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ABSTRACT

Objective: To examine incision and breast pain and discomfort, and their predictors in women 12 months following sternotomy.

Design: Extension survey following participation in a clinical trial.

Setting: 10 Canadian centres.

Patients: Women (n = 326) who completed the Women's Recovery from Sternotomy Trial.

Interventions: None.

Main outcome measures: Pain and discomfort data (numeric rating scales) collected by standardised interview at 5 days, 12 weeks and 12 months following sternotomy.

Results: More patients reported having incision or breast discomfort (46.6%) than pain (18.1%) at 12 months postoperatively. No symptoms at 5 days postoperatively were significantly associated with symptom presence at 12 postoperative months. However, having incision pain and discomfort as well as breast pain and discomfort at 12 postoperative weeks was associated with incision pain (odds ratio (OR) = 3.26, 95% confidence interval (CI) 1.51 to 7.07), incision discomfort (OR = 4.87, 95% CI 3.01 to 7.88), breast pain (OR = 9.36, 95% CI 3.91 to 22.38) and breast discomfort (OR = 6.42, 95% CI 3.62 to 11.37), respectively, at 12 postoperative months. Increasing chest circumference was associated with having ongoing incision pain (OR = 1.12, 95% CI 1.03 to 1.21) and breast pain (OR = 1.10, 95% CI 1.00 to 1.22). Harvesting of bilateral internal mammary arteries (IMAs) was associated with having ongoing incision pain (OR = 4.71, 95% CI 1.54 to 14.3), while harvesting only the left IMA was associated with having ongoing breast pain (OR = 2.78, 95% CI 1.06 to 7.32) and breast discomfort (OR 1.80, 95% CI 1.02 to 3.19).

Conclusions: Patients reported incision and breast pain and discomfort as long as 12 months post-sternotomy. Improved management of postoperative pain and discomfort up to at least 12 weeks following surgery may render reduced long-term pain and discomfort symptoms.

Pain is one of the most prevalent symptoms identified by patients following sternotomy both in hospital[1–3] and after discharge.[4–6] Studies have revealed that the majority of sternotomy patients report having some sternal incision pain.[1–6] Watt-Watson *et al*,[3] for example, found 69% of patients (n = 312/452) reported having moderate to severe pain at the time of hospital discharge. Pain and other discomforts following sternotomy can persist for months and even years.[4–7]

Chronic post-sternotomy pain, defined as persisting longer than three months, can be a debilitating complication following cardiac surgery.[5 8–11] The clinical presentation of chronic pain syndromes may include numbness, severe tenderness on palpation, allodynia across the area of numbness, as well as constant pain across the anterior chest wall.[5] The incidence of chronic post-sternotomy pain has not been well evaluated. Most investigations to date have been retrospective in nature, had variable measures of pain (and not associated measures of sensations or discomforts), had variable durations of postoperative follow-up, and have had predominantly male samples.[7–13] Reported estimates of chronic post-sternotomy pain have varied from 14% to 52%.[11–13]

The aetiology of chronic pain post-sternotomy has not been established. Some authors suggest that techniques associated with internal mammary artery (IMA) harvesting are responsible for this persistent pain,[9 10 14 15] while others contend that yet unidentified factors are responsible as patients who have not had IMA harvesting report an equally high incidence of post-sternotomy pain at one year following surgery.[12 13] The theoretical rationale for the development of chronic post-sternotomy pain and its associated sensitisations or discomforts can best examined by considering the physiological aspects of the pain experience. Central pain-signalling neurons can be sensitised through intense and prolonged nociceptive activity, accounting for abnormal response to low-threshold mechanoreceptor activity as in allodynia and hyperalgesia.[16 17] In addition, this prolonged sensory input may produce central nervous system remodelling that contributes to the development of a chronic pain state. There is some evidence to suggest that persistent pain following sternotomy is associated with pain in the early postoperative period.[12 18]

There is a paucity of literature regarding the pain trajectory of patients following sternotomy. Even less is known regarding other short-term and long-term discomfort symptoms such as numbness, tingling, dull ache, itchiness and tenderness. Further, women experience pain and discomfort symptoms following sternotomy that extend into or are situated in the breasts.[5 19 20] We aimed therefore to describe the long-term post-sternotomy incision and breast pain and discomfort of women. Also, given that early postoperative pain may predict future chronic pain,[12 18] we examined the predictors of incision and breast pain and discomfort at 12 months following sternotomy.

METHODS

Study protocol

This is an extension of the Women's Recovery from Sternotomy (WREST) Trial[20 21] (registration

ISRCTN 47669580), in which we examined the use of a novel compression undergarment in women following first-time median sternotomy. Important exclusion criteria included previous mastectomy or radiation therapy to the chest or breasts. Using a standardised interview, trained site-based research assistants collected data in person while patients were in hospital. Following the patients' discharge from hospital, centrally located research assistants (who were blinded to the extent possible to the patients' treatment group allocation) collected data by telephone using the same standardised interview. The primary outcomes included incision and breast pain and discomfort over a period of 12 postoperative weeks. To examine the longer-term outcomes of women following sternotomy and their predictors, we extended the study protocol to include follow-up at 12 postoperative months (plus or minus 2 weeks).

Institutional ethics approval was obtained from all 10 trial sites (see Acknowledgements) to seek patients' consent for the additional follow-up. Verbal informed consent was obtained from each participating patient.

Data acquisition and analysis

The primary outcomes of interest in WREST-E were sternal incision and breast pain and discomfort. As in the original trial, pain and discomfort were measured using 11-point numeric rating (Likert-type) scales.[20 21] The scales were anchored with descriptors 0 = none, 10 = worst. The patients were asked first to rate the pain emanating from their sternal incision and breasts. Then, they were asked to rate other sensations or discomforts associated with their sternal incision and breasts. The descriptors of sensations/discomforts were consistent with those generated from qualitative and descriptive studies of women's post-sternotomy recovery. These descriptors (that is, tingling, dull ache, numbness, itchiness, tenderness, other patient-identified factor) have been used successfully in studies focusing on women's discomfort following cardiac surgery.[5 19] Pain was scored as rated in the single-item question. Given that patient discomfort may have stemmed from only one or all of the descriptors, the discomfort score was generated by counting the highest score given to any one of the descriptors.

In all, 385 women completed the WREST Trial.[20] Of those, 326 (85%) completed the 12-month follow-up for WREST-E. No formal sample size calculation was undertaken as only those patients willing to participate in the extension study could be included. The centrally located research associates who undertook telephone assessments for the WREST Trial contacted patients by telephone[22] and undertook data collection for this extension study. Exactly the same standardised case report forms were used and continued to have excellent inter-rater reliability scores (>95%). The data were archived and underwent quality assurance assessments at the EPICORE Centre, University of Alberta.

Patient characteristics were described (using proportions or means) for all women who completed the 12-month follow-up. We observed that pain and discomfort scores were positively skewed in the WREST Trial,[20] thus we dichotomised these scores. A score of $\geqslant$3/10 indicated some-moderate pain and $\leqslant$2/10 indicated no pain.[20 23 24] We followed the same procedure for WREST-E analyses. We used a last observation carried forward strategy to fill in missing data in the WREST Trial[20] and used this dataset in the analyses for the prespecified 5-day and 12-week postoperative predictor times for WREST-E. We examined the proportion of patients who reported having any incision or breast pain or discomfort 12 months postoperatively who had reported having any incision or breast pain or discomfort at 5 days and 12 weeks postoperatively. Then, using separate logistic regression models, we examined the influence of having incision and breast pain or discomfort at 5 days and 12 weeks postoperatively on incision and breast pain or discomfort at 12 months postoperatively. Finally, we examined the influence of certain clinical variables (that is, those driven by previous literature) on incision and breast pain and discomfort at 12 months postoperatively. SAS Version 8.1 (Cary, NC, USA) was used to analyse the data.

Table 1 Characteristics of all 326 women who completed 12-month postoperative follow-up

Variable	Mean/No	SD/%
Age (mean)	66.35	11.17
BMI (mean)	29.24	6.33
Chest circumference* (mean)	39.11	4.21
Brassiere cup size		
A	18/326	5.5%
B	92/326	28.2%
C	124/326	38.0%
D+	92/326	28.2%
Study brassiere size		
XS (32″)	1/326	0.3%
S (34″)	11/326	3.4%
M (36″)	34/326	10.4%
L (38″)	48/326	14.7%
XL (40″)	73/326	22.4%
XXL (42–44″)	81/326	24.9%
XXXL (44–46″)	49/326	15.0%
XXXXL (48″+)	29/326	8.9%
Surgery type		
CABG	192/326	58.9%
Valve	91/326	27.9%
CABG + valve	29/326	8.9%
Other	14/326	4.3%
Donor graft site		
Left only IMA	185/221	83.7%
Bilateral (left and right) IMA	19/221	8.6%
Saphenous	167/221	75.6%
Other site	31/221	14.0%
Wound closure		
Staples	70/326	21.5%
Sutures	230/326	70.6%
Retention sutures	9/326	2.8%
Postoperative course		
CPR	0/326	0.0%

*Chest circumference in inches (note: add 2 inches to determine brassiere size).
BMI, body mass index; CABG, coronary artery bypass graft; CPR, cardiopulmonary resuscitation; IMA, internal mammary artery.

RESULTS

Significantly more women from the intervention group (172/195; 88.2%) than usual care group (154/190; 81.0%) participated in this extension study (p = 0.01). Like women in the WREST Trial, women who remained in WREST-E (see table 1) were on average overweight[25] and had a mean chest circumference of more than 39 inches (rendering a brassiere size of 40–42 inches). The majority of patients had a C or D+ brassiere cup size, a study brassiere size of XL or greater, and underwent coronary artery bypass graft (CABG) surgery (with 83.7% having single, left IMA grafts and 8.6% having bilateral (both left and right) IMA grafts). None of the WREST-E patients had cardiopulmonary resuscitation performed during the postoperative period.

Table 2 Proportion of patients who reported having any pain or discomfort at 12 postoperative months who reported having any pain or discomfort at 5 days and 12 weeks postoperatively

Symptom at 12 months		5 days		12 weeks	
		Yes	No	Yes	No
Any pain	Yes (n = 59)	66.1% (39/59)	33.9% (20/59)	79.7% (47/59)	20.3% (12/59)
	No (n = 267)	58.1% (155/267)	42% (112/267)	51.3% (137/267)	48.7% (130/267)
Any discomfort	Yes (n = 152)	63.2% (96/152)	36.8% (56/152)	77.0% (117/152)	23.0% (35/152)
	No (n = 174)	56.3% (98/174)	43.7% (76/174)	38.5% (67/174)	61.5% (107/174)

The proportions of patients who reported having any pain or discomfort at 12 postoperative months who reported having any pain or discomfort at 5 days and 12 weeks postoperatively are shown in table 2. A smaller proportion of patients reported having any pain (18%) than having any discomfort (46.6%) at 12 postoperative months. Of the patients who reported having any pain at 12 postoperative months, more reported having pain at 12 weeks (79.7%) than at 5 days (66.1%) postoperatively. Similarly, of the patients who reported having any discomfort at 12 postoperative months, more reported having discomfort at 12 weeks (77.0%) than at 5 days (63.2%).

Overall, in logistic regression models (see table 3), pain and discomfort at the 12 postoperative week point in time dominated as a predictor of symptoms at 12 months postoperatively. None of the symptoms at 5 days postoperatively were significantly associated with symptom presence at 12 postoperative months. However, having incision pain and discomfort, as well as having breast pain and discomfort at 12 postoperative weeks, was significantly associated with incision pain (odds ratio (OR) = 3.26, 95% confidence interval (CI) 1.51 to 7.07), incision discomfort (OR = 4.87, 95% CI 3.01 to 7.88), breast pain (OR = 9.36, 95% CI 3.91 to 22.38) and breast discomfort (OR = 6.42, 95% CI 3.62 to 11.37), respectively, at 12 postoperative months.

We examined the influence of specific clinical variables (that is, chest circumference, brassiere cup size, left internal mammary artery (IMA) graft, bilateral IMA graft) on incision and breast pain and discomfort at 12 postoperative months. Increasing chest circumference was associated with having ongoing incision pain (OR = 1.12, 95% CI 1.03 to 1.21) and breast pain (OR = 1.10, 95% CI 1.00 to 1.22) at 12 postoperative months. The use of bilateral IMAs for coronary artery bypass grafting was associated only with having ongoing incision pain (OR = 4.71, 95% CI 1.54 to 14.37). Finally, the use of the left IMA for coronary artery bypass grafting was associated with having ongoing breast pain (OR = 2.78, 95% CI 1.06 to 7.32) as well as breast discomfort (OR 1.80, 95% CI 1.02 to 3.19). Brassiere cup size was not a significant factor in predicting ongoing symptoms at 12 postoperative months.

Table 3 Logistic regression models to predict influence of incision and breast pain and discomfort at 5 days and 12 weeks postoperatively on incision and breast pain and discomfort at 12 postoperative months

	5 days	12 weeks
Symptom at 12 months	OR (95% CI)	OR (95% CI)
Incision pain	1.82 (0.92 to 3.61)	3.26 (1.51 to 7.07)
Incision discomfort	1.56 (0.97 to 2.52)	4.87 (3.01 to 7.88)
Breast pain	1.07 (0.27 to 4.28)	9.36 (3.91 to 22.38)
Breast discomfort	1.99 (0.93 to 4.29)	6.42 (3.62 to 11.37)

DISCUSSION

We extended follow-up of patients enrolled in a clinical trial to describe the long-term incision and breast pain and discomfort outcomes and their predictors for women following sternotomy. Nearly 85% (326/384) of women who completed the WREST Trial[20] (which included 12 weeks of postoperative follow-up) agreed to participate in one more interview at 12 postoperative months. Though a considerable proportion of women continued to report incision or breast pain (18%) at 12 months following sternotomy, nearly 47% continued to report ongoing incision or breast discomfort. The patients in this study reported having long term post-sternotomy incision and breast pain less frequently relative to some previous studies.[7 11–13] However, the WREST-E patients continued to report having discomfort in the incision and breasts. Though the discomforts assessed were congruent with some elements of chronic pain syndrome,[5] they have not been previously measured to this extent as separate entities.

Some authors have suggested that the severity of acute postoperative pain during the early days following sternotomy may predict future chronic pain.[1 12 18] We hypothesised that the same may hold true for symptoms of post-sternotomy discomfort experienced by women. However, our findings suggest that pain and discomfort at 12 postoperative weeks, and not in the early days following sternotomy, are prominent in predicting pain and discomfort 12 months later. Patients may be concerned regarding the advisability of continuing to take medication for postoperative pain and discomfort, citing fear of addiction, concerns about side effects and a belief that to be "good" they should not complain about their pain.[3 26 27] Moreover, it is well recognised that women tend to engage in household tasks that are physically demanding (that is, upper body movements that produce tension on the sternal wound) early and regularly throughout their recovery from sternotomy. Indeed, household work is the "yardstick" with which women measure their recovery.[28] Thus, assessment and management of pain and discomfort in women following cardiac surgery must extend well into the recovery period (at least 12 weeks postoperatively), and as needed thereafter. Further, counselling for women and their families following sternotomy, should be focused on creating a balance between engaging in meaningful (and aerobic versus anaerobic) activities while managing pain/discomfort symptoms.

Having a larger chest circumference and larger breasts have been associated with increased sternal tension.[29] Our findings suggested that women with larger chest circumference and not those with larger breasts were more likely to experience incision pain and possibly breast pain at 12 months following sternotomy. Though clinicians often suggest that larger women, in particular, wear a comfortable brassiere in the early period following sternotomy to reduce the potentially uncomfortable tension associated with increased chest and breast size, findings from the WREST Trial[20] revealed that women were unlikely to

Table 4 Logistic regression models (unadjusted) to predict influence of specific clinical variables on incision and breast pain and discomfort at 12 postoperative months

	Incision pain	Incision discomfort	Breast pain	Breast discomfort
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Chest circumference	1.12 (1.03 to 1.21)	1.05 (0.99 to 1.11)	1.10 (1.00 to 1.22)	1.04 (0.97 to 1.11)
Cup size	1.03 (0.68 to 1.57)	0.92 (0.70 to 1.21)	0.59 (0.36 to 0.97)	0.81 (0.59 to 1.12)
Left IMA*	0.86 (0.41 to 1.77)	1.19 (0.74 to 1.89)	2.78 (1.06 to 7.32)	1.80 (1.02 to 3.19)
Bilateral IMA	4.71 (1.54 to 14.37)	2.58 (0.96 to 6.94)	2.47 (0.71 to 8.55)	1.74 (0.64 to 4.74)

*IMA, internal mammary artery.

follow this suggestion. Only 15% and 22% of women randomised to the usual care (using own brassiere) group wore their own brassiere for more than 12 hours per day on day 5 and 2 weeks postoperatively. Using a comfortable and supportive undergarment throughout the early, as well as into the extended, postoperative recovery period may be a message that needs to be consistently reinforced for women having sternotomy.

Of patients who had bypass grafting, the majority (83.7%) had left IMAs and occasionally (8.6%) bilateral IMAs were used as donor grafts. The Coronary Artery Surgery Study (CASS) revealed that IMA graft is the bypass graft "of choice" as it rendered improved survival in a variety of patient subgroups.[30] However, the literature has revealed inconsistent findings regarding the impact of IMA harvesting for coronary artery bypass grafts, on pain outcomes.[9 10 12–15] Our study findings reveal that patients who had left IMAs only used as donor grafts were significantly more likely to have breast pain and discomfort at 12 postoperative months. Further, patients who had bilateral (both the left and right) IMAs used as donor grafts, were significantly more likely to experience incision pain 12 months following sternotomy.

Our study has some important limitations. Firstly, only women who participated in the original WREST Trial were eligible for participation in this study. This poses a potential selection bias in the cohort on whom we are reporting here. Secondly, there was a nearly 16% loss of patients between the 12-week and 12-month follow-ups. Though the clinical characteristics of patients remaining in the study were similar to those in the original study, the loss of patients may have rendered a different estimate of the incidence of post-sternotomy incision and breast pain and discomfort. Thirdly, though the simple measures of pain and discomfort were readily understandable and discernable (note table 2) by the participants and thus had good internal validity, the findings may not be as well generalised as if standardised pain scales had been used. Finally, because the pain and discomfort scores were dichotomised (presence/absence) we are unable to make a comment on any change in intensity of these symptoms over the course of follow-up.

CONCLUSIONS

To our knowledge, this is the largest prospective study of women in which the incidence and predictors of pain and discomfort following sternotomy have been examined. We have identified that incision and breast pain and discomfort as long as 12 months post-sternotomy is a potentially significant problem for women. Further, the pain and discomfort experienced at 12 weeks following surgery, and not necessarily in the early postoperative course (that is, 5 days), may be predictive of longer-term symptoms.

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