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Cardiac arrest during hip arthroplasty with cement gun

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Introduction

Intraoperative hypotension is fairly common during total hip arthroplasty with cement. There are several reports of intraoperative cardiac arrest in association with methylmethacrylate for fixation of components of a total hip arthroplasty [1–3]. One of the mechanisms is diffuse microembolization of the lungs as a consequence of extrusion of the bone marrow content by the pressurized bone cement. Hyland and Robins discovered air and fat in the pelvic veins on the side that was operated on, the right heart, and the coronary vessels of a 96-year-old woman who had a cardiac arrest during a hemiarthroplasty with cement [3]. By reducing intramedullary pressure and changing the operative technique such as thorough saline lavage of the femoral canal [4], complications associated with bone cement implantation can be diminished, but death still occurs.

We report a case in which thorough saline lavage of the femoral canal, continuous blood pressure monitoring, 100% oxygen, and intravenous ephedrine (8 mg) given prophylactically before insertion of bone cement were not enough to prevent cardiac arrest.

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Case report

A 68-year-old man weighing 58 kg in whom carcinoma of the right lung had metastasized to widespread osseous locations, including the left femur, sustained a pathological fracture of the left hip. A left hemiarthroplasty was scheduled, with the patient under general anesthesia.

The laboratory data were hematocrit 37.5%, with normal electrolytes and coagulation studies. A room air blood gas analysis revealed pH 7.44, PCO_2 40 mmHg, PO_2 62 mmHg, and base excess 4.2 mM/l. Morphine sulfate was used for pain relief.

Premedication consisted of 0.5 mg atropine and 25 mg hydroxyzine intramuscularly. Anesthesia was induced with 70 mg propofol, 50 μg fentanyl, and 7 mg vecuronium bromide and was maintained with sevoflurane. Nitrous oxide was not used. Before insertion of the cement, arterial blood pressure ranged from 90/55 to 130/80 mmHg and pulse rate ranged from 92 to 116 beats·min^{-1}. Blood loss was 260 ml, and lactated Ringer's solution, 1400 ml, and 5% albumin, 300 ml, were infused before using the cement gun. Two minutes after methylmethacrylate cement was inserted with a cement-injection gun, the blood pressure fell from 110/76 to 40/30 mmHg. The capnogram showed a gradual decrease from 31 to 17 mmHg as blood pressure decreased. The airway pressure was not elevated. No ST change was seen on the electrocardiogram. Skin rash was not seen. The blood pressure did not respond to the infusion of 5% albumin and vasopressors. Although the heart rate remained at approximately sixty beats·min^{-1}, the blood pressure could not be measured, suggesting electromechanical dissociation. External cardiac massage was started, and the patient was turned to the supine position. In spite of 3 h of resuscitation with full doses of epinephrine, norepinephrine, and dopamine, the patient died. No postmortem examination was performed.

Discussion

The cardiovascular effects of pressurization of methylmethacrylate, including decreased cardiac output, elevated pulmonary artery pressure, and systemic hypotension, have been examined in the laboratory. However, the etiology of intraoperative cardiac arrest in association with methylmethacrylate apparently is still unknown.

The anaphylactoid mechanism as a major factor in complications associated with bone cement implantation is receiving renewed attention, since increased plasma histamine levels were recently demonstrated after the implantation of bone cement and a prosthesis [5]. However, Lamade et al. reported that histamine-receptor-blocking agents did not have a prophylactic potential in complications associated with bone cement implantation [6]. In this case an anaphylactoid reaction is not excluded as a cause of the event, although the skin was neither reddish nor erupted.

Substantial evidence supports an embolic etiology [1,3]. The risk of thromboembolic disease is increased in patients who have cancer, especially if an operation is being done [7].

It is controversial to use the cement gun with high-risk patients. The cement gun requires earlier insertion and elevates the plasma level of the monomer higher than manual insertion does. The pulmonary system is the primary organ for clearance of methylmethacrylate monomer [8], which may be responsible for the hypotension and hypoxia. However, Evans et al. reported that the incidence of air embolism and associated cardiovascular changes during total hip replacement may be expected to be reduced in those patients in whom a cement gun is used to place the cement instead of insertion by hand [9].

Patterson et al. recommend inspiration of 100% oxygen, adequate volume replacement, invasive hemodynamic monitoring, and ready-mixed vasopressor solutions as useful adjuncts in the treatment of patients who are at risk for cardiac arrest. They routinely infuse low-dose epinephrine via a central venous line during the insertion of methylmethacrylate [1]. In the present case, the CVP line was not inserted, although a cannula was placed in the left radial artery for continuous blood pressure monitoring, and 100% oxygen and intravenous ephedrine were supplied prophylactically before the insertion of bone cement.

There are also some case reports of neurologic complications associated with knee and hip arthroplasty [10–13]. The pathogenesis and operative events that lead to acute neurologic injury during joint arthroplasty are not well understood but are thought to be a consequence of the fat embolism syndrome. In a patient with a patent foramen ovale, diffuse embolic infarcts were reported to be confirmed after bilateral knee arthroplasty [10]. A patent foramen ovale is reported to be present in approximately 27% of people [14]. Recently Edmonds et al. reported that cerebral embolization during total hip arthroplasty is common and may be attributable to transpulmonary passage of emboli [15].

In conclusion, thorough saline lavage of the femoral canal, continuous blood pressure monitoring, and 100 per cent oxygen and intravenous ephedrine supplied prophylactically before insertion of bone cement were not enough to prevent cardiac arrest. The etiology of the present hypotensive event was unknown; however, a direct cardiodepressant effect of bone cement was suspected. Early detection of embolic events seems useless to prevent further embolism, because once bone cement is inserted we cannot do anything. After this case we employed a central venous catheter for prophylactic continuous infusion of dopamine and emergent flush of dopamine in high-risk patients.

References

1. Patterson BM, Healey JH, Cornell CN, Sharrock NE (1991) Cardiac arrest during hip arthroplasty with a cemented long-stem component. J Bone Joint Surg 73A:271–277
2. Powell JN, McGrath PJ, Lahiri SK, Hill P (1970) Cardiac arrest associated with bone cement. BMJ 3:326
3. Hyland J, Robins RHC (1970) Cardiac arrest and bone cement [letter]. BMJ 4:176–177
4. Christie J, Robinson CM, Singer B, Ray DC (1995) Medullary lavage reduces embolic phenomena and cardiopulmonary changes during cemented hemiarthroplasty. J Bone Joint Surg 77B:456–459
5. Tryba M, Linde I, Voshage G, Zenez M (1991) Histamine release and cardiovascular reactions to bone cement used in total hip replacement surgery. Anaesthetist 40:25–32
6. Lamade WR, Friedl W, Schmid B, Meeder PJ (1995) Bone cement implantation syndrome. A prospective randomised trial for use of antihistamine blockade. Arch Orthop Trauma Surg 114:335–339
7. Rickles FR, Edwards RL (1983) Activation of blood coagulation in cancer: Trousseau's syndrome revisited. Blood 62:14–31
8. McLaughlin RE, DiFazio CA, Hakala M, Abbott B, MacPhail JA, Mack WP, Sweet DE (1973) Blood clearance and acute pulmonary toxicity of methylmethacrylate in dogs after simulated arthroplasty and intravenous injection. J Bone Joint Surg 55A:1621–1628
9. Evans RD, Palazzo MGA, Ackers JWL (1989) Air embolism during total hip replacement: comparison of two surgical techniques. Br J Anaesth 62:243–247
10. Weiss SJ, Cheung AT, Stecker MM, Garino JP, Hughes JE, Murphy FL Jr (1996) Fatal paradoxical cerebral embolization during bilateral knee arthroplasty. Anesthesiology 84:721–723
11. Dorr LD, Merkel C, Mellman MF, Klein I (1989) Fat emboli in bilateral total knee arthroplasty: predictive factors for neurologic manifestations. Clin Orthop 248:112–119
12. Pell ACH, Hughes D, Keating J, Christie J, Busuttil A, Sutherland GR (1993) Brief report: fulminating fat embolism

syndrome caused by paradoxical embolism through a patent foramen ovale. N Engl J Med 329:926–929
13. Orsini EC, Byrick RJ, Mullen JB, Kay JC, Waddell JP (1987) Cardiopulmonary function and pulmonary microemboli during arthroplasty using cemented or non-cemented components: the role of intramedullary pressure. J Bone Surg (Am) 69:822–832
14. Hagen PT, Scholz DG, Edwards WD (1984) Incidence and size of patent foramen ovale during the first 10 decades of life: an autopsy study of 965 normal hearts. Mayo Clin Proc 59:17–20
15. Edmonds CR, Barbut D, Hager D, Lo Y, Sharrock NE (1997) Intraoperative cerebral arterial embolization during total hip arthroplasty. Anesthesiology 87:A150