THE TECHNIQUE AND APPLICATIONS OF CRYOTHERAPY IN SURGERY

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SYNOPSIS

This paper is intended to illustrate the technique of cryosurgery for the office practitioner using nitrous oxide as cryogen. The importance of (a) an adequate understanding of the principles of cryobiology, (b) careful patient selection, and (c) the proper method of freezing to achieve the best results, is emphasized.

Illustrative cases drawn from the 150 benign and 5 malignant cases treated at the Dept of Surgery, Changi Hospital over a 1 year period will be used to demonstrate its many useful applications in the surgical management of orofacial, dermatological and proctologic lesions.

Finally, the more serious as well as the commoner minor complications of this therapeutic modality will be discussed with respect to prevention and treatment.

INTRODUCTION:

In recent years cryosurgery has joined surgical excision and radiotherapy as an effective method of removing unwanted tissue. The controlled destruction can be achieved by using several cryogenic agents including nitrous oxide, freon, carbon dioxide and liquid nitrogen which produces subfreezing temperatures of -70 deg C, -22 deg C, -78.5 deg C and -196 deg C respectively. So long as a temperature of at least -20 deg C is obtained in the tissue, cryonecrosis of the lesion occurs.

Our 1 year experience at the Dept of Surgery, Changi Hospital (1981), has been limited mainly to the use of nitrous oxide which is ideal for office practice. The purpose of this paper is to give the practitioner a background of cryobiology and instruction in the use of the closed nitrous oxide probe in the management of common orofacial, dermatological & proctologic lesions (TABLE I) with emphasis on the special points which gives the best results.

CRYOBIOLOGY:

Freezing causes gross tissue changes in the cryolesion in temporal sequence as follows:

1) The immediate phase: Cryolesion produced by a 'freeze-thaw-freeze' cycle is a homogenous, soft tissue spherical lesion that stands out clearly from the surrounding normal tissue.
2) The delayed phase: This represents the ultimate stage of tissue destruction (cryonecrosis) occurring gradually over a few hours to 3 days. Final sloughing of the necrotic tissue may take from 1 to 2 weeks, with healing occurring in 4 to 8 wks.

The histologic picture is essentially one of ischaemic necrosis; marked constriction of microvessels occurs within the first 15 minutes. At cellular level, profound freezing cause ice crystal formation within the cells producing a disruptive effect on intracellular architecture particularly involving mitochondria, endoplasmic reticulum and cell membranes. Where freezing is less profound, extracellular ice may be deposited which causes water to be drawn from neighbouring cells with a damaging effect on their tonicity and the development of toxic levels of intracellular electolyte concentration. The reversal of these changes during thawing produces further cellular disorganisation.

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TABLE I:

ORAL LESIONS	
Retention cysts (buccal & lip)	22
Ranulas	3
Fibroepithelial papilloma	1
Accessory soft palate	1
SKIN LESIONS — FACIAL, TRUNK & EXTREMITIES	
Naevi	10
Acneiform moles	8
Haemangiomas	5
Pyogenic granulomas	8
Verrucae (warts)	17
Extremity papillomas (pedunculated)	3
Superficial pustules	16
PROCTOLOGIC LESIONS	
Acute fissure in ano	5
Condylomata	3
Haemorrhoids — first degree	9
— second degree	27
— third degree	12

SELECTION OF CASES:

This modality is particularly suitable in the following situations:

1) In patients who are highly anxious and nervous or have a fear of excisional surgery,
2) In the cosmetically inclined or for lesions located in areas which are cosmetically important e.g. the face,
3) When formal excisional surgery is refused,
4) In patients who are high surgical risks because of age or severe associated disease,
5) For patients who have infiltrating cancers persisting after failure of other methods of treatment, e.g. cancer arising in irradiated skin,
6) As palliative treatment for advanced cancer presenting for the first time.

THE APPARATUS:

The equipment used is a closed nitrous oxide probe (eg. Frigitronics, Connecticut, U.S.A.) which operates on the Joule Thompson Principle of rapid cooling during the adiabatic expansion of a gas. It is usually supplied with a complete range of cryosurgical probes to meet the requirements of each and every situation. This system (Figure I) marketed by Frigitronics, gives a working temperature of -70 deg C and is suitable for most purposes including the treatment of malignant lesions. To ensure thermal conductivity between cryolesion & probe, a gel (e.g. K-Y Jelly, Johnson and Johnson) is required. The latter also determines the size of the iceball created.

THE TECHNIQUE:

The method is to apply the cryoprobe to the lesion (Figure II), allow nitrous oxide gas to flow and induce freezing in the tissue and observe the course of freezing as it extends around the cryolesion. When freezing has reached satisfactory limits, which means that the entire lesion and a satisfactory margin (approx. 2 to 5 mm) of apparently normal tissue is frozen, the probe is allowed to rewarm and removed (Figures III & IV). The duration of each freeze should take between one & a half to 3 minutes depending on the type of lesion. Lesions too large to be frozen in a single application of the probe are treated by multiple applications, each time to a different area of the same lesion. Alternatively, a probe

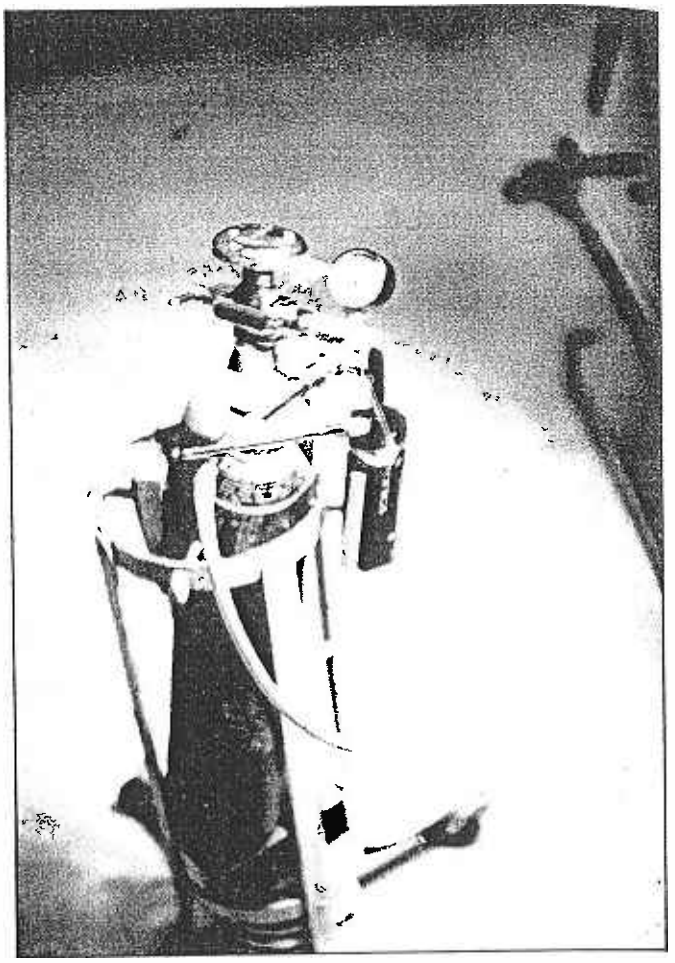

Fig. 1

with a larger surface area is used. After the lesion has thawed a second cycle of freezing is necessary because repetition of freezing increases the certainty of cellular death. In summary, the basic technique is to induce rapid freezing, allow slow unassisted thawing & repeat the freezing cycle.

To obtain optimal results, the following factors require strict attention:

1) the probe temperature,
2) period of exposure to low temperatures,
3) thermal conductivity of the tissue to cold application,
4) freezing surface of the cryoprobe,
5) the pressure exerted on the lesion during the procedure.

It is essential that the probe temperature be lower than -20 deg C. Certain instruments contain an in-built thermocouple for monitoring probe temperature. However for all practical purposes, the probe tip temperature is best maintained by ensuring an adequate pressure of the inflowing nitrous oxide gas. The duration of freezing required for each lesion can be quickly learnt as more experience is gained while the freezing area of the probe can be easily adjusted by changing to a different cryoprobe with a surface area and shape corresponding to the lesion. The thermal conductivity of various tissues is more difficult to adjust e.g. keratinised skin is more resistent to damage by freezing as compared to mucous membranes and may therefore require liberal use of a thermal enhancing jelly between the probe and the lesion and an extended period of freezing time as well as further freeze-thaw cycles. The greater the pressure exerted on the lesion, the greater the depth of freezing is achieved.

AFTER-CARE

After cryotherapy, the area should be kept as dry as possi-

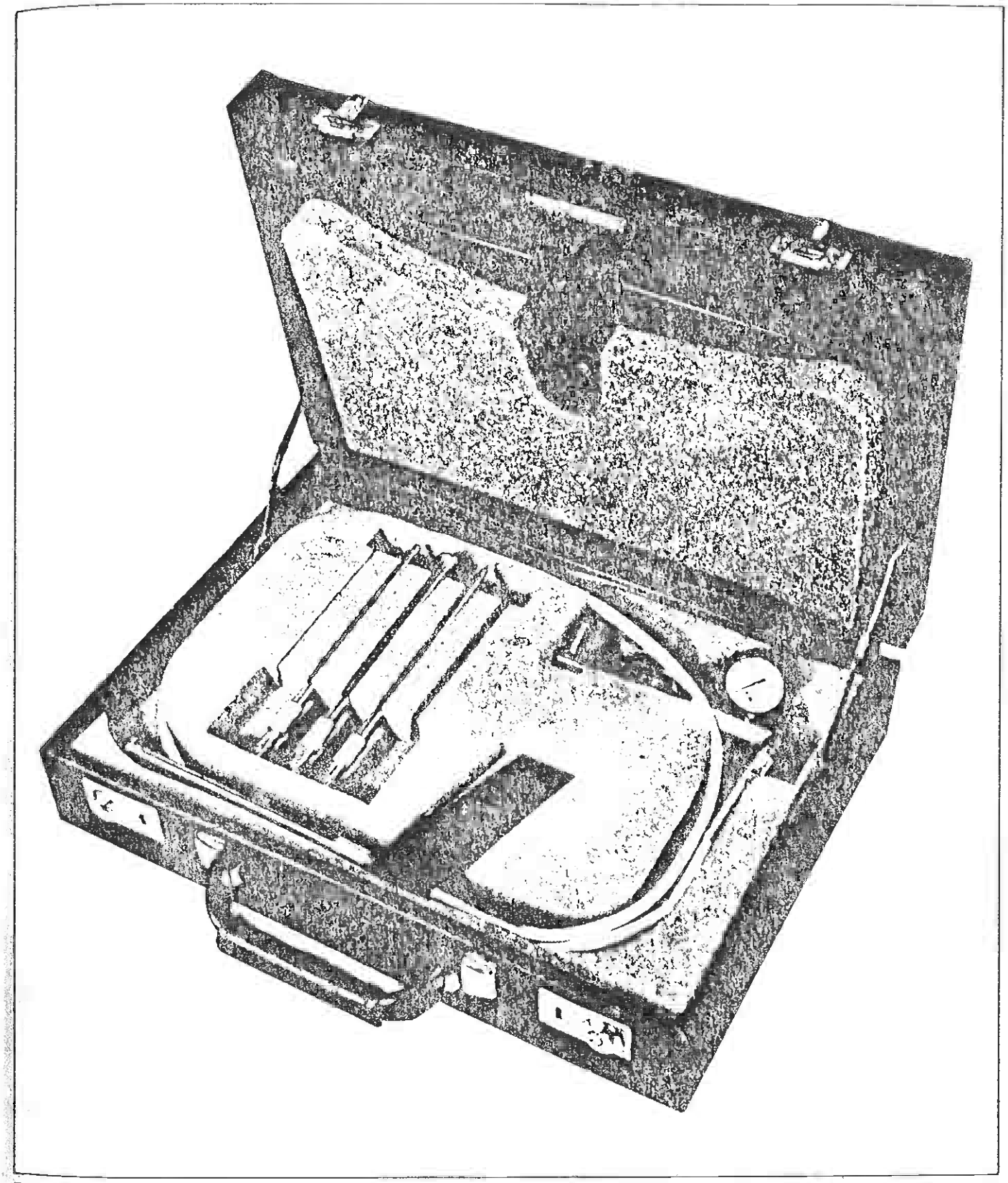

FIGURE I: CM-73

ble and preferably covered with a clean dressing. Scabs should be allowed to separate naturally. For lesions producing profuse discharge after cryosurgery e.g. haemorrhoids, absorbent dressings are required. In proctology, we have found the use of female sanitary pads advantageous & convenient for the patient. For oozing wounds following cryosurgery of malignant lesions, a high molecular weight dextran powder with strong hydrophilic properties (Debrisan®) can be used on the dressings. It is a simple, effective and safe method to collect postoperative wound exudation. Good oral hygiene and frequent cleansing is essential for all oral lesions. Lesions on the extremities can often be left exposed with good advantage.

COMPLICATIONS: (TABLE II)

The more serious complications (1) following cryosurgery include reactionary or secondary haemorrhage, infection, nerve damage and hypertrophic scarring. We have not experienced any of these. However we have encountered

the 'minor complications' which include post-inflammatory hyperpigmentation, hypopigmentation & delayed healing. Reassurance and the use of steroid creams is the treatment for postinflammatory hyperpigmentation while reassurance suffices for delayed healing. The best treatment for hypopigmentation is its prevention ie. treatment should be staged for larger lesions. Once it occurs, reassurance that the extent of the area will contract to an acceptable size is that that can be done, and for all intents & purposes is cosmetically acceptable. We have met with cases in which total return of colour returned when the initial cryolesion did not involve the basal layer of the skin; hence the rationale for staging the procedure.

The serious complications indicated above are rare. Electrocoagulation of the bleeding points may be necessary for reactionary haemorrhage while a course of antibiotics & pressure dressings is treatment for infective bleeding. Prohylactic antibiotics should in this respect be considered if the lesion is noted to be large and necrotic. Nerve damage to perpheral nerves usually recover although this may take several months. Hypertrophic scars are treated by intralesional steroid injections.

TABLE II:

COMPLICATIONS OF CRYOSURGERY

	Temporary	Permanent	Total
Hypopigmentation	5	1	6
Hyperpigmentation	2	1	3
Delayed healing			1
Infection			1
Hypertrophic scarring			1
Nerve damage			0
Secondary haemorrhage			0
			12

USE FOR BENIGN LESIONS: (TABLE III)

Cryohaemorrhoidectomy (2, 3) (Fig. II) has an established place in the practice of proctology. Freezing of the vascular haemorrhoid has many advantages over conventional methods including that of ligation, although cryosurgery is often used in conjunction with the latter. We employed cryosurgery alone for grades I & II haemorrhoids but combined it with ligation for the grade III variety, and have found good results with this approach. A shortened postoperative recovery period is the major advantage of cryohaemorrhoidectomy. Patients can usually go home immediately following the operation and return to work in a day or so. However many patients prefer to remain at home until the period of excess drainage (usually 3-4 days) is over. Conventional surgery requires a hospital stay of 3-4 days and 1-2 weeks of further convalescence during which the patient cannot return to work. There is also postoperative pain and interference with bowel movements, both of which are lacking with cryosurgery. Additionally, no general or spinal anaesthesia is required for the procedure. Local anaesthesia may only be required if freezing is done below the pectinate line.

We discovered like Williams & Holden (4) that cryo-

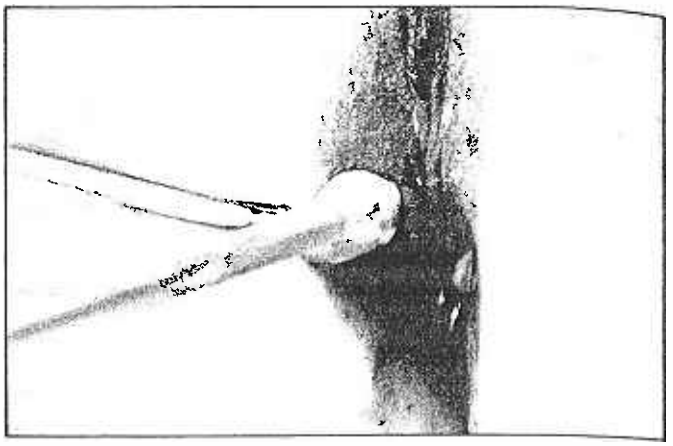

Fig. 2A

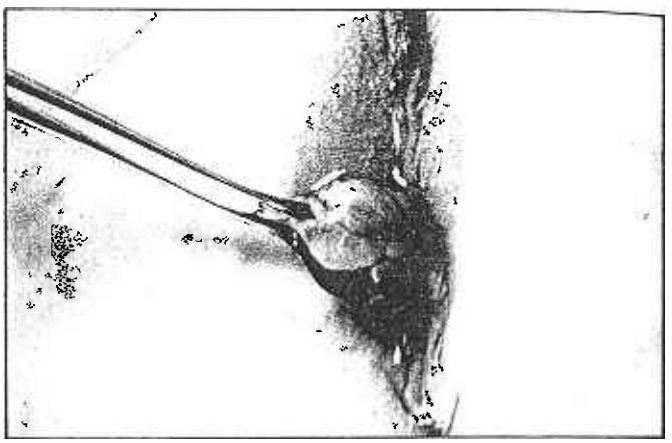

Fig. 2B

TABLE III:

BENIGN LESIONS — RESULTS OF TREATMENT

	Cured after 1st cryo	Cured after 2nd cryo	Failure
Haemorrhoids — 1st deg	9	—	nil
— 2nd deg	12	10	5
— 3rd deg	5	5	2
Retention cysts (buccal & lip)	14	7	1
Fibroepithelial papilloma	1	—	nil
Accessory soft palate	1	—	nil
Acute fissure in ano	5	—	nil
Condylomata	3	—	nil
Naevi	6	4	nil
Acneiform moles	4	4	nil
Haemangiomas	3	2	nil
Pyogenic granulomas	6	2	nil
Verrucae	11	6	nil
Extremity papillomas	3	—	nil
Superficial pustules	16	—	nil
Ranulas	3	—	nil

Fig. 2C

surgery was ideal for treating epitheleal cysts, ranulas and other lesions including small fibroepithelial papillomas of the oral region. Others[5] have not had the same good results probably because of differences in technique. Many vascular lesions ranging from small telangiectases & naevi to massive haemangiomas have been treated with excellent results. Freezing produces thrombosis of the microcirculation after 24 hours. Before cryosurgery was available, many of these lesions due to their size or location were virtually untreatable. The treatment may require to be staged in order to prevent scarring and hypopigmentation in the area of the face. The same good results is reported elsewhere (1, 4, 6). Seborrhoeic and infectious lesions eg. verrucas, warts, condylomas and infective granulomas are reported admirably suitable for cryotherapy (1, 4), and our experience confirms this finding.

USE FOR MALIGNANT LESIONS: (TABLE IV)

Although it is tempting to use cryosurgery as a primary form of therapy for cancer, we have chosen to reserve this form of treatment for selected patients only (7, 8). Other authors (6, 9, 10, 11) hold the same reservations preferring to use conventional surgery except for patients meeting with the criteria mentioned earlier. Essentially our experience with malignant lesions is with:—

(1) a large & fungating basal cell carcinoma on the scalp of a 90 year old female (Fig. III) who has had an esophageal bypass operation done for carcinoma of the esophagus. The 2 tumours and her age explains our bias towards cryosurgery for her basal cell tumour.
(2) a 48 year old male who developed recurrence to the groin skin after amputation had been done for a carcinoma of the penis followed by radiotherapy to the groin nodes. A further course of radiotherapy to the groin area would aggravate lymphoedema of his right leg which was already obvious this time.
(3) Three cases of recurrent Carcinoma of the breast. The patients, all females in their fifties, each had simple mastectomy & postoperative radiotherapy for one sided cancer breast between 2 to 4 years ago. Because of moderate lymphoedema arising in the arm of the side receiving radiotherapy, Cryosurgery was elected as the treatment modality of choice for their recurrent skin lesions.

The results were very good and the patients were relieved of their painful, infected & fungating tumours.

IMPORTANT ADVANTAGES:

The advantages of cryosurgery over cold knife surgery are that it is simple & safe. The procedure is virtually painless

TABLE IV:

MALIGNANT LESIONS — RESULTS OF TREATMENT

	Treatment satisfactory	Treatment unsatisfactory
Basal cell carcinoma	1	nil
Carcinoma penis	1	nil
Carcinoma breast	3	nil

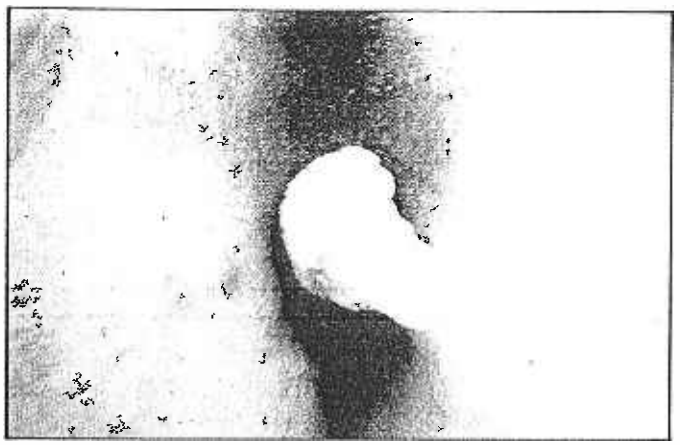

Fig. 3A

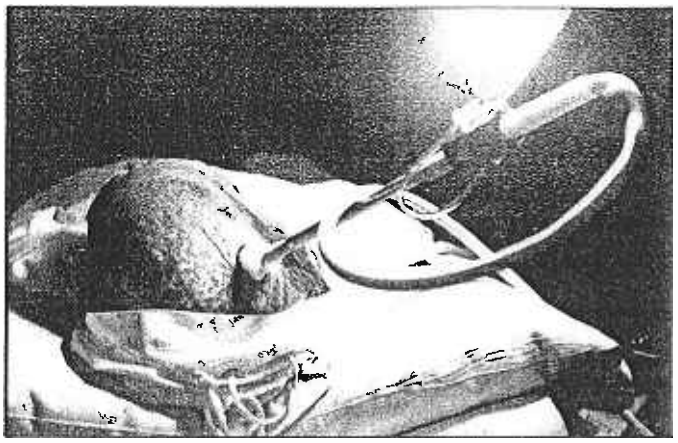

Fig. 3B

Fig. 3C

(due to cryoanaesthesia of the nerve endings). At the time of the therapy there is absence of haemorrhage due to the immediate haemostatic effect of this modality, thus affording the opportunity for cryobiopsy should this be deemed necessary. Furthermore, the area treated is rendered completely aseptic. Focalisation of the treatment on only the area to be treated, even in complex anatomical regions, is

an added advantage when cosmetic or functional considerations are important.

CONCLUSION:

Cryosurgery should be performed for the common orofacial, dermatological and proctologic lesions we have described. Proper selection is essential especially when malignancy is being treated. To get the best results, the finer points in the technique are important and should be strictly followed

REFERENCES:

1. Torre D: Cryosurgery in Dermatology, in Von Leyden H, Cahan W (eds): Cryogenics in Surgery. Flushing, N Y, Med Exam Publ Co, 1971, 500-529
2. Lloyd Williams K. Cryodestruction of haemorrhoids. Brit Med J 1973; 1:666 — 8.
3. Kaufman H D: Outpatient Treatment of haemorrhoids. Brit J Surg 1976, 63:462 — 3.
4. Williams K L, Holden H B: Crosurgery in general and ENT surgery. J Hosp Med 1975; 14:14-25.
5. Poswillo D E: Cryodestruction of the oral mucous membranes. Proc roy soc med 1975; 68:608-9.
6. Bradley P F Cryosurgery of the Oral region. Ann Acad Med Singapore 1980; 9:350-3.
7. Gage A A, Gonder M et al: Cancer cryotherapy. Milit Med 1967; 132:550-6
8. Blackwwod J, Moore F et al: Cryotherapy for malignant tumours Cryobiology 1967, 4 33-8.
9. Gage A A: Cryosurgery for cancer — an evaluation. Cryobiology 1969, 5.241-8.
10. Giovanni, D. Medical News. JAMA 1971; 216:31-32.
11. Holden H. Indications and limitations of cryosurgery in head and neck neoplasia. Proc roy soc med 1974:67;76-9.