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Postmortem Decrease in Brain Temperature

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Summary. The postmortem decrease in central brain temperature in a small number of forensic cases is presented. Each case shows a simple exponential fall during the time of the measurements.

The data reported by Brinkmann et al. (1978), when plotted in semi-logarithmic coordinate system, also show—after an initial "plateau" of about 2 h—a strictly one-term exponential temperature fall for several hours post mortem. The curve of brain temperature fall allows conclusions about the time of death without considering clothing, body stature, and weight. The interval temperature measurements which are required may be obtained on the spot, and the calculations needed are very simple.

The method, therefore, seems preferable to those depending on rectal temperature measurements.

Key words: Time of death, brain temperature – Post mortem brain temperature, time of death

Zusammenfassung. Bei fünf forensischen Fällen plötzlichen Todes wurde die zentrale Gehirntemperatur gemessen. Bei jedem Fall ließ sich ein einfacher exponentieller Temperaturabfall in Abhängigkeit von der Todeszeit nachweisen.

Die von Brinkmann et al. (1978) publizierten Daten zeigen im halblogarithmischen Koordinatensystem nach einem anfänglichen "Plateau" von zwei Stunden einen geraden exponentiellen Temperaturabfall über mehrere Stunden post mortem. Ohne Kleidung, Statur und Körpergewicht berücksichtigen zu müssen, erlaubt die Kurve des Gehirn-Temperaturabfalls Rückschlüsse auf die Todeszeit. Die in verschiedenen Zeitintervallen vorzunehmenden Messungen können vor Ort vorgenommen werden; die Berechnung ist sehr einfach. Diese Methode scheint der Messung der Rektaltemperatur überlegen zu sein.

Schlüsselwörter: Todeszeitbestimmung, Gehirntemperatur – Abkühlung, Gehirntemperatur – Gehirntemperatur, Todeszeitbestimmung

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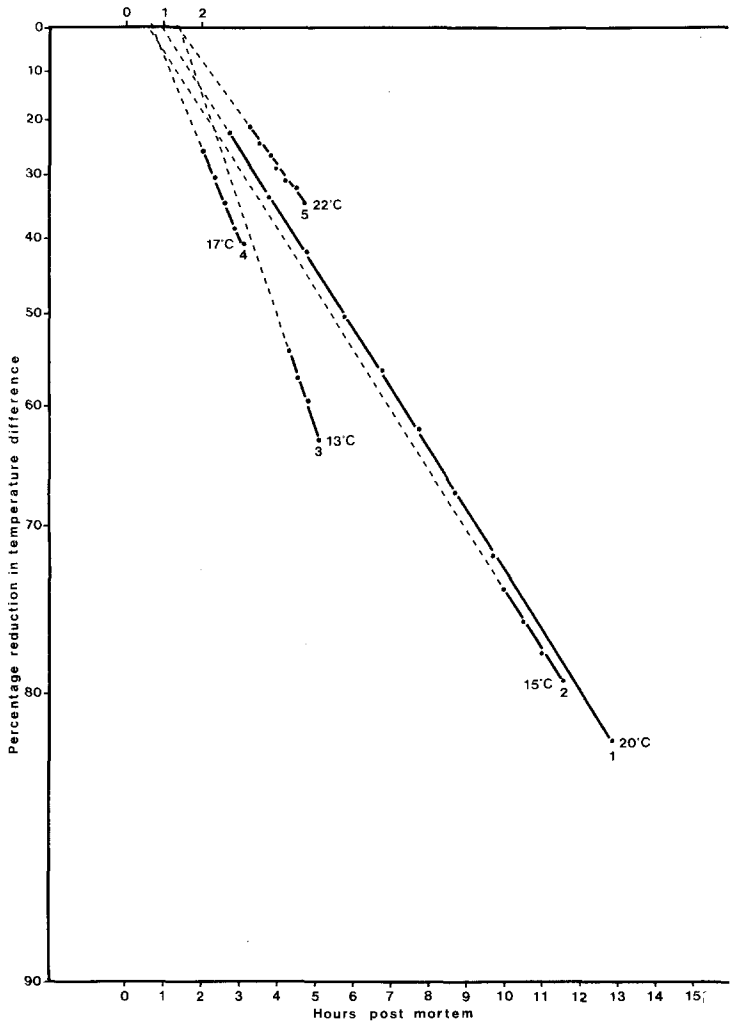

Fig. 1. Curves showing the relative individual brain temperature fall in five corpses. Start brain temperature is set to 37° C. The actual cooling temperatures are indicated

An early estimate of the time of death may, if it is a good one, be of great value in the investigation of suspicious deaths. So far, the most valuable medical information is the temperature of the corpse. Rectal temperature measurements have been used for this purpose for many years. The sigmoid form of the post mortem rectal temperature curve is well established. In a comprehensive study Marshall (1965) shows the inaccuracy of formulas containing a single exponential term for estimating time of death. Most of this inaccuracy is due to the initial temperature plateau. This plateau shows marked variations depending on different factors as the clothing of the body, the amount of insulating subcutaneous fat, and the surrounding temperature.

In later years, central brain temperature measurements have been introduced as preferable to rectal measurements. Comprehensive studies have been reported

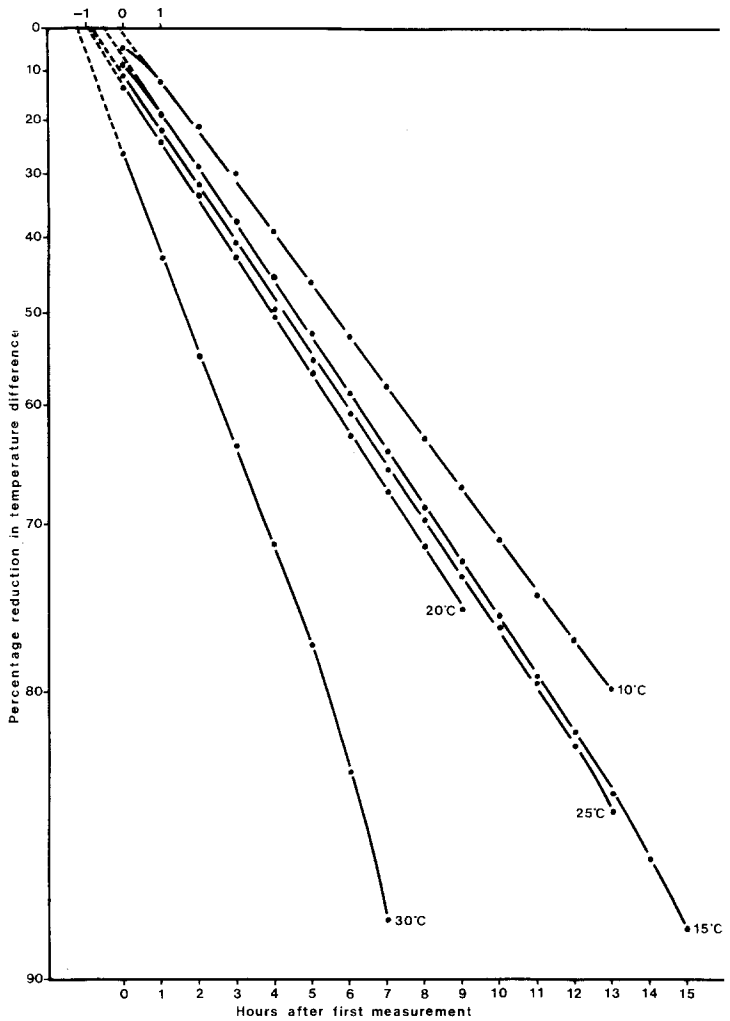

Fig. 2. The Figures of Brinkmann et al. (1978) plotted in the same way. Curves showing relative brain temperature fall in five groups with different cooling temperatures, five cases in each group. Start brain temperature is set to 37° C. The cooling temperature of each group is indicated

by Naeve and Apel (1973), and by Brinkmann et al. (1976, 1978). The advantages yielded by this method are, e.g., the shortness of the initial plateau and the small individual variation in the central brain temperature fall. This report was precipitated by the observation that the fall in central brain temperature as measured on the spot of forensic cases showed a simple one-term exponential fall.

Material and Methods

Own material comprises five cases of sudden death, i.e., two natural deaths (thrombosis of carotis artery, cancer metastases), and three violent deaths without cranial fractures.

In one instance (case 1) temperature measurements were performed at the Institute, in the other four cases at the place of death.

The time of death was known in each instance, the interval between death and the first temperature measurement varied from 2 to 10 h.

Temperature measurements were performed by a Digimed HO1 digital thermometer, probe H1. The probe is 20 cm long, flexible, and the diameter is 2—5 mm. At the tip is mounted a metal temperature registrator, 5 mm long with 2 mm diameter. The probe was introduced into the central brain area after preforming a hole in *lamina cribrosa* with a metal pin, diameter about 4 mm. The metal registrator was placed in a distance of about 11 cm from the nostril, i.e., in the frontal part of the central brain. Room temperature was measured at the beginning and at the end of the central brain temperature measurements.

Results

Figure 1 shows the results of the temperature measurements plotted in a semilogarithmic coordinate system. The *ordinate* shows the per cent reduction in temperature difference between central brain and the environment (the value 0% reflecting 37° C brain temperature) in a logarithmic scale, the *abcissa* shows the post-mortem time in a metric scale.

All the five curves obtained are straight linear. In case 1 the temperature was measured for 10.5 h, in the other four cases, a much shorter time. When the curves are extended (dotted lines) they cross the 37° C line 0.5—1.5 h after death. In Fig. 2 are presented in the same semilogarithmic system point values obtained from the curves presented by Brinkmann et al. (1978). His material contains five different groups in a controlled "cooling experiment", and with five cases in each group. The temperature of the surroundings were kept at 30° C, 25° C, 20° C, 15° C, and 10° C, in the different groups, respectively. From Fig. 2 it is to be seen that for each of the five different groups, a one-term exponential temperature fall occurs 2—3 h after death. The linear fall lasts only 6 h in the 30° C experiment, while it lasts at least 10—13 h in the other temperature groups.

Discussion

The data reported by Brinkmann et al. (1978) and the results of own cases presented here shows that for several hours *post mortem* there is ordinarily, after a rather short, initial plateau, a one-term exponential fall in central brain temperature. The initial period probably reflects the building up of a temperature gradient between the skull and central brain. Assuming a one-term exponential fall from the moment it starts (brain temperature assumed to be 37° C), and extending the line between the interval measurements obtained in the period of exponential fall to the 37° C line, the crossing point will be about 0.5—1.5 h post mortem. A larger observation material is necessary to tell exactly what variance this "lag time" shows.

One important advantage of this method is, that except for the "lag period", it is not dependent on large empirical data on temperature fall in bodies under equal conditions. From the cases presented, it appears that not only temperature

difference between central brain and air is important for the rate of brain temperature fall, but other factors, e.g., the size of the head, insulating effect of hair and clothings probably play important roles as well. However, since a straight line is obtained in each case such factors are unimportant—with the possible exception of the "lag time". The variance of this is, however, probably rather small.

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