOTAL DE CADERA Y HOMBRO

SUMARIO
Un testigo de Jehová que presentaba artritis reumatoide incapacitadora y una anemia normocrómica de carácter normocita, fue sometido en diversas ocasiones al reemplazamiento total de cadera y hombro lo cual se efectuó en varias fases. Se usó hipotensión controlada con dosis terapéuticas de nitroprussiato de sodio para reducir a un mínimo la pérdida de sangre, usándose una hemodilución con fluidos cristalloïdes para mantener el ritmo cardiaco normal.