Acta orthop. scand. 47, 186–188, 1976

EXTRAOSSEOUS VARIATIONS OF TEMPERATURE DURING POLYMERIZATION OF ACRYLIC CEMENT IN HIP ARTHROPLASTIES

A. d'HOLLANDER, F. BURNY, E. MONTENY & M. DONKERWOLCKE

Departments of Anesthesiology and Orthopedic Surgery, Brugmann Hospital, and Laboratory of Experimental Surgery, Fondation Médicale Reine Elisabeth, Brussels University, Brussels, Belgium.

In order to evaluate the extraosseous temperature variations during polymerization of acrylic cement being used in hip arthroplasty, measurements were taken on the anterior aspect of the upper part of the femur and also in the ipsilateral iliac vein. No variations were observed in the blood stream. On the external surface of the upper femur, the greatest variations were of the order of 3° C. The significance of these findings is discussed.

Key words: methylmethacrylate; hip prosthesis; temperature of polymerization

Accepted 14.x.75

The temperature variations resulting from the polymerization of methylmethacrylate (MM) have been measured in many investigations in animals and *in vitro* (Wiltse et al. 1957, Ohnsorge & Goebel 1969, Homsy 1969, Charnley 1970, Jefferiss 1971, Hupfauer & Ulatowski 1972). This exothermic reaction was suspected by Frost (1970) to have cardiovascular effects during the insertion of a cemented endoprosthesis.

The aim of this study was to evaluate, under clinical conditions, the extent of the exothermic reaction on the anterior aspect of the upper femoral shaft and in the ipsilateral iliac vein, after insertion of cement in the femur for hip arthroplasty.

MATERIAL AND METHOD

McKee-Farrar or Moore hip arthroplasties are performed under general anesthesia through a lateral approach. The temperature was recorded using a thermistor after the hip had been dislocated.

Methylmethacrylate Simplex® (40 g of powder and 20 cm^3 of liquid) mixed with 10 cm^3 Isopaque 60® is pushed into the femoral medullary cavity after 2 minutes of manual preparation (Charnley & Smith 1968).

The juxta-cortical temperature was measured on nine patients. The thermistor was inserted through a needle close to the anterior aspect of the upper femoral shaft. Intravenous measurements were done by catheterization of the femoral vein in six patients, introducing the thermistor up to the sacro-iliac joint under fluoroscopic monitoring.

The thermistor was connected to a thermometric module (accuracy 0.1° C) and the temperature recorded every 30 seconds (digital out-

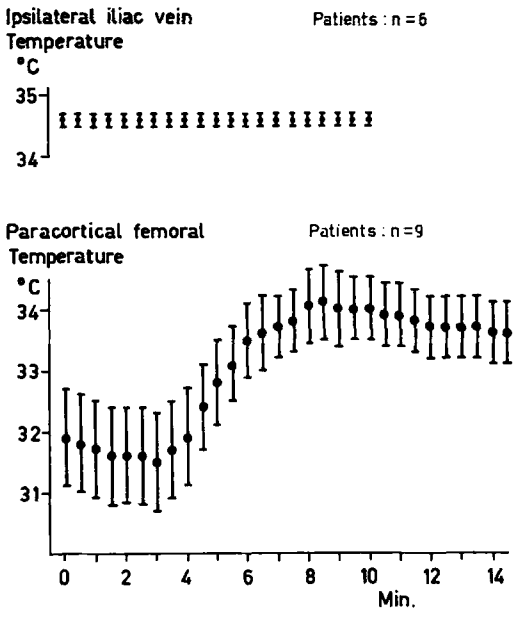

Figure 1. Extraosseous temperature variations during polymerization of acrylic cement in hip arthroplasty.

put) or continually registered (potentiometric recorder).

RESULTS

Juxta-cortical measurements

After a delay of 3 minutes, the temperature increased from 31.5 ± 0.8° C to 34.1 ± 0.6° C in about 8 minutes. The temperature then remained stable up to the end of the period of measurement (14 minutes) (Figure 1).

Venous measurements

No temperature variation was noted during the first 10 minutes following the introduction of the cement (taken as time 0) in the femur (Figure 1).

DISCUSSION

Due to the exothermic polymerization of MM, *in vivo* insertion of acrylic cement is suspected to be associated with the production of a large amount of heat. Many experiments have been carried out under various experimental conditions in order to evaluate the extent of the thermic reaction (Table 1).

At the sites of measurement, spectacular variations previously described were not observed in our study. In the ipsilateral iliac vein, the temperature did not change during the time of observation. It seems that if blood circulation plays a role in heat transportation, under clinical conditions, this role is strictly local.

On the external surface of the upper part of the femur, the greatest variations registered were about 3° C, which increased the temperature of the zone investigated to 34° C. This small increase in temperature as compared with that encountered in preparations of isolated human femur (Ohnsorge & Goebel 1969) may be due to the lower cortical temperature at the beginning of the cementing procedure (31.8 as against 37° C), to possible heat exchange between bone and surrounding tissues and to the role of blood circulation in local thermal redistribution. The thermic degradation of organic material must therefore be limited to the inner cortex portion. This concept is in agreement with observations made in animal (Homsy 1969, Wiltse et al. 1957) and human studies (Homsy 1969, Charnley 1970). Having demonstrated that the only thermic lesions are localized to the bone cement interface, the role, if any, of exothermic polymerization in inducing cardiovascular reactions and the consequences of thermic lesions remain difficult to appreciate in human subjects.

CONCLUSION

No variation of temperature was observed in the femoral vein of patients during polymerization of acrylic cement for hip arthroplasty. On the external sur-

Table 1. Experiments on the temperature of polymerization of methylmethacrylate

Date	Authors	Type of preparation	Cement	Details	Maximum T° reached
		Human conditions			
1969	Ohnsorge & Goebel	Isolated femur and prosthesis.	Palacos	Bone cement interface.	
				Greater trochanter.	68° C (at 6 min)
				Middle third of the femur.	61° C (at 6 min)
				Outer lateral cortex.	42.5° C (at 9 min)
1970	Charnley	Cadaveric condition.	Simplex	Unknown	12° C
		Animal conditions			
1957	Wiltse et al.	Isolated bone in air.	Unknown	Unknown	79.5° C
1969	Homsy	Cement in medullary cavity, without prosthesis.	Simplex P	Bone cement interface.	88° C
		Isolated cement in air			
1969	Ohnsorge & Goebel		Palacos	52.6 g	122° C (interior of the cement)
					92° C (surface of the cement)
1971	Jefferiss		Simplex	Quantity unknown.	79.5° C
1972	Hupfauer & Utalowski		C H W	60 g	121° C
			Simplex	57 g	116° C
			Palacos	55 g	108° C

face of the upper part of the femur the greatest variation registered was about 3° C.

REFERENCES

Charnley, J. & Smith, D. (1968) *The physical and chemical properties of self curing acrylic cement for use in orthopedic surgery.* p. 13. Internal Publication, No. 16. Centre for Hip Surgery, Wrightington Hospital, near Wigan, England.

Charnley, J. (1970) *Characteristics of self curing acrylic cement in orthopedic surgery.* Livingstone, Edinburgh and London.

Frost, P. M. (1970) Correspondence. Cardiac arrest and bone cement. *Brit. med. J.* **3**, 524.

Homsy, C. A. (1969) *Prosthesis seating compounds of rapid cure acrylic polymer.* Joint workshop on total hip replacement and skeletal attachment. National Academy of Science. American Academy of Orthopedic Surgeons.

Hupfauer, W. & Ulatowski, L. (1972) Die Temperaturentwicklung verschiedene Knochenzemente während des Abhärtungsvorganges. *Arch. orthop. Unfall. Chir.* **72**, 174.

Jefferiss, C. D. (1971) Avoidable complication of McKee-Farrar arthroplasty. *Brit. med. J.* **2**, 382.

Ohnsorge, J. & Goebel, G. (1969) Oberflächentemperaturen des abhärtenden Knochenzementes Palacos beim Verankern von Metallendoprosthesen im Oberschenkelmarkraum. *Arch. orthop. Unfall. Chir.* **67**, 89.

Wiltse, L. L., Kall, R. M. & Stevenhjem, J. C. (1957) Experimental studies regarding the possible use of self-curing acrylic in orthopedic surgery. *J. Bone Jt Surg.* **39**-A, 961.

Correspondence to: Dr. A. d'Hollander, Department of Anesthesiology, Brugman Hospital, 4 Place van Gehuchten, 1020 Brussels, Belgium.