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Systematic Review

Early Ambulation and Vascular Complications in Patients under Cardiac Catheterization through the Femoral Artery: An Updated Systematic Review

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Abstract

Introduction: Cardiac catheterization is one of the major diagnostic procedures in CADs involving examination of the right or left part of the heart and the coronary arteries. The present study aimed to systematically review the best time to leave the bed with superior care efficacy and minimum complications.

Methods: Google Scholar, Pub Med, ISI Web of Science, and Scopus databases were searched to obtain the relevant articles. All the clinical trial studies that mentioned all three clinical trial indices, including randomization, control, and intervention groups, were included. Nine RCT papers accounting for 2242 subjects were systematically reviewed.

Results: The rest time in bed varied from 2 to 24h. The sandbag's weight in the angiography catheter insertion site ranged from 2.3 to 4.5 kg. All studies revealed that despite decreasing the post-angiography bed hospitalization duration, early ambulation caused no significant difference in the emergence and severity of the angiography-induced complication (hematoma and hemorrhage) in the intervention group compared to the control group. The pain severity difference between the intervention and control groups was statistically addressed in some studies, and the results indicated that the reduction of hospitalization duration managed to decline the pain severity in the intervention group significantly.

Conclusion: This review study suggests that the patients can leave the bed 2-4 h after the procedure, which can reduce low back pain and urinary complications.

Keywords: Coronary Artery Disease, Cardiac Catheterization, Early Ambulation, Low Back Pain, Hematoma, Supine Position

Introduction

Among cardiac diseases, CADs are the most common life-threatening disease,[1] ranks first among the cardiovascular diseases with a prevalence of 51%, according to the report of the American cardiology association.[2,3] Cardiac catheterization is one of the major diagnostic procedures in CADs involving examination of the right or left part of the heart and the coronary arteries. Cardiac catheterization requires accessing the hearth by a catheter through radial, brachial, and femoral arteries. Cardiac catheterization is conducted through the femoral artery due to its large diameter.[4,5] This method, however, could result in complications such as hemorrhage, hematoma in the insertion site, ambulation at the end of organs, and arteritis thrombosis.[6] These complications could occur in 1.96% of the patients undergoing femoral catheterization. Therefore, all the patients should lie on their backs for 2 to 24 hours (h) in a supine position.[7] The potential complications have been traditionally reduced by restricting the patient to at least six hours of bed rest after angiography.[8] Cheer et al., showed higher urinary complications and pain in the control group.[9] Plard et al., also reported higher pain and inconvenience among the control group having 4.5 h of rest than the intervention group who rested for 2.5 h.[10] Remaining in such a position may cause defecation problems;

applying a bedpan would be problematic when the patient lies on their back. Studies have shown that the severity of low back pain increases with long-term rest after cardiac catheterization.[5]

The size of the catheter and the applied sheath in the angiography are among the critical factors in deciding the time of ending absolute rest.[11] Removing the sandbag and letting the patient change their position in the bed can reduce the low back pain and increase their satisfaction. In addition, early movements during hospitalization will reduce nursery care costs. Studies have reported many times for starting to move after cardiac catheterization. Most claimed that early ambulation is safe and applicable.[7] Cato et al., recommended two hours after catheterization with the 4F catheter,[12] while Moeini et al.,[13] suggested two and four hours after catheterization with 6F and 7F catheters, respectively. As the findings were different and there is no clear conclusion on the proper duration of rest after catheterization by femoral artery,[7] the present study aimed to systematically review the best time of leaving the bed, which has superior care efficacy and minimum complications.

Materials and Methods

Searching Strategy

Google Scholar, PubMed, ISI Web of Science, and Scopus databases were searched for relevant articles. The search was done based on the keywords from Jan 2000 to Jun 2018. Searching had two phases: the first phase involved more general keywords; catheterization or angiography and "vascular complications" or "low back pain" or urinary complications". Second phase involved more precise terms in finding more specified articles. Instead of catheterization and angiography, more specific terms such as "left hearth angiography", "arteriography", "ventriculography", "coronary angiography", and "angiocardiography" were used. "hematoma", "hemorrhage", "re-hemorrhage", "pseudoaneurysm", "vascular rupture" "low back pain", "pain", and "artery-venous fistula" were searched for post-angiography problems. Post-angiography cares related terms such as "rest duration", absolute rest duration", "supine position", "fast ambulation", "quick walking after angiography", "patient's satisfaction", "results evaluation", "manual pressure", arterial closure device", "sheath removal", "heparin", "BIVALIRUDIN" and "access site" were also searched.

After selecting the studies meeting the inclusion criteria, the information such as the authors' names, year of publication, sample volume, consequences, pain expression type, post-procedure pain, pain number, hematoma, hematoma size, bed leaving time, control and intervention groups, catheter size, pressure application duration was extracted from the papers and entered to the excel 2019 software.

Paper Selection

All the clinical trial studies that mentioned all three indices of the clinical trials included randomization, a control group, and intervention groups. All studies focusing on diagnostic procedures in interventional cardiology were included.

Data Extraction

The paper's title and abstracts were entered into the Endnote, and the duplications were removed. Two separate reviewers investigated the documents, and the non-relevant ones were excluded. The papers which satisfied the inclusion criteria were downloaded. We downloaded all the relevant documents without needing to contact the corresponding author. Two reviewers independently reviewed the entire text of the downloaded papers, and the results were investigated; in cases of contradiction, the problem was solved by negotiation.

Study Quality Assessment

To evaluate the quality of the papers and reduce the bias, the Jadad tool was employed by which the articles were assessed in terms of randomization, blinding, and follow-up. Papers scoring 3 or more were included in this systematic study. This tool investigated all the entered studies to determine whether they deserved to be included in the study. Also, to exclude the low-quality papers, two separate reviewers assessed the articles' quality to determine their bias risk. However, it isn't easy due to the presence of different methods in the field of medicine.

Results

Studies Description

In the primary research, 3292 studies were obtained. Using Endnote software, 1831 papers were eliminated (Figure 1). After investigating the remaining papers, 42 articles were entered the review process. After studying

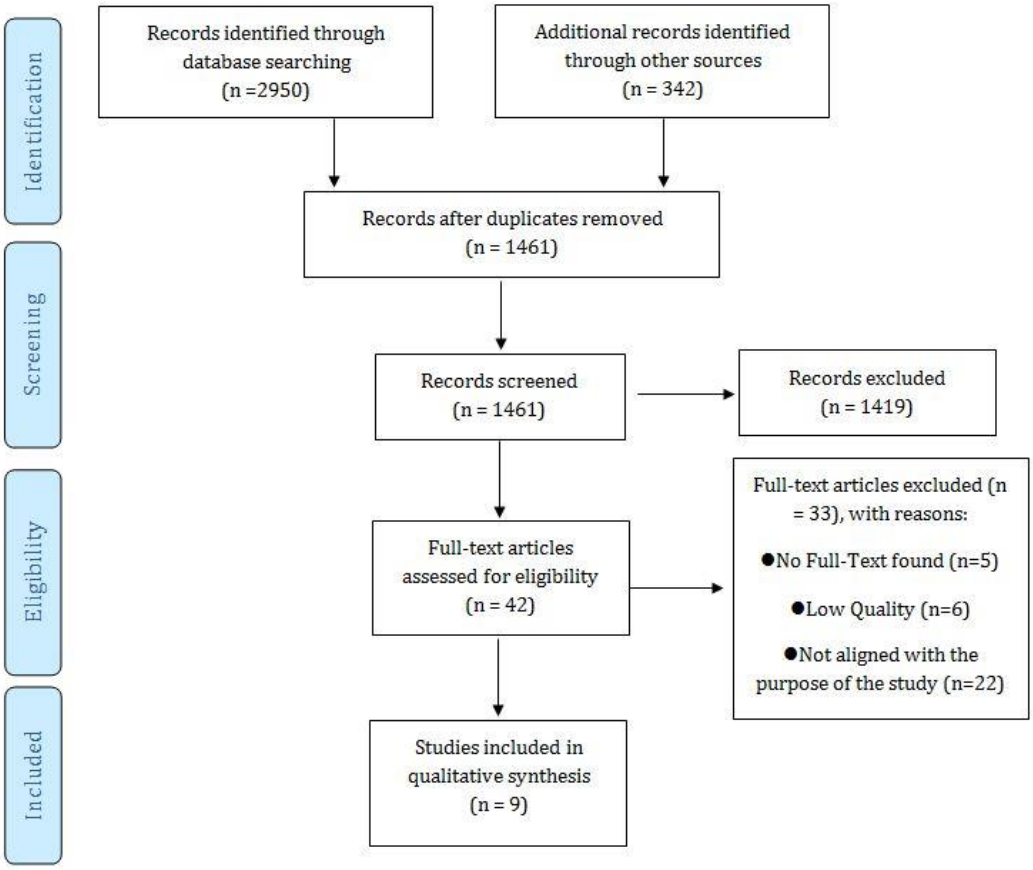

Figure 1. Study Selection Flowchart According to PRISMA Checklist

the full text of the remaining articles and considering the inclusion criteria, 9 RCT papers accounting for 2242 subjects were systematically reviewed (Table 1). The minimum and maximum sample volumes were 70 and 730 subjects, respectively. The mean age of the studied people in the control groups was 59.20, and in the intervention groups was 56.61. Seven studies possessed two groups (control and intervention groups). At the same time, one study had three intervention and one control groups, and the other study, had two intervention groups that were compared. Angiography was conducted in all the studies to investigate coronary artery diseases.

Rest time, Catheters Size, Hemostasis, Drugs and Weight of the Sandbag

The rest time in bed varied from two to 24 h. In two studies, four hours of rest in bed was compared with 12-24 h.[6,9] Another study compared 2 h of bed rest with 4 h.[14] One study made a comparison between 2.5 h of bed rest and 4.5 h,[10] while the other compared 4 h of rest with 8-10 h;[15] three with 5 h.[4] Four with six h,[16] 7-8 with 10-24 h,[17] and one compared 6 with 6-24 h.[18]

The applied catheter size ranged from 6 to 9. Catheter 6 was used in most patients (approximately 70%). Hemostasis was manually conducted; Four studies employed manual compression and sandbag for hemostasis.[15-18] Concerning the application of anticoagulant drugs, 1 study employed heparin,[16] while the others used aspirin and Plavix.[14]

The sandbag's weight in the angiography catheter insertion site ranged from 2.3 to 4.5 kg.

Early Ambulation-induced Hemorrhage and Hematoma

Seven studies reported early ambulation-induced complications in the form of hematoma. Hemorrhage (Bleeding) was studied as an early-ambulation complication in 8 studies.

In four studies, bleeding was considered a hematoma with sizes beyond 5 cm, defined as the cases requiring manual compression for re-hemostasis.[6,9,15,16] One study classified hematoma into four classes; hematomas smaller than 2 cm^2 were considered no hematoma,

Table1. Research Articles Reviewed

NO	1	2	3	4	5	6	7	8	9
First Author/year	Chair. SY 2007[9]	Abdollahi. AA 2015[16]	Yu. M 2012[6]	Bakhshi. F 2014[18]	Matte. R 2016[14]	Elsaid. R 2015[4]	Pollard. S 2003[10]	Farmanbar. R 2012[15]	Rezaei-Adaryani. M 2009[17]
Sample size	86 (41males) CG:43 IG:43	140 CG:35 IG1:35 IG2:35 IG3:35	137 CG:74 IG:63 Male:69(50/4%) CG:33(44/6%) IG:36(57/1%) Female:68(49/6%) CG:41(55/4%) IG:27(42/9%)	80 CG:40 IG:40	730 CG:363 female (CG):196(54) IG:367 female (IG):211(57/5)	164 IG1:82 male:46(56/1%) female:36(43/97%) IG2:82 male:45(54/9%) female:37(45/1%)	705 CG:362 IG:343	130 CG:65 female:43/1% male:56/9% IG:65 female:49/2% male:50/8%	70 CG:M/F=24/11 IG:M/F=17/18
Mean age (year)	CG:63/2±9/7 IG:62/7±9/7	CG:55/4±7/81 IG1:56/1±8/23 IG2:55/5±7/40 IG3:55/7±7/87	<65 All:66(48/2%) CG:32(43/2%) IG:34(54/0%) 65 All:71(51/8%) CG:42(56/8%) IG:29(46/0%)	CG:59/35±8/44 IG:56/55±10/99	CG:63±10 IG:61/5±11	IG1:50/32±7/71 IG2:48/49±7/62	NR	CG:58/46±8/09 IG:59/54±9/68	CG:55/82 ± 11/34 IG:59/74±11/05
Hemostasis method	Manual compression	Manual compression & Sandbag	Manual compression	Manual compression & Sandbag	Hemostasis valve manual(digital) compression	Manual compression	Manual compression	Manual compression & sandbag	Manual compression & Sandbag
weight of sandbag/ duration of sandbag use	NR	2/5-4kg/3h	NR	2/3-4/5kg CG:6h IG:1h	NR	NR	NR	3kg CG:4-5h IG:3h	sand bag on the puncture site for CG:8h IG:3h
duration of manual compression	NR	NR	NR	CG:4/63±1/26 Min IG:4/16±1/31 Min	15Min	15Min	a minimum of 10 Min	NR	NR
Pain after procedure/ pain instrument/pain score	Yes/VAS CG: 4h:1/55,8h;4/41, next morning:4/01 IG: 4h:0/97,8h;1/34, next morning:1/77	Yes/NRS back pain in 4h CG:0/88(2/01) IG1:0/34(1/16) IG2:1/51(2/58) IG3:0/33(0/051)	Yes/VAS/NR	Yes/VAS Back pain: CG:5/05± 3/11 IG:0/05± 0/31	Yes/NR/NR	Yes/VAS No pain: scored=0 to Worse: scored=10 Back pain IG1: At ambulation: No:63(76/8%) Modarete:11(13/4%) Worse:8(9/8%) after 1W: No:79(96/3%) Mooderate:3(3/7%) Worst:0(0/0%) IG2: At ambulation: No:65(79/3%) Modarete:9(11/0%)	Yes/McGill pain questionnaire	Yes/NR/NR	NR/VAS/NR

						Worse:8(9/8%) after 1W: No:81(98/8%) Mooderate:1(1/2%) Worst:0(0/0%)			
Control of bleeding	Yes	NO	NO	Yes	Yes	Yes	Yes	Yes	Yes
Size of hematoma (Cm)	>5cm	>5cm	>5cm	NR	small<10cm large≥10cm	No hematoma:<2cm in diameter small hematoma:2 - 5cm in diameter Medium hematoma:5-10cm in diameter Large hematoma: ≥10cm in diameter	NR	>5cm	NR
Size of catheter	NR	6F	NR	NR	6F	6-9F	6F	6 & 7 F	6F
Time of Out of bed	CG:12-24h IG:4h	CG: 6h IG1:6h IG2:4h IG3:4h	CG:12-24h IG:4h	CG:6-24h IG:6h	CG:4h IG:2h	IG1:3h IG2:5h	CG:4/5h IG:2/5h	CG: 8-10h IG:4h	CG:10-24h IG:7-8h
complication	Urinary discomfort, Hematoma, Bleeding	low back pain, urinary retention	Bleeding NO All:136(99/3%) CG:73(98/6%) IG:63(100%) Yes All:1(0/7%) CG:1(1/4%) IG:0	Hematoma(cm) CG:0/08±0/18 IG:0/03±0/16 Bleeding(cm) CG:0/56±1/65 IG:0/27±0/97 Back pain Foot pain Discomfort	Hematoma CG:13(4) IG:12(3) Major bleeding CG:6(2) IG:4(1) Vasovagal response CG:4(1/1) IG:5(1/4)	Hematoma IG1: At ambulation:8 Next week:10 IG2: At ambulation:6 Next week:5 Bleeding IG1: At ambulation:9 Next week:5 IG2: At ambulation:5 Next week:2	Hematoma CG:34(9/4%) IG:44(12/8%) Bleeding CG:21(5/8%) IG:25(7/3%)	Hematoma 1h:CG:1(1/5%), IG:0(0%) 2h:CG:1(1/5%), IG:0(0%) 2/5h:CG:0(0%), IG:1(1/5%) 4h:CG:2(3/1%), IG:0(0%) Bleeding 0h:CG:1(1/5%), IG:0(0%) 4h:CG:0(0%), IG:1(1/5%)	Hematoma, bleeding
Use anticoagulant/type of anticoagulant	NO/NR	Yes/heparin	NR/NR	NR/NR	Yes/Aspirin/Clopidogrel (Plavix)	NR/ NR	NO/NR	NR/NR	NR
Time of follow up	NR	6h	NR	1h 2h 3h 6h Next morning at 9:00 a.m.	24&48&72 h after hospital discharge	1 weeks	30days	NR	NR

CG: Control Group, IG: Intervention Group, VAS: Visual Analog Scale, NRS: Numerical rating scale, NR: Not Reported, Min: minute, Cm: centimeters, Cm : centimeters square, h: hours, M: male, F: female, W: week

those with sizes ranging from 2 to 5 cm^2 were considered small, and those sized from 5 to 10 cm^2 were considered medium. In contrast, those with sizes above 10 cm^2 were classified as large hematomas.[4] Another study grouped hematoma into two classes: large (equal or larger than 10 cm^2) and small.[14]

Various scales have been employed to define the bleeding. A study considered losing more than 100 ccs of blood as bleeding, which requires re-compression and re-hemostasis.[6,9,15,16] A research classified hemorrhage into four groups: no oozing (dry bandage), mild oozing (blood-wetted bandage 2 cm^2), moderate oozing (blood-wetted bandage 2-5 cm^2), and severe oozing (blood-wetted bandage 5-10 cm^2).[4]

In two studies, pseudoaneurysm was considered one of the post-angiography complications.[14,18] Some studies employed a visual analog scale numerical index to investigate the effects of the intervention on low back pain reduction to elucidate the impact of bed rest duration and early ambulation on the patient's convenience.[4,6,9,17,18] However, Polard et al., and Abdollahi et al.,[10,16] used the McGill pain questionnaire and Numerical rating scale,respectively.

All the studies revealed that despite decreasing the post-angiography bed hospitalization duration, early ambulation caused no significant difference in the emergence and severity of the angiography-induced complication (hematoma and hemorrhage) in the intervention group as compared with the control one.[4,6,9,10,14-18]

In some studies, the low back pain severity was first evaluated four hours after the angiography procedure and the last evaluation was conducted the morning of the day after the procedure.[9,16] The pain severity difference between the intervention and control groups was statistically addressed in some studies. The results indicated that the reduction of hospitalization duration significantly declined the pain severity in the intervention group.[6,9,10,16,18] The study by Reham,[4] however, reported no significant difference in the low back pain severity of the intervention and control groups.

The impact of early ambulation on urinary complications such as urinary retention was also addressed in several studies.[9,16] Cheer et al.,[9] showed a significant reduction in the intervention group's urinary complications compared to the control group. However, Abdollahi et al.,[16] reported higher urinary retention rates in the control group, which was not significant. One research also demonstrated the impact of the intervention on the convenience level of the patients through leg pain evaluation which showed no significant difference between the control and intervention groups.[18]

Discussion

This study aimed to investigate the effect of post-angiography early ambulation (through the femoral artery) on vascular complications such as hematoma, bleeding, and urinary complications and its impact on low back pain and patient convenience. Nine papers entered the study after a comprehensive search of 3292 studies.

The bed rest duration varied widely (2-24 h). In most of the studies, the minimum bed rest of the control group was four hours while its maximum was 24 h. The rest time of the intervention group (early ambulation) was from a minimum of 2 h to a maximum of 8 h. Mohammady et al.,[7] indicated that the minimum and maximum post-angiography bed rest duration was 2 and 24 h, respectively; the bed rest of the patients undergoing PCI ranged from 2 to 10 h after sheath removal.[19]

Our results indicated no statistically significant difference in the vascular complication (hematoma, hemorrhage, and pseudoaneurysm) of the control group with longer rest time compared to the intervention group with early ambulation. This means that early ambulation had no impact on the hematoma and hemorrhage. As the probable vascular incidents at the angiography site are possible in the patients, they should lie on their back in a supine position after the procedure.[17] Hematoma and hemorrhage naturally occur in the soft tissue above the thigh, whose formation chance will be minimized several days after the catheterization.

Blood clotting initiated upon the simultaneous blood vessels rupture both in internal (in the blood itself) and external (damage to the vessel wall and surrounding tissues) pathways. The tissue factor triggers the external pathway, while the XII factor and platelets' contact with the collagen content of the vessel wall starts the internal pathway. The significant difference between these two pathways is that the external one can have an explosive nature; hence, upon its initiation, its rate could be only limited by the amount of tissue

factor released from the damaged tissues as well as V, VII, and X factors in the blood. In severe tissue damage, the clotting may occur in only 15 seconds. The internal pathway has a much slower progression rate and usually requires 1-6 minutes. Regarding the time required for clot formation and vessel regeneration, early ambulation can be considered an alternative to the conventional post-angiography homeostasis methods.[20]

Therefore, developing a safe and convenient approach without increasing the risk of vascular complications (hematoma and hemorrhage) is crucial. In this regard, Mohammady et al.,[7] showed no significant difference in vascular complications (hematoma, hemorrhage, bruise and pseudoaneurysm) in the control group with a routine bed rest period and those having early ambulation. Also, Kim et al.,[21] Mohammady et al.,[19] and Tongsai et al.,[22] studies regarding the post-PCI early ambulation complications indicated no significant difference in the post-PCI hematoma and hemorrhage of the control when compared to the intervention group.

Studies have shown that the size of the angiography sheath ranged from 6 to a maximum of 9. Mohammady et al.,[19] also reported the size range of the PCI sheath from 6 to 9, while in the another study, Mohammady et al.,[7] showed that the size of the applied sheath ranged between 4 and 9.

Studies employed various catheter sizes.[4-9] However, no significant difference was found in the hematoma incidence when the catheters with different sizes were employed.[7] In the first decade of the 21st century, several studies revealed the safety of early sheath removal and ambulation after PCI using different catheter sizes.[22]

One of the primary measures to prevent complications is proper hemostasis. Despite recent advances in homeostasis devices to prevent vascular complications, our study revealed that manual compression is still the main method of homeostasis. Several studies indicated that manual compression was the only homeostasis method;[4,6,9,10] Other studies used a combination of sandbag and manual compression.[15-18] Mohammady et al.,[7] demonstrated that mechanical methods such as manual compression, sandbag, and compression dressing were used in 70% of cases to induce homeostasis.

Sandbag

Concerning the effect of reducing rest time on comfort and low back pain decline, most studies showed that shortening the rest time to below four hours can significantly decrease the pain of the patients in the intervention group. Placing a sandbag over the angiographic procedure site can prevent bleeding due to its compressive effects. Removing the sandbag will let the patient change their position on the bed; hence their fatigue and low back pain will significantly decline, leading to higher convenience and satisfaction.[23] Mohammady et al.,[7] showed that 2-4 h rest time would lower pain levels than six hours or more post-angiographic rest. Furthermore, shortening the rest time will reduce urinary complications in the intervention group. Lying on the back can disrupt the pattern of excretion and urinary retention, which may require catheterization in some patients. Mohammady et al.,[19] showed that shortening the rest duration did not reduce urinary complications. However, Mohammady et al.,[7] reported lower urinary complications in the patients who rested for four hours at maximum compared to those who sleptfor 4-12 h.

Conclusion

This study suggested that early ambulation after diagnostic procedures had no significant effect on vascular complications, including hemorrhage, hematoma, bruise, and pseudoaneurysm. Also, a group of patients who experienced early ambulation reported less low back pain and urinary complications than those with more extended bed rest periods. Regarding no high-risk vascular complication after angiography from the femoral artery and the importance of reducing the time that patients are immobile due to the long-term presence of a sandbag on their puncture site. This review study suggests that the patients can leave the bed 2-4 h after the procedure, which can reduce the low back pain and urinary complications.

Ethics Approval

This study was approved by the Ethics Committee of Guilan University of Medical Sciences (Code: IR.GUMS.REC.1399.547).

Authors' contributions

All authors contributed in designing, running, and writing all parts of the research.

Conflict of Interest

The authors declare no conflicts of interest.

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References

1. Moraveji M, Naserian J, Bazarghan M. The effect of early ambulation of patients on bleeding and hematom via the femoral artery in post angiography ward in Ayatollah Moosavy Hospital (Zanjan 2011). SSU_Journals. 2012;20(2):167-75.
2. Libby P, Bonow RO, Mann DL, Zipes DP. Braunwald's Heart Disease: A Textbook of Cardiovascular Medicine, 2-Volume Set: Elsevier Health Sciences; 2007.
3. Moghadamnia MT, Ardalan A, Mesdaghinia A, Naddafi K, Yekaninejad MS. Association between apparent temperature and acute coronary syndrome admission in Rasht, Iran. Heart Asia. 2018;10(2):e011068. doi:10.1136/heartasia-2018-011068
4. Elsaid R, Soliman H, Sobh H, Maaty AR. Effect of early ambulation; three versus five hours after transfemoral diagnostic cardiac catheterization: a randomized clinical one-arm study. J Nurs Health Sci. 2015;4(5):12-20. doi:10.9790/1959-04541220
5. Mahgoub A, Mohamed W, Mohammed M, Abdel-Aziz M, Kishk Y. Impact of Early Ambulation on Patients' Outcome Post Transfemoral Coronary Procedures, at Assiut University Hospital. J Educ Practice. 2013;28(4):22-32.
6. Yu M, Choi KC, Wong EM, Sit JW, Ip WY. Effect of early ambulation after transfemoral cardiac catheterization in Hong Kong: a single-blinded randomized controlled trial/Hong Kong'ta transfemoral kardiyak kateterizasyon sonrasi erken ambьlasyonun etkisi: Tek-kur randomize kontrolь bir ɜalisma. Anatol J Cardiol. 2012;12(3):222-30. doi:10.5152/akd.2012.065
7. Mohammady M, Heidari K, Sari AA, Zolfaghari M, Janani L. Early ambulation after diagnostic transfemoral catheterisation: a systematic review and meta-analysis. Int J Nurs Stud. 2014;51(1):39-50. doi:10.1016/j.ijnurstu.2012.12.018
8. Farmanbar R, Chinikar M, Gozalian M, Baghaie M, Roshan ZA, Moghadamnia M. The effect of post coronary angiography bed-rest time on vascular complications. J Tehran Univ Heart Cent. 2008;3(4):225-8.
9. Thompson D, Li SK. The effect of ambulation after cardiac catheterization on patient outcomes. J Clin Nurs. 2007:212-4. doi:10.1111/j.1365-2702.2006.01599.x
10. Pollard SD, Munks K, Wales C, Crossman DC, Cumberland DC, Oakley GD, et al. Position and Mobilisation Post-Angiography Study (PAMPAS): a comparison of 4.5 hours and 2.5 hours bed rest. Heart. 2003;89(4):447-8. doi:10.1136/heart.89.4.447
11. Bogart MA, Bogart DB, Rigden LB, Jung SC, Liston MJ. A prospective randomized trial of early ambulation following 8 French diagnostic cardiac catheterization. Catheter Cardiovasc Interv. 1999;47(2):175-8. doi:10.1002/(SICI)1522-726X(199906)47:2<175::AID-CCD9>3.0.CO;2-Q
12. Kato F, Sato Y, Yuasa N, Abo D, Sakuhara Y, Oyama N, et al. Reduction of bed rest time after transfemoral noncardiac angiography from 4 hours to 2 hours: a randomized trial and a one-arm study. J Vasc Interv Radiol. 2009;20(5):587-92. doi:10.1016/j.jvir.2009.02.003
13. Moeini M, Moradpour F, Babaei S, Rafieian M, Khosravi A. Four hour ambulation after angioplasty is a safe practice method. Iran J Nurs Midwifery Res. 2010;15(3):109-14.
14. Matte R, Hilбrio TD, Reich R, Aliti GB, Rabelo-Silva ER. Reducing bed rest time from five to three hours does not increase complications after cardiac catheterization: the THREE CATH Trial. Rev Lat-Am Enferm. 2016;24. doi:10.1590/1518-8345.0725.2796
15. Farmanbar R, Mohammadiyan MA, Moghaddamniya MT, Kazemnejad EH, Salari AR. The effect of position change and bed-rest duration after coronary angiography on vascular complications. Iran J Crit Care Nurs. 2012;4(4):177-82.
16. Abdollahi AA, Mehranfard S, Behnampour N, Kordnejad AM. Effect of positioning and early ambulation on coronary angiography complications: a randomized clinical trial. J Caring Sci. 2015;4(2):125-34. doi:10.15171/jcs.2015.013
17. Rezaei-Adaryani M, Ahmadi F, Asghari-Jafarabadi M. The effect of changing position and early ambulation after cardiac catheterization on patients' outcomes: a single-blind randomized controlled trial. Int J Nurs Stud. 2009;46(8):1047-53. doi:10.1016/j.ijnurstu.2009.02.004
18. Bakhshi F, Namjou Z, Andishmand A, Panabadi A, Bagherinasab M, Sarebanhassanabadi M. Effect of positioning on patient outcomes after coronary angiography: a single-blind randomized controlled trial. J Nurs Res. 2014;22(1):45-50. doi:10.1097/jnr.0000000000000020
19. Mohammady M, Atoof F, Sari AA, Zolfaghari M. Bed rest duration after sheath removal following percutaneous coronary interventions: a systematic review and meta-analysis. J Clin Nurs. 2014;23(11-12):1476-85. doi:10.1111/jocn.12313
20. Hall JE, Hall ME. Guyton and Hall textbook of medical physiology e-Book. Elsevier Health Sciences; 2020.
21. Kim K, Won S, Kim J, Lee E, Kim K, Park S. Meta-analysis of complication as a risk factor for early ambulation after percutaneous coronary intervention. Eur J Cardiovasc Nurs. 2013;12(5):429-36. doi:10.1177/1474515112462519
22. Tongsai S, Thamlikitkul V. The safety of early versus late ambulation in the management of patients after percutaneous coronary interventions: a meta-analysis. Int J Nurs Stud. 2012;49(9):1084-90. doi:10.1016/j.ijnurstu.2012.03.012
23. Woods SL. Cardiac nursing: Lippincott Williams & Wilkins; 2010.