Cryotherapy after total knee replacement: a survey of current practice

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ABSTRACT Background and Purpose. Cryotherapy is commonly used during physiotherapeutic rehabilitation after total knee replacement (TKR). Evidence for treatment effectiveness is contradictory and there are no clinical guidelines to inform treatment protocols within this patient group. The present survey investigated current cryotherapy practice after TKR throughout the United Kingdom (UK). Method. A postal survey, containing open and closed questions, was distributed to senior inpatient orthopaedic physiotherapists (n=453). Results. The response rate was 67% (304/453) and 58% (263/453) of the responses were completed by physiotherapists who treated TKR patients in the acute phase. Of these, 33% (85/263) routinely applied some form of cryotherapy after TKR. Physiotherapists working in the private sector were more likely to use cryotherapy and had greater access to Cryocuff equipment. The two main methods of cryotherapy application were the Cryocuff device, 59% (155/263) and crushed ice, 30% (79/263). Treatments were applied most frequently between 24 and 48 hours post-surgery, for 20 minutes, twice a day. Lack of proven efficacy was the most frequently stated reason for not applying cryotherapy treatment, and swelling was the most common indicator for treatment. There was particular uncertainty about the physical management of the Cryocuff device. Conclusions. There was little consensus with regard to treatment indicators, method of application and the management of cryotherapy after TKR. The results highlight a lack of consistency in the application of cryotherapy after TKR, indicating a need for further research.

Key words: Cryocuff, cryotherapy, physiotherapy, total knee replacement (TKR)

INTRODUCTION

For thousands of patients who have severe degenerative changes or arthritic disease of the knee, a total knee replacement (TKR) is the treatment of choice (Ritter and Stringer, 1979) and the procedure is now common-place in orthopaedic hospitals in the UK. It is recognized that the majority of TKR operations have a positive outcome, including improved quality of life, decreased pain, increased range of movement and function (Insall et al., 1989). However, the immediate post-operative
period and early recovery is hindered by substantial pain (Crutchfield et al., 1996) and swelling (Schroder and Passler, 1994).

Insertion of a TKR causes a localized severe inflammatory response in the soft tissues of the knee, with local haemorrhage and haematoma formation. The mechanism of the acute inflammatory process has been described extensively (Knight, 1976; Michlovitz, 1996) and reaches its peak in the first few hours after surgery. Swelling is maximal in the early post-operative stage, and is a common complaint in the initial rehabilitation stage of TKR (Jurkovich et al., 1988).

The benefit of cold and compression in reducing swelling and pain has been well established for many years (McMaster and Liddle, 1980; Berman et al., 1988; Sloan et al., 1988; Cohn et al., 1989; Shelbourne and Wilkens, 1990; Healy et al., 1994) and a variety of devices have been designed to deliver controlled cryotherapy with and without added compression (Knight, 1995, Chapter 8), including:

- Ice packs.
- The Cryocuff: a device that combines ice-cold water and compression (<30 mmHg) using an inflatable cuff (Aircast Cryocuff, 2003).
- Chemical cold packs.
- The Cryologic: a device that employs a pump mechanism to circulate cooled water continuously through a knee cuff to maintain a constant reduced temperature.

The application of cryotherapy after TKR has been described extensively in the literature; however, its benefits are unclear. Some authors reported reduced levels of blood loss, reduced analgesic requirement and improvements in range of motion (Walker et al., 1991; Levy and Marmar, 1993; Webb et al., 1998), but others do not demonstrate these findings (Healy et al., 1994; Leutz and Harris, 1995). Possible explanations for variation in trial results are differences in the clinical protocol or the type of cryotherapy application. The aim of the present survey was to establish the range of current cryotherapy practice after TKR in the UK, and to inform the design of a clinical trial investigating cryotherapy treatment.

METHOD

A postal questionnaire was designed specifically for this project following a literature review of the existing evidence of cryotherapy use and semi-structured interviews with three senior physiotherapists. The purpose of the interviews was to establish the framework and content of the questionnaire. Each physiotherapist interviewed had more than four years' experience in the management of TKR and therefore could be regarded as having in-depth knowledge of the procedure (Oppenheim, 1992; Bork, 1993). A draft version of the questionnaire was sent to 33 physiotherapists, all of whom were known to be involved in the acute management of TKR patients, after which further amendments were made to the format and content of the instrument. The final questionnaire comprised 19 questions in four distinct sections:

- Type of hospital and grade of respondents.
- Questions on cryotherapy use.
- The Cryocuff device.
- Cryocuff device maintenance.

Population sample

The target population comprised chartered physiotherapists who treat acute TKR patients in the National Health Service.
(NHS) and private hospitals within the UK. The sample frame was constructed from several databases: the Association of Chartered Physiotherapists in Management; the Association of Orthopaedic Chartered Physiotherapists; and from a manual search through a database of UK NHS trusts and private hospitals. Purposive sampling was then used to target the strata of hospital sites that would carry out TKR surgery (Cohen and Manion, 1994; Sim and Wright, 2000). In total, 453 questionnaires were posted to selected sites (92 private, 361 NHS). If the questionnaire was not appropriate to a particular site a request was made that it was passed on to a colleague considered qualified to respond to the questionnaire, thus utilizing the ‘snowball technique’ (Oppenheim, 1992, p. 43; Polit and Hungler, 1997).

Data analysis

Data were summarized as frequency counts, or as the mean and standard deviation (SD) for continuous data. Chi-square tests were used to test for significant differences in the application of cryotherapy between NHS and private sites. A comparison of continuous variables was made by use of independent sample Student’s t-tests. Data analysis was performed using the Statistical Package for Social Sciences (SPSS) software, Version 9, and statistical significance was claimed at \( p < 0.01 \). Frequency analysis was used for responses to the open questions to identify recurring themes and elements within the data.

RESULTS

The response rate to the initial mailing was 58% (263/453); this increased to 67% (303/453) after a second mailing to non-responders. A total of 13% (40/303) of returns were inappropriate (as responders were not involved in TKR rehabilitation), leaving 263 questionnaires coded for analysis. The majority, 74.5% (196/263), of respondents reported that they were employed by the NHS, 69.2% (182/263) were employed in general hospitals, 4.9% (13/263) in orthopaedic hospitals and 0.4% (1/263) in a community unit. The remaining 25.5% (67/263) of respondents were employed in the private sector. Just over 63% (166/263) of respondents were graded senior 1, 18% (48/263) were superintendents, 12% (34/263) were graded senior II, 4% (10/263) were clinical specialists, 1% (3/263) were physiotherapy managers and there was one team leader and one self-employed respondent, representing 0.4%, respectively.

Use of cryotherapy

The results indicated that 33% (85/263) of respondents would routinely use some form of cryotherapy after TKR. However, based on clinical need, 99% (260/263) of TKR patients would be considered for treatment with cryotherapy. Three respondents (1%) reported that they never used any form of cryotherapy after TKR.

Application of cryotherapy

The application methods reported were: the Cryocuff device 59% (156/263); crushed ice 30% (80/263); the Cryologic device 4% (11/263); chemical ice packs 3% (9/263); and cold wraps 2% (4/263). One per cent (3/263) of respondents did not use cryotherapy.

The most common time to deliver the first cryotherapy application was within 48 hours of surgery, 33% (86/263), with the majority of patients, 77% (204/263), receiving their first cryotherapy application between 24 and 48 hours of surgery (Figure 1).
The most common frequency of cryotherapy application was twice per day, reported by 39% (102/263) of respondents (Figure 2).

The average duration of cryotherapy treatment was 23 minutes (SD 17.8 minutes). Two respondents who used the Cryologic device reported that the device, once applied, was used constantly for the initial post-operative period. Owing to the nature of the Cryologic device, individual treatment times (from 20 minutes to three hours) are not comparable with the other more standard methods of applying cryotherapy and therefore the results from use of the Cryologic device are not presented here. The mean duration of treatment times was similar between NHS (23 minutes, SD 15.8 minutes) and private sites (22.7 minutes, SD 11.4 minutes), suggesting a similar approach to this aspect of treatment management (Student’s t-test (258) = 0.562; p>0.05).

**Decision to apply cryotherapy**

Respondents cited personal preference, 93% (244/263), and consultant preference, 86% (226/263), as the most common indicators for the application of cryotherapy. Lack of proven efficacy, 92% (242/263); lack of time, 76% (200/263); and concern about complications, 69% (181/263), were also reasons for its non-application.

The vast majority of respondents, 96.6% (254/263), reported no complications associated with cryotherapy application. However, 2.3% (6/263) of respondents gave details of complications (Table 1); 1.1% (3/263) of respondents did not reply to this question as they did not apply cryotherapy.

When asked which clinical features influenced the decision to apply cryotherapy, 96% (254/263) of respondents indicated that swelling was an important factor, as were pain, 85% (223/263), and increased skin temperature, 81% (214/263).
The results indicate that NHS sites commonly have more TKR patients (mean 6.7, SD 4.4) needing treatment than they have Cryocuff devices (mean 4.2, SD 3.3), whereas within the private sector the reverse is true (number of TKR patients: mean 3.2, SD 2.1; number of Cryocuff devices: mean 4.7, SD 3.6).

The majority of respondents (88%, 164/187) who had used a Cryocuff device after TKR reported that the initial Cryocuff treatment was applied by a physiotherapist, and by a physiotherapy assistant in 7% (14/187) of cases. Physiotherapists applied subsequent treatments in 60% (113/187) of cases, and this was applied by physiotherapy assistants in 37% (70/187) of cases.

The majority of respondents (80.2%, 150/187) stated that if able, patients were encouraged to self-treat. However, these respondents indicated that only 60% (112/187) of the patients able to self-treat with the Cryocuff device actually did so.

Respondents were asked how the Cryocuff devices were cleaned, decontaminated and protected between patient contacts. A total of

![Frequency of cryotherapy application](image)

**FIGURE 2: Frequency of cryotherapy application.**

**TABLE 1: Reported complications of cryotherapy**

| Poor wound healing due to sweating beneath Cryocuff (n = 1) |
| Poor wound healing due to sweating beneath plastic cover used to protect the Cryocuff (n = 1) |
| Pad of Cryocuff slipped onto the skin and caused a small blister (n = 1) |
| Ice burn — ‘need to skin sensation test first’ (n = 1) |
| Drop foot after Cryocuff application, ‘recovered after Cryocuff removed’ (n = 1) |
| Ice pack applied directly over wound of a patient with poor skin healing process — delayed wound healing further — delayed rehabilitation process (n = 1) |

![Table 1: Reported complications of cryotherapy](image)
188 responses concerning cleaning the Cryocuff device were received, detailing the use of 23 separate cleaning solutions and methods, each of which could be categorized as having one of three main effects, cleansing, disinfecting or sterilizing, with some respondents using more than one cleaning method.

In total 4% (7/188) of respondents commented that the infection control department had authorized their method of cleaning the Cryocuff device, and 17% (32/188) of Cryocuff users commented that the Cryocuff is marketed as a single-patient-use device. In total, 8% (16/188) of respondents reported that they always used the Cryocuff device for one patient. All these respondents were from the private sector; there was no evidence of single-patient use within NHS sites.

How the Cryocuff device was protected from soiling by wound exudate or blood was commented on by 165 respondents, with 14 different methods being described. Significant differences between NHS and private sector utilization of cryotherapy are detailed in Table 2.

**DISCUSSION**

This is the first national survey to report on the use of cryotherapy after TKR. The initial response was increased following a reminder letter to non-responders. The response rate was high for both original and first follow-up mailings (Cohen and Manion, 1994, p. 114) so further follow-up mailshots and a survey of non-responders was considered unnecessary. The majority of responders were of at least Senior 1 clinical grade and would therefore be representative of experienced clinicians.

Evidence of the effectiveness of cryotherapy is uncertain; however, the present survey indicates that the majority of physiotherapists in the UK apply some form of cryotherapy following a TKR. At some centres, cryotherapy was automatically part of the post-operative routine. At others, treatment was applied on the basis of ‘clinical need’, with the majority of patients still receiving the treatment. The application of post-operative cryotherapy is a practice supported by Shelbourne and Wilkens (1990), Levy and Marmar (1993), Leutz and Harris (1995) and Webb et al. (1998), who documented the benefits of cryotherapy following efficacy trials. However, Healy et al. (1994) report no objective benefit in range of movement, swelling, blood loss or analgesia.

There is considerable variation in how cryotherapy is applied. The most popular

| TABLE 2: Factors in which there are significant differences in cryotherapy management between NHS and private sites |
|-------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Factor                                           | Important       | NHS (Yes/No) | Private (Yes/No) | Chi-square (χ²) | Degrees of freedom (df) | p = |
| Lack of time                                     | Yes             | 75            | 2               | 70.001          | 1               | 0.001          |
|                                                  | No              | 4             | 20              |                 |                 |               |
| Consultant preference                            | Yes             | 27            | 2               | 7.059           | 1               | 0.008          |
|                                                  | No              | 9             | 0               |                 |                 |               |
| Ice availability/cost                            | Yes             | 64            | 2               | 49.221          | 1               | 0.001          |
|                                                  | No              | 9             | 20              |                 |                 |               |
| Cryotherapy used routinely                       | Yes             | 52            | 34              | 13.305          | 1               | 0.001          |
|                                                  | No              | 144           | 33              |                 |                 |               |
method of cryotherapy application was the Cryocuff device, which is also able to deliver a controlled amount of compression during treatment. There is supportive evidence that external compression limits haematoma formation (Watson-Jones, 1957; Matsen and Krugmire, 1974; Brodell et al., 1986), reduces swelling (Cote et al., 1998) and that a combination of both compression and cryotherapy is more effective than either treatment in isolation (Sloan et al., 1988).

The popularity of the Cryocuff device found in the present survey may relate to ease of use, in that it conveniently combines cryotherapy and compression and can be applied by trained and untrained clinical staff or patients themselves.

In the literature the Cryocuff device has not been associated with any post-operative complications, whereas crushed ice and chemical ice packs placed directly against the skin have been reported as giving rise to complications (Stevens and D’Angelo, 1978; Drez, 1989; Bassett et al., 1992; Fye and Denkler, 1993; McDowell et al., 1994; Moeller et al., 1997). The present survey reports six undesired events associated with the application of a Cryocuff device, which appear to relate to a sub-optimal mode of application. This appears a very low complication rate, although it should be noted that the survey did not elicit utilization rates on a per-patient basis.

There is disagreement about the effect cryotherapy has on swelling. Knight (1995, p. 173) states that cryotherapy has a beneficial effect on swelling, although experiments on pigs (Farry and Prentice, 1980) suggest that cryotherapy alone could increase post-traumatic swelling and even cause swelling on uninjured tissue. The exact reduction in temperature achieved in the treated tissue was not stated in this study so comparison with other research is problematic. The issue of whether cryotherapy alone influences swelling is further complicated as many researchers have investigated cryotherapy and compression combined (Levy and Marmar, 1993; Healy et al., 1994; Schroder and Passler, 1994; Whitelaw et al., 1995; Dahlstedt et al., 1996; Speer et al., 1996).

There are indications that the availability of resources is a factor affecting the provision of cryotherapy treatment. There were statistically significant and quite notable differences between NHS and private sites relating to lack of treatment time and cryotherapy resources; all the respondents who reported single-patient usage with the Cryocuff device were from the private sector.

There was considerable variation in reported methods of cleaning and protecting Cryocuff devices. Recycling single-use items is a recognized occurrence in the NHS (Wilson, 1995) and provided the recycling is performed responsibly and under the direction of the infection control department, it has been suggested that there is no reason why this practice should involve any additional risks (Meers et al., 1997; Pickersgill, 1998). There was little consensus on the methods of protecting the wound from the Cryocuff and, conversely, protecting the Cryocuff device from contamination from wound exudate.

It is unclear from the current literature whether differences in the method of cryotherapy application are important. Some studies do not stipulate how long after surgery cryotherapy is applied, whereas others indicate that the first treatment was applied immediately after the wound was closed and dressed in the operating theatre. This practice is supported by McLean (1989), Low and Reed (1994) and Knight (1995, Chapter 9), the PRICE guidelines (CSP, 1998) and Jozsa (1998), all of whom support the application of cryotherapy as soon as possible after acute trauma to slow
the metabolism and protect surrounding healthy tissue from ensuing secondary hypoxic injury. Ho et al. (1995), in an investigation of cryotherapy duration, concluded that a treatment of 25 minutes produced optimum effects, and this was remarkably similar to the average duration of cryotherapy application reported in our survey. From the present survey, it appears that there is a wide range of current practice, indicative of uncertainty as to whether cryotherapy is effective, and if so, which is the optimal method of application. There are no standardized clinical guidelines relating to cryotherapy management in terms of the method of application, or on which post-operative day therapy is started, or the frequency with which it is applied. However, despite this apparent confusion, there is evidence in the literature that cryotherapy can be effective and present experience suggests that patients derive some objective and subjective benefits from it (Shelbourne and Wilkens, 1990; Webb et al., 1998; Leutz and Harris, 1995). Enloe et al. (1996) investigated physiotherapists’ methods of treating TKR and observed a multitude of different treatment programmes. Their study concluded that it would be beneficial for physiotherapists to have standardized treatment methods devised from expert consensus. However, Wakefield (2000) recognizes that ‘Expert opinion, although much revered, is purely subjective and may vary between experts on the same subject’. This is a view shared by Sackett and Richardson (1996) and Bithell (2000), who recommend that external evidence borne from rigorous research should always be used to supplement expert opinion.

IMPLICATIONS

The present survey found that after TKR the Cryocuff device is used in preference to all other forms of cryotherapy. However, there remains both variation in practice and uncertainty in the literature as to whether this treatment modality is to be used routinely, only in the presence of certain clinical indicators, or not at all.

The survey confirms that cryotherapy is considered by some physiotherapists to be a useful adjunct to physiotherapeutic rehabilitation of TKR, despite a lack of clarity regarding clinical benefits and conflicting evidence in the literature. Further research is required to investigate the clinical benefits associated with cryotherapy application after TKR.

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