

Original Article

Comparison the effects of pressurized salt ice packs with water ice packs on patients following total knee arthroplasty

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Abstract: The aim of this study was to estimate the effects of pressurized salt ice packs (PIP) with water ice packs (WIP) which are used to relieve pain and decrease swelling on patients following total knee arthroplasty (TKA). Sixty-nine patients undergoing primary unilateral TKA were randomly divided into two groups (PIP group and WIP group). We used a visual analog scale (VAS) to score knee pain and the score was recorded. The knee bilateral girth, the slipping times of the ice pack, and the times of wound dressing or bed moist were recorded during cryotherapy. The scores of pain between the two groups were significant difference in 12 h, 24 h, 48 h and 72 h after TKA ($P < 0.05$). No significant difference was found for the girth measurements of the operative knee on the two levels in 12 h, 24 h and 72 h, respectively. However, there was statistically difference for girth measurements between the two groups in 48 h after TKA ($P < 0.05$). PIP is a cheap, safe and simple method, which is more effective than WIP on reducing pain and swelling degree of patients. Thus, PIP is recommended in clinical nursing work.

Keywords: Cryotherapy, total knee arthroplasty, pain, swelling

Introduction

Nowadays, osteoarthritis (OA) is a very common joint disorder in worldwide. Radiographic evidence shows that majority of patients with OA aged 65 years or above and about 80% of patients with OA aged 75 years or older [1]. OA patients were characterized by frequent pain, loss of function and disability. OA currently ranked the eleventh leading cause among patients with disability [2]. In 2012, nearly one seventh adults aged over 45 years had doctor-diagnosed OA in South Sweden [3]. In US, it is second only to ischaemic heart disease as a cause of work disability in men over 50 years old, and accounts for more hospitalizations than rheumatoid arthritis (RA) every year [1]. It is reported that over 26000 new OA cases of 1000000 population aged 45 or older will have consulted healthcare by 2032 [3].

Total knee arthroplasty (TKA) is a common surgical procedure for patients who have an end-

stage OA. In fact, the patients following TKA will undergo a severe pain and have frequent chronic pain. Several factors are associated with the severe acute pain after surgery, including psychological factors and severe preoperative pain [4]. Pain can affect patients' walk ability, general exercise [5]. The rehabilitation time of patients will decrease when the pain is better managed [6].

To manage pain, a non-pharmaceutical approach maybe a valid method which reduces medication use. Evidences support that cryotherapy combined with pharmaceuticals for managing pain become more popular [7]. Cryotherapy can effectively relieve swelling and pain of patients [8]. Meanwhile, Cryotherapy also is a useful measure, adjunctive and analgesic. Many studies showed that cold can relieve the pain of wound which is an analgesic method to patients [9-11].

In present study, we aimed to compare the effects of managing pain and swelling between

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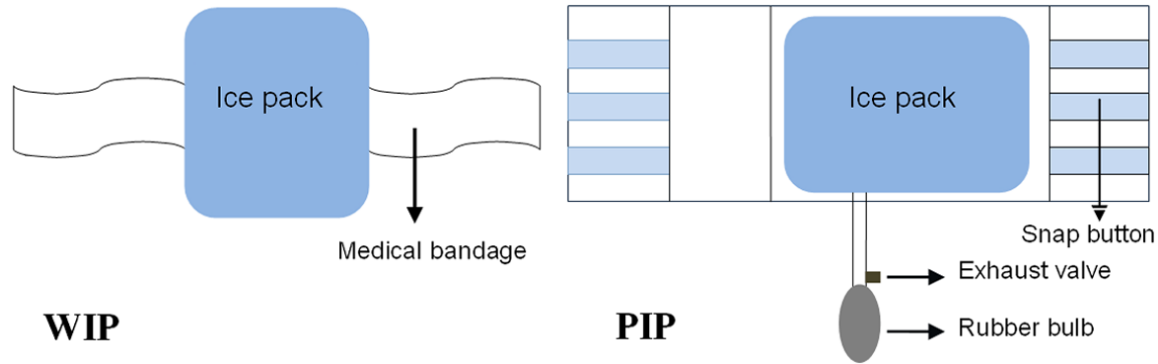


Figure 1. Schematic pictures of PIP and WIP styles.

Table 1. The general character of patients before the operation

Group	Male	Female	Age	Pre-operation VAS score	Pre-operation swelling (cm)	
					PB-5	PB+5
PIP	11	23	66.91±8.84	2.79±0.73	1.15±1.09	0.63±0.83
WIP	10	25	64.97±6.61	2.94±0.64	1.20±1.85	1.11±2.18
t	0.166 (χ^2)		1.034	0.902	0.144	1.222
p	0.733		0.305	0.370	0.886	0.288

pressurized salt ice packs (PIP) and water ice packs (WIP).

Subjects and methods

Subjects

This prospective study concerned patients who were undergoing primary unilateral TKA in the First Affiliated Hospital of Wannan Medical College. Patients were eligible for the study met the following criterias.

Inclusion criteria

Aged 42-81 years, the blood pressure was stable, severe osteoarthritis required TKA.

Exclusion criteria

Subjects had severe varus or valgus deformity, rheumatoid arthritis, peripheral vascular disease; Raynaud's phenomenon associated acute pathology, cold urticaria, hypertension and diabetes, et al.

This study consists of 69 subjects, we divided them into experimental group 34 (11 males and 23 females) and control group 35 (10 males and 25 females). All patients gave writ-

ten informed consent. This study was approved by local ethics committee.

Preparations

The production of PIP: PIP was made from abandoned sphygmomanometer cuffs and rubber bulbs. Firstly, we kept the blood pressure cuff

airbags and automatic paste part. Secondly, we used the elastic tape to stitch the connection paste tape on both sides of the airbag. Thirdly, put the ice packs into the opened airbag. Finally, put 250 ml 10% sodium chloride solution into a 250 ml flexible packaging bag which was full of saline and then stored in refrigerator (at -18°C) for 12 hours. The production of WIP: we equipped the hot water bag with 250 ml water and kept it in a refrigerator (at -18°C) for 12 hours. **Figure 1** shows the styles of PIP and WIP.

Methods

Two groups of patients were performed orthopaedic conventional treatment. Related knowledge about disease, preoperative and postoperative matters were explained to patients, and then we interpreted the reason for using ice packs after operation. Cold therapy was used for patients in both groups within 6 h after operation, which last three days (every day performed two split an hour long treatment). Patients in experimental group were treated by PIP, an ice pack was put on the patella, pressurized fixed. Patients in control group were used traditional WIP. The ice pack was wrapped with a towel, and then used a medical bandage to fix

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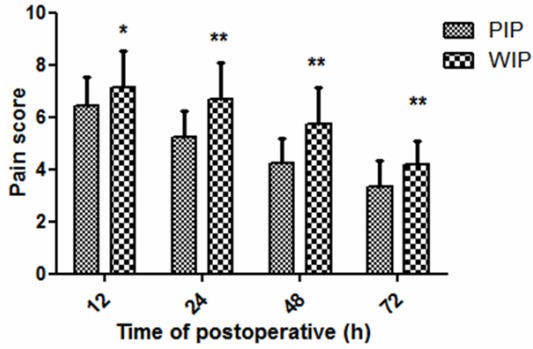


Figure 2. Pain scores of the operative knee (mean \pm SD) were recorded in the groups of PIP and WIP in 12 h, 24 h, 48 h and 72 h after TKA. Values are mean \pm SD. * $P < 0.05$, ** $P < 0.01$ vs. respective PIP values.

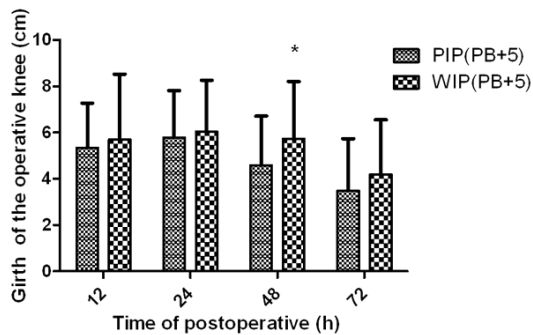


Figure 3. Girth of the operative knee (mean \pm SD) was measured (5 cm above patella) in PIP and WIP in 12 h, 24 h, 48 h and 72 h after TKA. Values are mean \pm SD. * $P < 0.05$ vs. respective PIP values.

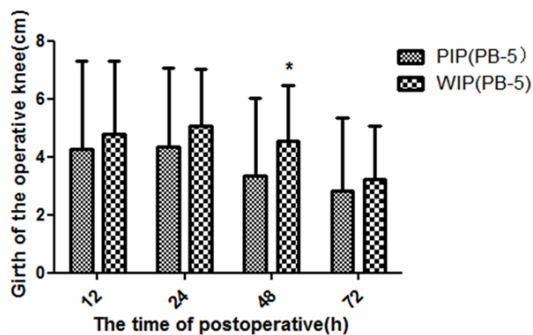


Figure 4. Girth of the operative knee (mean \pm SD) was measured (5 cm below patella) in PIP and WIP in 12 h, 24 h, 48 h and 72 h after TKA. Values are mean \pm SD. * $P < 0.05$ vs. respective PIP values.

it on the patella. More attention should be paid during the cryotherapy. We need to pay attention to the limb sensory, movement, local skin color, temperature, peripheral blood supply and

then observe the ice pack whether slips off, water leakage or appears condensed water phenomenon, watch whether the wound dressing or the bed unit is moist. Measurements were respectively carried out in 12 h, 24 h, 48 h and 72 h after TKA.

Pain scores

We used a visual analog scale (VAS) to evaluate knee pain and the scores were recorded when patients were taken rest. Draw a 10 cm line and its ends were marked 0 and 10, which represent painless and most severe pain, respectively. The patients were asked to make a vertical mark on the line at the place that best reflected the intensity of the pain.

Swelling

The bilateral girth of Knee was measured by a meter rule between 5 cm below and 5 cm above the patella. The value of swelling equals the circumference of operative knee minus the circumference of healthy knee.

The slipping times of ice packs and the wound dressing or the bed unit moist situation

The slipping times of the ice packs and the times of wound dressing or the bed unit moist were recorded during cryotherapy.

Statistical analysis

Data were summarized as frequency counts, or as the mean and standard deviation (SD) for continuous data. We used the two independent sample t-tests to measure the pain scores and swelling of the patients. Chi-square tests were used to test the slipping times of ice packs and the times of the wound dressing or the bed unit moist between the two groups. SPSS 18.0 was used to analysis the data, and statistical significance was claimed at $P < 0.05$.

Results

The general character of patients before the operation was showed in **Table 1**. Pain scores of knee (mean \pm SD) were recorded in 12 h, 24 h, 48 h and 72 h after TKA and they were showed in **Figure 2**. The scores of pain between two groups were significant difference in 12 h, 24 h, 48 h and 72 h after TKA ($P < 0.05$). The swelling of the knee was measured by the girth

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Table 2. The slipping times of bags in the two groups during the time of using the ice packs and the times of the wound dressing or the bed unit moist situation (times, %)

Group	n	Ice pack slippage	Wound dressing or bed unit moist situation
PIP	34 (204)	0 (0)	2 (0.98)
WIP	35 (210)	85 (40)	67 (31.9)
χ^2		103.904	71.25
P		0.000	0.000

measurements of the operative knee, which was shown in **Figures 3** and **4**. Except for 48 h after TKA, no significant difference was found for the girth measurements of the operative knee on two levels in 12 h, 24 h and 72 h, respectively ($P > 0.05$). The slipping times between the two group patients during using ice packs have significant difference ($P < 0.05$), and the times of the wound dressing or bed unit moist also have significant difference ($P < 0.05$), and we can see it in **Table 2**.

Discussion

The aim of our study was to evaluate the effects of PIP on patients after TKA, and to compare the superiority of it with the traditional WIP. In our study, we found that the scores of pain between the two groups were significant difference in 12 h, 24 h, 48 h and 72 h after TKA ($P < 0.05$) (**Figure 2**). As demonstrated in the earlier studies [12-15], cryotherapy had an analgesic function and can relieve the pain. Although some research advances of pain mechanisms were gained in recently, pain after TKA is still an inevitable issue which can affect the quality of life and rehabilitation on patients undergoing TKA [16]. It is reported that acute postoperative pain at rest after joint replacement, particularly TKA, was poorly managed [17], although it did not reach the severity of preoperative pain, it also necessary to relieve the pain of patients.

Nowadays, cryotherapy is applied to reduce the degree of swelling whether in theory or clinical practice after trauma [18]. Cold can reduce oedema. The analgesic action by applying cold is related to vascular spasm and the decrease of local blood flow [19]. In our study, no significant difference was found for the girth measurements of the operative knee on two levels

in 12 h, 24 h and 72 h, respectively. This may due to PIP can decrease the early swelling of the patients and has a better effect than the WIP. When we put the two frozen ice packs out of the refrigerator, the ice in the PIP was frosted while the WIP was ice cubes. As the time went by, the ice in the PIP became a mixture which was composed of frost and water. However, the ice in the WIP became a mixture composed of ice cubes and water. The temperature of the PIP was lower than WIP.

The slipping times of WIP was 85 (40% of the total) and the times of the wound or bed unit moist was 67 (31.9% of the total) (**Table 2**). However, the times of slippage to PIP was 0 and the wound or bed unit moist was 2 (0.98% of the total). There were significant differences for cold therapy effects between the two groups. We could see that it's difficult to fix the bags and the cold therapy effect of PIP was better than WIP.

As far as we know, our study is the first to use the cuffs of abandoned sphygmomanometer and rubber bulbs to given pressure to the knee joint. The pressure given to the knee joint can be tolerated by the patients and did not make the ice packs slip. Due to the cuff is waterproof material, However, there are no consensuses about the best time to use cryotherapy [20, 21]. It was reported that the use of cryotherapy may cause frostbite [22-24]. There were some limitations in our study, such as the sample size was too small, the effects of cryotherapy may be influenced by the dressing types [25]. Thus, further studies need to increase simple size and control some factors to further evaluate the effects of cryotherapy.

Conclusion

PIP is a cheap, safe and simple methods, which are more effective than WIP on reducing patients' pain and swelling degree. Thus, PIP is recommended in clinical nursing for reducing patients' pain and swelling degree.

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Disclosure of conflict of interest

None.

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References

- [1] Arden N and Nevitt MC. Osteoarthritis: epidemiology. *Best Pract Res Clin Rheumatol* 2006; 20: 3-25.
- [2] Vos T, Flaxman AD, Naghavi M, Lozano R, Michaud C, Ezzati M, Shibuya K, Salomon JA, Abdalla S, Aboyans V, Abraham J, Ackerman I, Aggarwal R, Ahn SY, Ali MK, Alvarado M, Anderson HR, Anderson LM, Andrews KG, Atkinson C, Baddour LM, Bahalim AN, Barker-Collo S, Barrero LH, Bartels DH, Basanez MG, Baxter A, Bell ML, Benjamin EJ, Bennett D, Bernabe E, Bhalla K, Bhandari B, Bikbov B, Bin Abdulhak A, Birbeck G, Black JA, Blencowe H, Blore JD, Blyth F, Bolliger I, Bonaventure A, Boufous S, Bourne R, Boussinesq M, Braithwaite T, Brayne C, Bridgett L, Brooker S, Brooks P, Brugha TS, Bryan-Hancock C, Bucello C, Buchbinder R, Buckle G, Budke CM, Burch M, Burney P, Burstein R, Calabria B, Campbell B, Canter CE, Carabin H, Carapetis J, Carmona L, Cella C, Charlson F, Chen H, Cheng AT, Chou D, Chugh SS, Coffeng LE, Colan SD, Colquhoun S, Colson KE, Condon J, Connor MD, Cooper LT, Corriere M, Cortinovis M, de Vaccaro KC, Couser W, Cowie BC, Criqui MH, Cross M, Dabhadkar KC, Dahiya M, Dahodwala N, Damsere-Derry J, Danaei G, Davis A, De Leo D, Degenhardt L, Dellavalle R, Delossantos A, Denenberg J, Derrett S, Des Jarlais DC, Dharmaratne SD, Dherani M, Diaz-Torne C, Dolk H, Dorsey ER, Driscoll T, Duber H, Ebel B, Edmond K, Elbaz A, Ali SE, Erskine H, Erwin PJ, Espindola P, Ewoigbokhan SE, Farzadfar F, Feigin V, Felson DT, Ferrari A, Ferri CP, Fevre EM, Finucane MM, Flaxman S, Flood L, Foreman K, Forouzanfar MH, Fowkes FG, Franklin R, Fransen M, Freeman MK, Gabbe BJ, Gabriel SE, Gakidou E, Ganatra HA, Garcia B, Gaspari F, Gillum RF, Gmel G, Gosselin R,

Grainger R, Groeger J, Guillemin F, Gunnell D, Gupta R, Haagsma J, Hagan H, Halasa YA, Hall W, Haring D, Haro JM, Harrison JE, Havmoeller R, Hay RJ, Higashi H, Hill C, Hoen B, Hoffman H, Hotez PJ, Hoy D, Huang JJ, Ibeanusi SE, Jacobsen KH, James SL, Jarvis D, Jasrasaria R, Jayaraman S, Johns N, Jonas JB, Karthikeyan G, Kassebaum N, Kawakami N, Keren A, Khoo JP, King CH, Knowlton LM, Kobusingye O, Koranteng A, Krishnamurthi R, Lalloo R, Laslett LL, Lathlean T, Leasher JL, Lee YY, Leigh J, Lim SS, Limb E, Lin JK, Lipnick M, Lipshultz SE, Liu W, Loane M, Ohno SL, Lyons R, Ma J, Mabweijano J, MacIntyre MF, Malekzadeh R, Mallinger L, Manivannan S, Marcenes W, March L, Margolis DJ, Marks GB, Marks R, Matsumori A, Matzopoulos R, Mayosi BM, McAnulty JH, McDermott MM, McGill N, McGrath J, Medina-Mora ME, Meltzer M, Mensah GA, Merriman TR, Meyer AC, Miglioli V, Miller M, Miller TR, Mitchell PB, Mocumbi AO, Moffitt TE, Mokdad AA, Monasta L, Montico M, Moradi-Lakeh M, Moran A, Morawska L, Mori R, Murdoch ME, Mwaniki MK, Naidoo K, Nair MN, Naldi L, Narayan KM, Nelson PK, Nelson RG, Nevitt MC, Newton CR, Nolte S, Norman P, Norman R, O'Donnell M, O'Hanlon S, Olives C, Omer SB, Ortblad K, Osborne R, Ozgediz D, Page A, Pahari B, Pandian JD, Rivero AP, Patten SB, Pearce N, Padilla RP, Perez-Ruiz F, Perico N, Pesudovs K, Phillips D, Phillips MR, Pierce K, Pion S, Polanczyk GV, Polinder S, Pope CA 3rd, Popova S, Porrini E, Pourmalek F, Prince M, Pullan RL, Ramaiah KD, Ranganathan D, Razavi H, Regan M, Rehm JT, Rein DB, Remuzzi G, Richardson K, Rivara FP, Roberts T, Robinson C, De Leon FR, Ronfani L, Room R, Rosenfeld LC, Rushton L, Sacco RL, Saha S, Sampson U, Sanchez-Riera L, Sanman E, Schwebel DC, Scott JG, Segui-Gomez M, Shahraz S, Shepard DS, Shin H, Shivakoti R, Singh D, Singh GM, Singh JA, Singleton J, Sleet DA, Sliwa K, Smith E, Smith JL, Stapelberg NJ, Steer A, Steiner T, Stolk WA, Stovner LJ, Sudfeld C, Syed S, Tamburlini G, Tavakkoli M, Taylor HR, Taylor JA, Taylor WJ, Thomas B, Thomson WM, Thurston GD, Tleyjeh IM, Tonelli M, Towbin JA, Truelsen T, Tsilimbaris MK, Ubeda C, Undurraga EA, van der Werf MJ, van Os J, Vavilala MS, Venketasubramanian N, Wang M, Wang W, Watt K, Weatherall DJ, Weinstock MA, Weintraub R, Weisskopf MG, Weissman MM, White RA, Whiteford H, Wiersma ST, Wilkinson JD, Williams HC, Williams SR, Witt E, Wolfe F, Woolf AD, Wulf S, Yeh PH, Zaidi AK, Zheng ZJ, Zonies D, Lopez AD, Murray CJ, AlMazroa MA and Memish ZA. Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990-2010: a systematic analysis for

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- the Global Burden of Disease Study 2010. *Lancet* 2012; 380: 2163-2196.
- [3] Turkiewicz A, Petersson IF, Björk J, Hawker G, Dahlberg LE, Lohmander LS and Englund M. Current and future impact of osteoarthritis on health care: a population-based study with projections to year 2032. *Osteoarthritis Cartilage* 2014; 22: 1826-1832.
- [4] McCartney CJ and Nelligan K. Postoperative pain management after total knee arthroplasty in elderly patients: treatment options. *Drugs Aging* 2014; 31: 83-91.
- [5] Akyol O, Karayurt O and Salmond S. Experiences of pain and satisfaction with pain management in patients undergoing total knee replacement. *Orthop Nurs* 2009; 28: 79-85.
- [6] Duellman TJ, Gaffigan C, Milbrandt JC and Allan DG. Multi-modal, pre-emptive analgesia decreases the length of hospital stay following total joint arthroplasty. *Orthopedics* 2009; 32: 167.
- [7] Corti L. Nonpharmaceutical approaches to pain management. *Top Companion Anim Med* 2014; 29: 24-28.
- [8] Kuo CC, Lin CC, Lee WJ and Huang WT. Comparing the antismelling and analgesic effects of three different ice pack therapy durations: a randomized controlled trial on cases with soft tissue injuries. *J Nurs Res* 2013; 21: 186-194.
- [9] Guillot X, Tordi N, Mourot L, Demougeot C, Dugue B, Prati C and Wendling D. Cryotherapy in inflammatory rheumatic diseases: A systematic review. *Expert Rev Clin Immunol* 2014; 10: 281-294.
- [10] Murgier J and Cassard X. Cryotherapy with dynamic intermittent compression for analgesia after anterior cruciate ligament reconstruction. Preliminary study. *Orthop Traumatol Surg Res* 2014; 100: 309-312.
- [11] Shirvani MA and Ganji Z. The influence of cold pack on labour pain relief and birth outcomes: a randomised controlled trial. *J Clin Nurs* 2014; 23: 2473-2479.
- [12] Adie S, Kwan A, Naylor JM, Harris IA and Mittal R. Cryotherapy following total knee replacement. *Cochrane Database Syst Rev* 2012; 9: CD007911.
- [13] Macedo LB, Josue AM, Maia PH, Camara AE and Brasileiro JS. Effect of burst TENS and conventional TENS combined with cryotherapy on pressure pain threshold: randomised, controlled, clinical trial. *Physiotherapy* 2015; 101: 155-160.
- [14] Block J. Cold and compression in the management of musculoskeletal injuries and orthopedic operative procedures: A narrative review. *Open Access J Sports Med* 2010; 1: 105-113.
- [15] Fang L, Hung CH, Wu SL, Fang SH and Stocker J. The effects of cryotherapy in relieving postarthroscopy pain. *J Clin Nurs* 2012; 21: 636-643.
- [16] Grosu I, Lavand'homme P and Thienpont E. Pain after knee arthroplasty: an unresolved issue. *Knee Surg Sports Traumatol Arthrosc* 2014; 22: 1744-1758.
- [17] Wylde V, Rooker J, Halliday L and Blom A. Acute postoperative pain at rest after hip and knee arthroplasty: Severity, sensory qualities and impact on sleep. *Orthop Traumatol Surg Res* 2011; 97: 139-144.
- [18] Adie S, Naylor JM and Harris IA. Cryotherapy after total knee arthroplasty a systematic review and meta-analysis of randomized controlled trials. *J Arthroplasty* 2010; 25: 709-715.
- [19] Oliveira SM, Silva FM, Riesco ML, Latorre Mdo R and Nobre MR. Comparison of application times for ice packs used to relieve perineal pain after normal birth: a randomised clinical trial. *J Clin Nurs* 2012; 21: 3382-3391.
- [20] Cina-Tschumi B. [Evidence-based impact of cryotherapy on postoperative pain, swelling, drainage and tolerance after orthopedic surgery]. *Pflege* 2007; 20: 258-267.
- [21] Millard RP, Towle-Millard HA, Rankin DC and Roush JK. Effect of cold compress application on tissue temperature in healthy dogs. *Am J Vet Res* 2013; 74: 443-447.
- [22] Brown WC and Hahn DB. Frostbite of the feet after cryotherapy: a report of two cases. *J Foot Ankle Surg* 2009; 48: 577-580.
- [23] Lee CK, Pardun J, Buntic R, Kiehn M, Brooks D and Buncke HJ. Severe frostbite of the knees after cryotherapy. *Orthopedics* 2007; 30: 63-64.
- [24] Dundon JM, Rymer MC and Johnson RM. Total patellar skin loss from cryotherapy after total knee arthroplasty. *J Arthroplasty* 2013; 28: 376 e375-377.
- [25] Ibrahim T, Ong SM and Saint Clair Taylor GJ. The effects of different dressings on the skin temperature of the knee during cryotherapy. *Knee* 2005; 12: 21-23.