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MYONECROTIC GAS GANGRENE OF THE EXTREMITIES

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Twenty-three patients with proven myonecrotic gas gangrene of the extremities caused by Clostridium perfringens bacteria were treated by a combination of surgical measures, benzyl-penicillin and hyperbaric oxygen at three atmospheres.
87 per cent (20/23) of the cases were cured and half of the surviving patients (10) had to be amputated at least one level higher than on admission. No single factor could be established that influenced the course of the infection comparing age under and over 50 years, vascular insufficiency and normal vascular conditions, and toxicity and non-toxicity. Nor did the level of the infection of the limb seem to have any influence. The frequency of death in relation to the described variables could not be established when multi-variance analysis was used.

Key words: Clostridium perfringens; hyperbaric oxygenation; myonecrotic gas gangrene

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Gas gangrene caused by Clostridium perfringens bacteria is one of the most rapid spreading and lethal infections in man (Trippel et al. 1967, Holland et al. 1975). Myonecrotic infection is the most serious (Altemeier & Fullen 1971) and the purpose of this study is to describe the treatment of this entity in the extremities, which so far has not been dealt with specifically in the Scandinavian literature. Since the publication of Brummelkamp et al. (1961) hyperbaric oxygen therapy has found its place in the treatment of gas gangrene and most authors have agreed that this has contributed to a more favourable course of the infection (Brummelkamp et al. 1963, Trippel et al. 1967, Roding et al. 1972, Hommelgaard & Kolind-Sørensen 1974, Holland et al. 1975, Hedström 1975, Krebs & Jensen 1981).

Not everyone, however, is convinced on this point and some claim that the effect of hyperbaric oxygen is doubtful and that early and adequate surgical measures are still of utmost importance (Altemeier & Fullen 1971, Darke et al. 1977). Another purpose of this paper is to discuss the possible influence that age, vascular status and toxic condition might have on the outcome of the infection and on the basis of the literature to discuss the beneficial effect of hyperbaric oxygen therapy.

MATERIAL AND METHODS

Since 1971 and through 1981 31 cases of gas gangrene of the extremities have been treated in the Department of Orthopaedic Surgery, Rigshospitalet. Only 23 of these cases were definitively spreading or diffuse myonecrotic gangrene caused by Clostridium perfringens bacteria, defined by Altemeier & Fullen (1971) as a rapidly progressive infection of the muscles in which the connective tissue may be affected to a lesser degree at first. Several compartments are involved in the process. Only these cases will be considered in the present series.

The material comprises 14 men and nine women. Their average age was 52 years (range 12–82). All patients were admitted to the Department from an area covering 2.8 million inhabitants, which means a yearly frequency of 0.7 cases per million inhabitants.

In eight cases the cause of the clostridial infection was

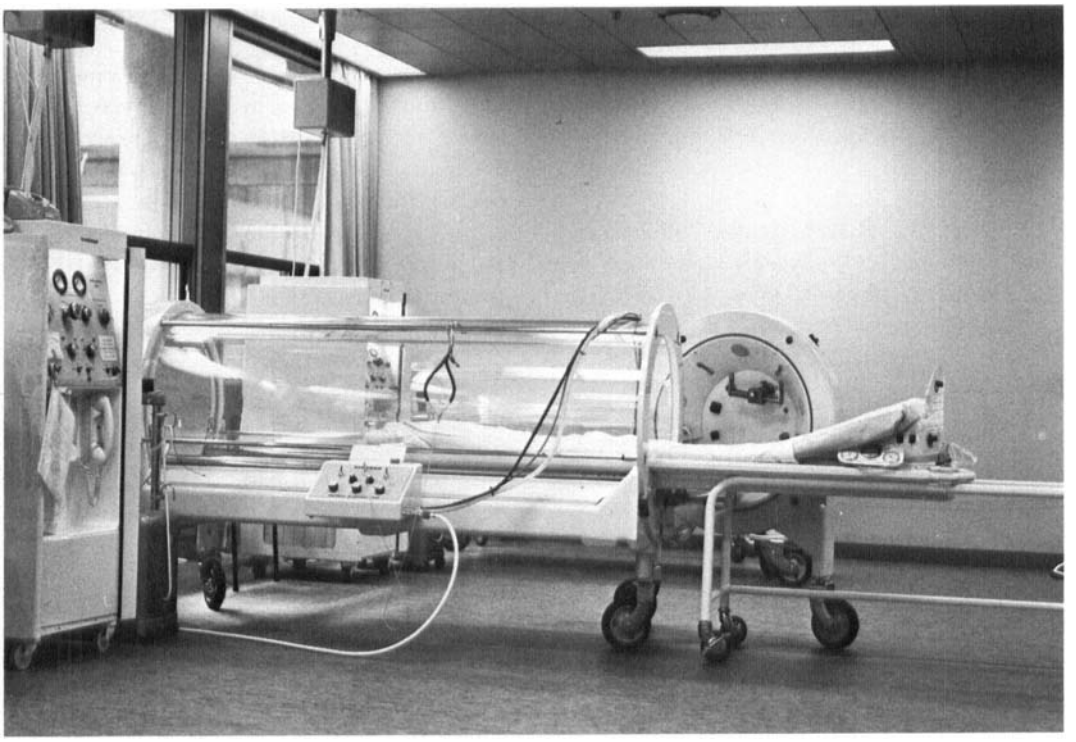

Figure 1.

fractures, six compound fractures and two fractures of the femoral neck. In seven other cases the cause of infection was amputation for arteriosclerosis or diabetic vascular insufficiency of the inferior limb and in one case a traumatic amputation of the lower limb. Two cases followed embolectomies of the femoral artery and four cases appeared in toe ulcers. Finally one case occurred spontaneously and another after an operation for a popliteal cyst. All cases were admitted from other hospitals and previous surgical measures such as wide incisions or amputations had been performed in all but two cases when the patients were first seen in this hospital. The bacteriological diagnosis was secured by anaerobic cultures.

On admission 11 out of 23 patients were toxic. Resuscitative measures were instituted and further treatment consisted of high-dosis benzyl-penicillin administration, opening of the wound if this was not done beforehand or fasciotomies in cases where the infection had spread more proximally than the incisions already made, followed by serial hyperbaric oxygen treatments for 1 hour at 3 atmospheres in an Armstrong-Vickers one-man Chamber (Figure 1). Every treatment was followed by surgical revisions, if necessary. All nonviable tissue was excised and treatments were continued until the patients were cured or had expired. Table 1 summarises the patients, causes of infection, previous treatment and results of treatment in this hospital.

RESULTS

In all, 87 per cent (20/23) of the cases were cured. Three patients died within 25 hours after admission in intractable shock. None of these obtained more than two treatments with hyperbaric oxygen, and all were toxic on admission. This means that three out of 11 toxic patients died, whereas none of the non-toxic patients died. However, this difference is not significant ($P = 0.1$, Fisher's exact test). Another point of interest was whether young people tolerated the infection better than elderly people. All of the seven patients under the age of 50 were cured whereas three out of 16 patients over the age of 50 were not cured. This difference is not significant. Neither could any significant difference be established in the outcome of the infection when cases with vascular insufficiency and cases with normal vascular conditions were compared, nor when the localisation distally or proximally of the extremity was compared. Multivariance analysis (Logit-analysis, Armitage 1971) was used in

order to find out whether the combination of age over 50, vascular insufficiency and toxicity was more crucial than age under 50, normal vascularity and non-toxicity. A significant difference in the frequency of death in relation to the described variables could not be established (P = 0.1).

When additional surgery after fulfilled treatment with hyperbaric oxygen was considered for the 20 patients who were cured, it was found that amputations were necessary in 10 patients, whereas the other half could be managed with revisions only.

The three patients that were not cured actually differed from the rest of the material as they were the only ones of their kind in the series, one being a spontaneous infection and the two others following embolectomies of the femoral artery.

DISCUSSION

First of all it should be stressed that gas gangrene is a *clinical diagnosis* characterised by the presence of infection and bacterial air production. Not all cases are caused by Clostridium perfringens and not all involve the muscles diffusely (Altemeier & Fullen 1971, Hedström 1975). However, every suspicion of gas gangrene should lead to institution of treatment which should always, as the first measure, include anaerobic and aerobic culturing of tissue from the affected area and not merely smears. It is believed that the reason why gas gangrene infections are so dangerous is the production and release of the potent alpha-toxin, the systematic absorption of which causes hemolysis and damage to organs, especially the brain and the kidneys. The proliferating Clostridium perfringens bacteria necrotises surrounding tissue, especially the muscles. The treatment is first and foremost aimed at rescuing the life of the patient. The bacteria is strictly anaerobic and this constitutes the basis for hyperbaric oxygen therapy. This does not stop the growth of the bacteria but stops the production of exotoxins (Jacobsen 1967). Several investigators have found that hyperbaric oxygen therapy should be performed at 3 atmospheres (Brummelkamp et al. 1961, 1963, Roding et al. 1972, Hedström 1975) in order to obtain this effect.

Most materials available are concerned with the treatment of gas gangrene as one entity and do not distinquish between different groups or affections, though it has been shown that the localised form and the cellulitis form are mild infections compared to the myonecrotic gangrene (Altemeier & Fullen 1971, Darke et al. 1977). Infections limited to the extremities run a milder course than if the trunk is involved (Holland et al. 1975). Others have found that trauma patients developing gas gangrene have a better prognosis than patients developing gas gangrene after elective operations (Roding et al. 1972). However, this difference could not be confirmed by Darke et al. (1977), or by the present series. Thus the mortality rate after gas gangrene of the extremities seems to lie between 8 and 13 percent in reports from Holland et al. (1975), Trippel et al. (1967) and Darke et al. (1977) all of whom used surgical measures, antibiotics and hyperbaric oxygen treatment. In contrast to these reports Altemeier & Fullen (1971) avoided the use of hyperbaric oxygen treatment and presented a mortality rate of 15 per cent in 54 patients with myonecrotic gas gangrene. Reports from the Second World War, where hyperbaric oxygen was not used, showed that surgery in combination with penicillin restricted mortality to between 14 per cent (Cutler & Sandusky 1944) and 25 per cent (Jeffrey & Thomson 1944). Thus one must agree with Darke et al. (1977) that so far the beneficial effect of hyperbaric oxygen therapy has not been definitively proved. Surgery, which diminishes intracompartmental pressure and thereby reduces muscular necrosis, still stands as one of the most important measures. On the other hand the importance of general resuscitative measures should not be forgotten as well as antibiotic therapy, which before the era of hyperbaric oxygenation proved to reduce mortality significantly (Macfarlane 1943, Cutler & Sandusky 1944, Jeffrey & Thomson 1944).

The postulated reduced amputation rate after treatment with hyperbaric oxygen (Roding et al. 1972) could not be confirmed by Darke et al. (1977) nor by the present series. The results are of course better than after so-called radical

Table 1. Clinical state of patients, treatment and results

Pat.	Age	Sex	Cause of infect.	Previous measures	Other diseases	Surgery after hyperbar treat.	No. of hyperbar treatments at 3 atm./hour	Result	Late result
1	79	M	Arterioscl. lower leg amp.	Femoral amp.	Diabetes TOXIC	None	9	CURE	
2	70	F	Spontaneous	None	TOXIC	Incisions	1	NO CURE	Died within 18 h Intract. shock
3	82	F	Arterioscl. lower leg amp.	Wound opening		Femoral amp.	11	CURE	
4	65	F	Pressure wound 5. toe	lower leg amp.	Diabetes	Femoral amp.	5	CURE	
5	59	M	Gangrene of great toe	Femoral amp.	Arterioscl. TOXIC	Revisions	4 (resp. probl.)	CURE	
6	58	F	Fem. neck fract. osteosynthesis	Incision	TOXIC	Exarticulation of the hip	18	CURE	Pelvic fistula for 1 year
7	73	M	Arterioscl. lower leg amp.	None	Diabetes	Femoral amp.	20	CURE	
8	54	M	Arterioscl. lower leg amp.	Femoral amp.	Diabetes	Exarticulation of the hip	15	CURE	
9	50	F	Embolus fem. art. Embolectomy	Incision	Leucaemia TOXIC	None	2	NOCURE	Died within 24 h Intract. shock
10	60	M	Embolus fem. art. Embolectomy	Femoral amp.	Diabetes TOXIC	Exarticulation of the hip	1	NO CURE	Died within 24 h Intract. shock
11	12	M	Vulnus lower leg Earth contaminat.	Incision	Haemophilia B	Femoral amp.	12	CURE	
12	16	M	Compound fract. lower leg	Incision		Revision	7	CURE	Pseudoarthrosis

13	31	M	Compound fract. Humerus	Humeral amp.	TOXIC	Revision	3 (claustroph.)	CURE	
14	20	F	Popletial cyst postop. infect.	Incision	TOXIC	Revision	7	CURE	
15	32	M	Compound fract. lower leg	Femoral amp.		Revision	6	CURE	
16	26	M	Compound fract. lower leg	Incision		Femoral amp.	8	CURE	
17	72	F	Compound fract. lower leg	Femoral amp.		Revision	17	CURE	
18	65	M	Diabetic toe ulcer	Lower leg amp.	Diabetes	Femoral amp.	7	CURE	
19	59	M	Compound fract. tibia & Femur	Incision	TOXIC	Femoral amp.	7	CURE	Femoral fistula for 3 years
20	64	F	Gangrene of foot	Femoral amp.	Arterioscl. TOXIC	Revision	16	CURE	
21	65	M	Fem. neck fract. osteosynthesis	None	TOXIC	Revision	10	CURE	
22	63	F	Toe ulcer	Incision	Diabetes Arterioscl.	Lower leg amp.	6	CURE	
23	19	M	Traum. Fem. amp. Earth contaminat.	None		Revision	4	CURE	

surgery (Jeffery & Thomsen 1944), which simply meant high amputation, but not better than wide incisions and fasciotomies as performed by Cutler & Sandusky (1944). This discussion does not intend to advise abandoning hyperbaric oxygenation in the treatment of gas gangrene, as no serious draw-backs have been reported (Jacobsen 1967) but it questions whether the better results could simply be on account of centralised treatment, which to-day has been instituted in many countries, and the better methods of resuscitation. We therefore suggest a comparative study, for instance in the Scandinavian area, where surgery (read wide incisions and fasciotomies) in combination with antibiotics is used as one treatment and the same measures in combination with hyperbaric oxygenation as the other.

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