

1 **Handgrip exercise in patients scheduled for cardiac surgery to attenuate**  
2 **troponin release: A feasibility study**

3  
4 **Short running head: Handgrip exercise to attenuate cardiac troponin-T release**

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19  
20 <https://trialregister.nl/trial/8583>, registration number: NL8583

21

22 **Abstract**

23

24 *Background.* Cardiac surgery, including surgical aortic valve repair (SAVR) and coronary artery bypass  
25 grafting (CABG), are associated with ischaemia-reperfusion (IR)-injury. Single bouts of exercise,  
26 including handgrip exercise, may protect against IR-injury. This study explored **(I)** the feasibility of daily  
27 handgrip exercise in the week prior to SAVR and/or CABG, and **(II)** its impact on cardiac IR-injury,  
28 measured as postoperative cardiac troponin-T (cTnT) release.

29

30 *Methods and Results.* Sixty-five patients undergoing elective SAVR and/or CABG were randomised to  
31 handgrip exercise + usual care (intervention,  $n=33$ ) or usual care alone (control,  $n=32$ ). Handgrip  
32 exercise consisted of daily 4x5-min handgrip exercise (30% maximal voluntary contraction) for 2-7 days  
33 prior to cardiac surgery. Feasibility was assessed using validated questionnaires. Postoperative cTnT  
34 release was assessed at 0-6-12-18-24h (primary outcome area-under-the-curve (cTnT<sub>AUC</sub>)). Most  
35 patients (93%) adhered to handgrip exercise and 77% was satisfied with this intervention. Handgrip  
36 exercise was associated with lower cTnT<sub>AUC</sub> ( $402,943\pm 225,206$  versus  $473,300\pm 232,682$  ng\*min/L),  
37 which is suggestive for a medium effect size (Cohen's D 0.31), and lower cTnT<sub>peak</sub> ( $313$  [190 – 623]  
38 versus  $379$  [254 – 699] ng/L) compared to controls.

39

40 *Conclusions.* We found that preoperative handgrip exercise is safe and feasible for patients scheduled  
41 for SAVR and/or CABG, and is associated with a medium effect size to reduce postoperative cardiac  
42 IR-injury. This warrants future studies to assess the potential clinical impact of exercise protocols prior  
43 to cardiac surgery.

44

45 **Keywords**

46 Handgrip exercise; exercise preconditioning; ischaemia-reperfusion injury; elective cardiac surgery

47

48 **Word count:** 223

49

## 50 **Introduction**

51 Surgical aortic valve replacement (SAVR) and/or coronary artery bypass grafting (CABG) procedures  
52 are highly common in contemporary medicine. During these surgical procedures, cardiac ischaemia  
53 occurs during aortic cross-clamping. Subsequently, upon release of the cross-clamp, the blood flow is  
54 restored. Paradoxically, this rapid reintroduction of blood flow can cause additional injury to the  
55 myocardium and vascular cells(1). The magnitude of this so-called ischaemia-reperfusion (IR)-injury  
56 strongly relates to post-surgical risk of mortality and morbidity(2). Other than ensuring timely reperfusion  
57 after cardioplegic arrest, currently no strategy effectively reduces IR-injury.

58 Previous work revealed that ischaemic preconditioning, *i.e.*, repeated, short-term ischaemia, reduces  
59 IR-injury(3, 4). However, these cardioprotective effects seem attenuated with certain types of  
60 anaesthesia, in those with cardiovascular disease, and with older age(3, 5, 6). Interestingly, exercise  
61 exerts an array of effects, including inducing local ischaemia(7). Studies in animals showed that exercise  
62 is associated with less IR-injury in healthy(8, 9), but also in senescent(10, 11) and obese animals(12).  
63 In humans, high-intensity exercise protects against IR-injury in healthy volunteers(13) and in older  
64 individuals(14), whilst regular cycling exercise attenuates IR-injury in heart failure patients(15). In the  
65 context of cardiac surgery, whole-body and/or high-intensity exercise are often contra-indicated  
66 preoperatively. We recently explored the effects of local handgrip exercise, which causes minimal  
67 cardiac load(16), and observed immediate downregulation of pro-inflammatory proteins in patients with  
68 cerebral small vessel disease(17). Moreover, we found handgrip exercise to provide (remote) protection  
69 against vascular IR-injury in healthy men(18). Therefore, handgrip exercise may be suitable for patients  
70 within the home-based setting prior to undergoing elective SAVR and/or CABG. To assess this  
71 hypothesis, the aim of this study is to explore **(I)** the feasibility of handgrip exercise prior to elective  
72 cardiac surgery, and **(II)** the release of postoperative markers of cardiac (IR) injury.

73

## 74 **Methods**

### 75 **Participants and design**

76 The study was conducted in accordance with the Declaration of Helsinki and approved by the local  
77 Medical Ethics Review Committee (CMO Arnhem-Nijmegen). This explorative pilot study was  
78 prospectively registered under NL8583 on the International Clinical Trial Registry Platform and is  
79 reported according to the CONSORT reporting guidelines. In this single centre, randomised, controlled

80 study we included patients that were scheduled for elective primary SAVR and/or CABG in the Radboud  
81 University Medical Center between August 2020 and March 2022. The inclusion criteria were age  $\geq 18$   
82 years, mentally able to give informed consent and good understanding of the Dutch language. The  
83 exclusion criteria were previous cardiac surgery, polyneuropathy, and inability to perform handgrip  
84 exercise.

85

86 After providing informed consent, patients were stratified for sex and surgical procedure (SAVR, CABG  
87 or SAVR+CABG) and randomised to handgrip exercise + usual care (intervention) or usual care alone  
88 (control) using Castor Electronic Data Capture (Castor EDC, v2023.1.0.1, Amsterdam, the Netherlands).  
89 Following surgery, patients were requested to fill in questionnaires to evaluate feasibility and blood was  
90 drawn as part of routine clinical practice to evaluate cardiac troponin-T (cTnT).

91

## 92 **Intervention**

93 *Usual care.* Usual care consisted of a standard pre-surgical outpatient clinic visit three months prior to  
94 cardiac surgery and included blood tests, electrocardiogram, and visiting the anaesthesiologist and  
95 cardiothoracic surgeon.

96

97 *Handgrip exercise.* Patients were educated for handgrip exercise during their pre-surgical visit. Maximal  
98 voluntary contraction (MVC) was assessed by three efforts of maximal handgrip force (in kg) with the  
99 dominant arm, separated by one minute of rest. The maximum value was used to determine MVC.  
100 Handgrip exercise consisted of 4x5-minutes exercise, separated by 5 minutes rest (**Supplemental**  
101 **figure 1**), which is in line with previous handgrip exercise protocols(17, 18). Handgrip exercise was  
102 performed at 30% MVC, which causes local ischaemia during exercise(16), with a dynamic 1 second  
103 contraction: 1 second relaxation cycle (frequency of 0.5 Hz). Handgrip was performed by the dominant  
104 or non-dominant arm, based on personal preference of the patient. Patients were allowed to switch  
105 between arms on subsequent days. Patients were instructed to start handgrip exercise once surgery  
106 was scheduled, with a maximum of 8 days and minimum of 2 days prior to surgery. The last handgrip  
107 exercise was planned on the day of surgery. To facilitate training at home, patients received an  
108 instruction video to coach handgrip training frequency, using a metronome, and training duration.

109

## 110 **Measurements**

111 Patients' characteristics were collected at the first study visit. Physical activity level was assessed using  
112 the Short Questionnaire to Assess Health-enhancing physical activity (SQUASH), which is a commonly  
113 used questionnaire to assess physical activity with respect to occupation, leisure time, and other daily  
114 activities. Habitual activity level is assessed by the metabolic equivalent of task (MET)-score as MET-  
115 hours/week(19). Feasibility of home-based handgrip exercise was assessed using an adjusted System  
116 Usability Scale (SUS) questionnaire(20), with a maximum of 40 points. Post-surgery, venous blood  
117 samples were collected 6-hourly in the first 24 hours and sent to the local laboratory to determine cTnT-  
118 levels (in ng/L). CTnT area-under-the-curve (AUC) was calculated according to the trapezoidal method.  
119 Linear interpolation was used if values at T12h or T18h were missing. For cTnT analyses, patients who  
120 did not perform handgrip exercise  $\geq 2$  days(9) were excluded from analysis. Post-surgery major adverse  
121 cardiovascular events (MACE) were collected during the initial hospital stay and included  
122 cerebrovascular events, myocardial infarction, acute kidney injury and death.

123

## 124 **Statistical analysis**

125 Given the explorative nature of the study, descriptive statistics were used. Categorical data are  
126 presented as frequencies and percentages. Continuous data are presented as mean  $\pm$  standard  
127 deviation or median [interquartile range]. For our primary analysis, we tested feasibility of handgrip  
128 exercise using the SUS questionnaire with "acceptable feasibility" being classified as a score of  $\geq 28$ .  
129 For our secondary research question, we evaluated cardiac IR-injury by measuring cTnT, with  
130 postoperative cTnT<sub>AUC</sub> as our primary parameter. We assessed effect size using Cohen's D, with  
131 classification of the effect size being no ( $d < 0.1$ ), small ( $0.1 \leq d < 0.3$ ), medium ( $0.3 \leq d < 0.7$ ) and large  
132 ( $\geq 0.7$ )(21). Secondary objectives are cTnT<sub>peak</sub>, intensive care and hospitalisation duration, and MACE  
133 during hospitalisation. Association between variables was assessed by Pearson's R. All analyses were  
134 performed using SPSS statistics (IBM SPSS Statistics version 27).

135

## 136 **Results**

137 In total, 77 patients were included and randomised (**Figure 1**). A total of 12 patients dropped out due to  
138 change in procedure (e.g., CABG to percutaneous coronary intervention,  $n=9$ ), acute hospitalisation

139 ( $n=2$ ), or conservative management (*i.e.*, no surgery,  $n=1$ ). This resulted in 65 patients; 33 were  
140 allocated to intervention and 32 to control. Mean age was 67 years and 85% was male (**Table 1**).

141

142 *Handgrip exercise.* Due to rescheduled surgery, 3 patients were unable to perform handgrip exercise,  
143 resulting in 30 patients who performed handgrip exercise. Variation in training duration was primarily  
144 related to rescheduled or postponed surgery (*e.g.*, availability intensive care units due to COVID-19),  
145 both being unrelated to the patient or intervention.

146

147 *Feasibility.* Two patients (7%) prematurely terminated handgrip exercise because they experienced the  
148 training too demanding. Patients performed a median of 5 [2-7] days of handgrip exercise prior to  
149 surgery. Most patients (82%) performed the last handgrip exercise bout within 24 hours prior to surgery,  
150 with 9 (32%) patients performing handgrip exercise <12 hours prior to surgery. In total, 26 patients (87%)  
151 filled in feasibility questionnaire (**Table 2**). Reasons for not filling in the questionnaire were post-surgery  
152 cerebrovascular event ( $n=1$ ), withdrawal of participation ( $n=1$ ), and lost to follow-up due to hospital  
153 transfer ( $n=2$ ). The average satisfaction score was  $30\pm 5$ , with 77% of patients demonstrating a score of  
154  $\geq 28$ . A total of 69% would recommend handgrip exercise to someone else. Satisfaction score was not  
155 associated with baseline physical activity level (Pearson's  $R=0.07$ ) or MVC (Pearson's  $R=0.11$ ).

156

157 *Cardiac troponin-T.* Six patients randomised to the intervention group (18%) were excluded for cTnT  
158 analyses because of inability to perform handgrip exercise ( $n=3$ ) or training duration <2 days ( $n=3$ ). Due  
159 to missing cTnT-values at T24h, we excluded 14 patients (24%) for cTnT<sub>AUC</sub> analysis. C<sub>TnT</sub><sub>AUC</sub> was  
160  $402,943\pm 225,206$  ng\*min/L in the intervention group ( $n=22$ ) and  $473,300\pm 232,682$  ng\*min/L in the  
161 control group ( $n=23$ ) (AUC  $\text{ratio}_{\text{handgrip/control}}$  0.851), resulting in a standardised difference of 0.31  
162 (Cohen's D 0.31, 95% confidence interval -0.28-0.89) (**Figure 2A**). cTnT<sub>peak</sub> was 313 [190-623] ng/L in  
163 the intervention group ( $n=27$ ) and 379 [254-699] ng/L in the control group ( $n=32$ ) (**Figure 2B**). We found  
164 comparable effects between shorter ( $\leq 5$  days) *versus* longer ( $>5$  days) handgrip exercise for cTnT<sub>AUC</sub>  
165 ( $398,750\pm 198,682$  *versus*  $407,135\pm 258,832$  ng\*min/L) and cTnT<sub>peak</sub> ( $373$  [182-656] *versus*  $304$  [233-  
166 591] ng\*min/L).

167

168 *Hospitalisation and MACE.* We found no differences between intervention and control group for intensive  
169 care ( $1.2\pm 0.9$  *versus*  $1.2\pm 0.5$  days) or hospital stay ( $7.6\pm 2.8$  *versus*  $7.9\pm 2.7$  days). Furthermore, MACE

170 was observed in two patients who performed handgrip exercise and in one patient in the control group  
171 (n=2 versus n=1).

172

## 173 **Discussion**

174 Our aim was to explore the feasibility of daily handgrip exercise prior to elective SAVR and/or CABG  
175 and to evaluate its impact on postoperative cTnT-release. First, we found that 28 out of 30 patients were  
176 able to successfully perform daily, home-based handgrip exercise training. Moreover, the handgrip  
177 exercise training was classified as feasible, and patients were satisfied with the intervention. Second,  
178 we observed a medium effect size of handgrip exercise training prior to elective cardiac surgery, leading  
179 to a smaller postoperative cTnT<sub>AUC</sub> compared to usual care. These results support future studies to  
180 explore the potential effects of (handgrip) exercise prior to cardiac surgery to reduce cardiac IR-injury.

181

182 We found that most of our patients were able to adhere to the handgrip exercise protocol prior to elective  
183 cardiac surgery, with only two patients (7%) who dropped out because they classified handgrip exercise  
184 being too demanding. The high adherence is in agreement with previous studies that performed  
185 handgrip exercise in comparable populations(22, 23). We also found that satisfaction with handgrip  
186 exercise was not associated with a priori physical activity level or maximal handgrip strength. This  
187 suggests that handgrip exercise is also feasible for physically inactive participants and/or those with low  
188 handgrip strength (e.g., frail patients). Moreover, previous studies revealed that handgrip exercise is low  
189 risk for injuries or complications and cardiac load is limited(16). Indeed, we also did not observe any  
190 adverse events related to handgrip exercise. These findings suggest that handgrip exercise prior to  
191 cardiac surgery is both safe and feasible.

192

193 It is well known that regular physical activity has cardioprotective effects (24, 25). An active lifestyle  
194 improves outcomes of patients with an acute myocardial infarction(26). However, besides the benefits  
195 of regular exercise, previous pre-clinical observations propose cardioprotection after short-term  
196 exercise. More specifically, short-term exercise is associated with a significantly lower infarct size in  
197 various animal models (9, 27). In humans, short-term exercise attenuated IR-injury induced peripheral  
198 vascular dysfunction. Importantly, these exercise protocols are mainly based on whole-body and/or  
199 moderate-to-high intensity cycling(9), which is not always feasible or safe in patients scheduled for

200 cardiac surgery. Alternatively, local handgrip exercise has already shown favourable effects on  
201 inflammatory biomarkers(17) and shows protective effects against vascular IR-injury in healthy men(18).  
202 The cardioprotective effects of handgrip exercise have so far not been explored. As our home-based  
203 handgrip exercise has shown to be feasible, handgrip exercise may be a suitable alternative for patients  
204 undergoing elective SAVR and/or CABG.

205

206 To better understand the clinical potential of handgrip exercise, we explored the impact of handgrip  
207 exercise on postoperative cTnT-levels. Based on the explorative nature of this study, we refrained from  
208 performing parametric statistical analyses, but evaluated the effect size using Cohen's D. For our  
209 primary outcome parameter cTnT<sub>AUC</sub>, we found a standardised difference of 0.31, which is suggestive  
210 for a medium effect size(21). Evaluating effect sizes are a useful tool for explorative studies to better  
211 understand the potential effect (and associated variation) one can expect, and to correctly power future,  
212 randomised, controlled trials. A medium effect size corresponds to future trials with a sample size of 34-  
213 176 patients per study arm(21), with our effect size of 0.31 being related to the upper end of this  
214 spectrum of sample sizes. Previous randomised, controlled trials examining ischaemic preconditioning  
215 prior to cardiac surgery reported comparable cTnT<sub>AUC</sub> ratios (0.629-0.898 *versus* 0.851 for our study)  
216 and included 45-811 participants per study arm(28-30). Those studies showed that ischaemic  
217 preconditioning reduced the risk of peri-operative myocardial infarction (cTnT<sub>AUC</sub> ratio 0.629)(28),  
218 reduced the incidence of postoperative atrial fibrillation and acute kidney injury, and reduced the  
219 intensive care unit stay (cTnT<sub>AUC</sub> ratio 0.744)(29), whilst these difference were not observed with  
220 cTnT<sub>AUC</sub> ratio 0.898(30). Our cTnT<sub>AUC</sub> ratio, induced by exercise preconditioning, falls within this range  
221 and therefore could support the potential for clinically relevant outcomes in sufficiently powered studies.

222

223 Timing of the last exercise bout may be of importance, as exercise seems to induce immediate effects,  
224 which disappear within 1-2 hours, but re-emerge 18-24 hours following exercise(31). For logistic  
225 reasons, we have not focused on the acute effects of exercise in the present study. Therefore, potential  
226 effects pertaining to handgrip exercise on cTnT<sub>AUC</sub> should be ascribed to the later effects, or to the  
227 summative effects of repeated handgrip exercise leading to early adaptations. Whether handgrip  
228 exercise performed within 1-2 hours prior to surgery leads to additional benefits, is currently unknown.

229 This could be considered for future studies, especially since we observed no potentially detrimental  
230 acute effect of handgrip exercise in this population.

231

232 Our study population consisted of older individuals with cardiovascular risk and/or comorbidities . Since  
233 cardiovascular risk factors interfere with the efficacy of ischaemic preconditioning(3, 5, 6), these factors  
234 may potentially interfere with the efficacy of exercise. In contrast to ischaemic preconditioning, exercise-  
235 induced cardioprotective effects were observed in animals with increased age and obesity (10-12). The  
236 stimulus of exercise may be distinct from ischaemic preconditioning, whilst various factors may affect  
237 the exercise stimulus (e.g., mode, intensity and/or frequency). Previous studies on exercise reported a  
238 higher effect of high-intensity exercise compared to moderate-intensity, which may relate to presence  
239 and magnitude of local ischaemia(9). Within the context and associated limitations of exercise prior to  
240 cardiac surgery, increasing the intensity(18) and/or volume(17) of handgrip exercise may potentiate its  
241 effects to attenuate IR-injury. In an attempt to increase muscle volume, previous work found that 4x5-  
242 minutes 'squats' (repeated sitting-standing in a chair) also successfully prevented IR-injury in middle-  
243 aged participants with increased cardiovascular risk(32). These data support exploring alternative  
244 exercise strategies, involving higher (muscle) volume and/or intensity, to evaluate the potential benefit  
245 of exercise.

246

247 *Limitations.* This explorative pilot study has some limitations. The study sample included more male than  
248 female participants. However, this relates to the clinical population as more CABG and SAVR  
249 procedures are performed in male compared to female patients(33, 34). Due to the COVID-19  
250 pandemic, several elective cardiac surgeries were rescheduled according to intensive care availability,  
251 often resulting in <7 training days. However, analysis revealed no differences in cTnT<sub>AUC</sub> between ≤5  
252 and >5 training days, suggesting that benefits may be present within 5 days of handgrip exercise . A third  
253 limitation is that we relied on self-reported adherence. Another limitation is that cTnT-measurements (at  
254 18h or 24h) were missing in some patients. Nonetheless, we found comparable effect sizes for cTnT<sub>AUC</sub>  
255 and cTnT<sub>peak</sub>, suggesting that missing data have not importantly affected our main observations.

256

257 In conclusion, our findings suggest that 2-7 day handgrip exercise prior to elective cardiac surgery is  
258 safe and feasible. Moreover, we found that handgrip exercise is associated with a medium effect size

259 for the presence of smaller cTnTAUC-levels compared to controls. These results warrant further  
260 exploration of the potential clinical effects of handgrip exercise prior to elective cardiac surgery in a  
261 larger sized study. Importantly, even when only a “small effect size” will be found, one should consider  
262 the feasibility, simplicity, low patient burden, and low-cost nature of handgrip exercise for (vulnerable)  
263 patients. In addition, variation in the intensity and/or frequency of exercise may further assist in exploring  
264 the potential benefits.

265

266 **Statements & Declarations**

267

268 **Funding**

269 Not applicable.

270

271 **Conflicts of Interest**

272 None declared.

273

274 **Author contributions**

275 All authors contributed to the study conception and design. Material preparation, data collection and  
276 analysis were performed by Hartman, Konijnenberg, and Dinnissen. The first draft of the manuscript  
277 was written by Konijnenberg and Hartman, and all authors commented on previous versions of the  
278 manuscript. All authors read and approved the final manuscript.

279

280 **Ethical approval**

281 This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted  
282 by the local Medical Ethics Review Committee (CMO Arnhem-Nijmegen).

283

284 **Informed consent**

285 Written informed consent was obtained from all individual participants included in the study.

286

287 **Data availability**

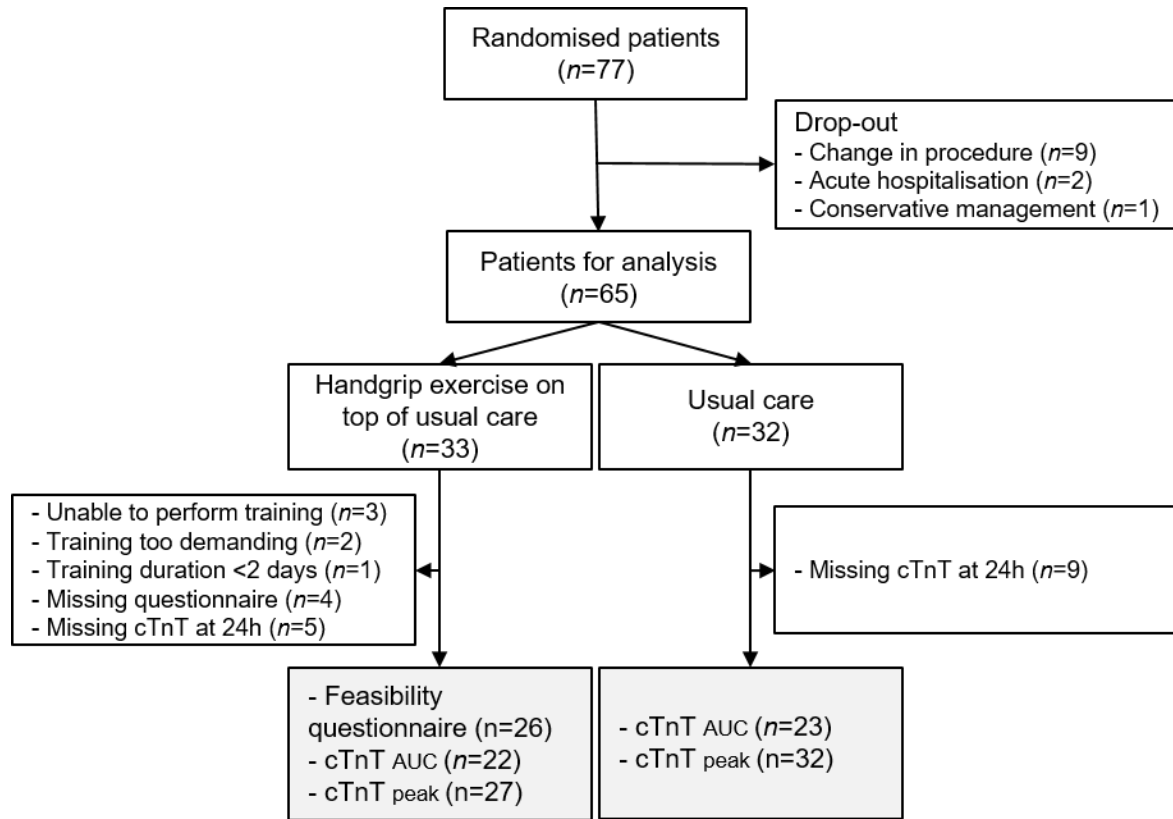
288 The data underlying this article are available in the article.

289

290 **Figure legends**

291

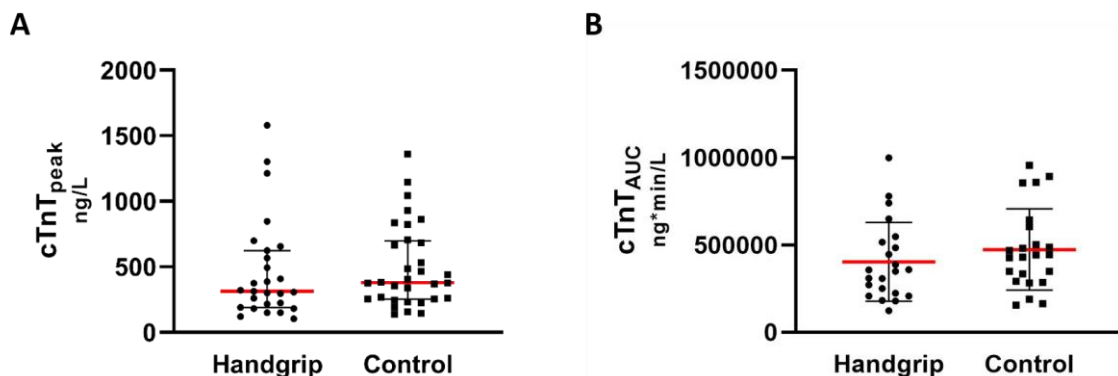
292 **Fig 1 CONSORT diagram.** AUC, area under the curve; cTnT, cardiac troponin T



293

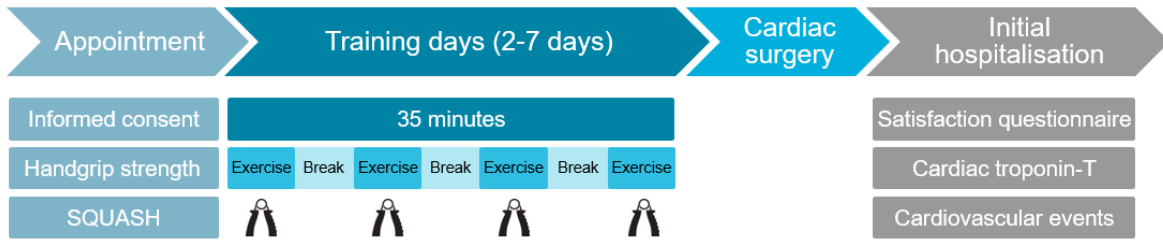
294 **Fig 2 Postoperative peak and area under the curve for cardiac troponin-T for handgrip exercise and control.**

295 **A)** cardiac troponin-T peak (in ng/L) for both groups (handgrip exercise, n=27; control, n=32), with median (red) and  
 296 interquartile range. **B)** cardiac troponin-T area under the curve (in ng\*min/L) for both groups (handgrip exercise,  
 297 n=22; control, n=23), with mean (red) and standard deviation. AUC, area under the curve; cTnT, cardiac troponin T



298

299 **Supplemental Fig 1 Overview of study design.** After written informed consent, handgrip strength was measured  
 300 and physical activity was assessed using the SQUASH questionnaire. The handgrip training consisted of daily 4x5-  
 301 min handgrip exercise separated by 5-min rest. After cardiac surgery, handgrip exercise satisfaction, cardiac  
 302 troponin-T and cardiovascular events during initial hospitalisation were assessed.



303

<b>Table 1. Baseline characteristics</b>		
	<b>Handgrip exercise (n=33)</b>	<b>Control (n=32)</b>
<b>Patient characteristics</b>		
Age, years	67.1±7.0	66.0±7.8
Men, n (%)	27 (82)	28 (88)
BMI, kg/m <sup>2</sup>	27.7±3.8	27.4±3.9
Previous arterial disease, n (%)		
TIA	4 (12.1)	2 (6.3)
CVA	2 (6.1)	1 (3.1)
PCI	5 (15.2)	5 (15.6)
Myocardial infarction	5 (15.2)	6 (18.8)
Peripheral artery disease	8 (24.2)	1 (3.1)
Diabetes Mellitus, n (%)	4 (12.1)	5 (15.6)
Hypercholesterolaemia, n (%)	17 (51.5)	15 (46.9)
Hypertension, n (%)	22 (66.7)	18 (56.3)
Smoking, n (%)		
No	5 (15.2)	10 (31.3)
Active	5 (15.2)	1 (3.1)
Former	23 (69.7)	21 (65.6)
Chronic Kidney Disease, n (%)	2 (6.1)	3 (9.4)
Atrial Fibrillation, n (%)	4 (12.1)	3 (9.4)
Systolic blood pressure, mmHg	148±18	142±20
Diastolic blood pressure, mmHg	80±9	77±11
Heart rate, beats/min	72±15	66±11
Left ventricular ejection fraction, n (%)		
Normal	25 (75.8)	25 (78.1)
Mildly abnormal	4 (12.1)	2 (6.3)
Moderately abnormal	4 (12.1)	4 (12.5)
Severely abnormal	0 (0)	1 (3.1)
Maximal voluntary contraction, kg	32±11	36±11
<b>Relevant medication</b>		
Beta-blocker	18 (54.5)	17 (53.1)
ACE-inhibitor or ARB	18 (54.5)	20 (62.5)
<b>Physical activity</b>		
SQUASH, MET-hours/week	77 [47-113]	96 [36-131]

Handgrip exercise duration, days	5 [2-7]	Not applicable
<b>Cardiac surgery</b>		
Surgery procedure, n (%)		
SAVR	13 (39.4)	10 (31.3)
CABG	15 (45.5)	16 (50.0)
<i>Number of anastomoses</i>	3.5±1.0	3.3±1.1
SAVR + CABG	5 (15.2)	6 (18.8)
<i>Number of anastomoses</i>	2.2±1.6	1.8±1.0
Duration of surgery, h:m	3:22±0:53	3:39±1:06
Extracorporeal circulation time, h:m	1:45±0:35	1:50±0:45
Aortic cross-clamp time, h:m	1:07±0:28	1:14±0:33
Type of cardioplegia		
Cold custodiol	15 (45.5)	17 (53.1)
Warm blood	18 (54.5)	15 (46.9)
Type of anaesthesia, n (%)		
Midazolam	7 (21.2)	12 (37.5)
Midazolam + propofol	5 (15.2)	4 (12.5)
Midazolam + sevoflurane	18 (54.5)	11 (34.4)
Midazolam + propofol + sevoflurane	3 (9.1)	5 (15.6)
Values are presented as mean ± standard deviation, median [interquartile range], or absolute number (%). ACE, angiotensin-converting-enzyme; ARB, angiotensin receptor blocker; BMI, body mass index; CABG, coronary artery bypass grafting; CVA, cerebrovascular accident; MET, metabolic equivalent of task; PCI, percutaneous coronary intervention; SAVR, surgical aortic valve repair; SQUASH, Short Questionnaire to Assess Health-enhancing physical activity; TIA, transient ischaemic attack		

<b>Table 2: Experiences with handgrip exercise</b>					
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I enjoyed performing the handgrip training regularly	3.8%	0%	42.3%	34.6%	19.2%
I found the handgrip training easy to use	3.8%	3.8%	3.8%	46.2%	42.3%
I think I need a coach to perform the handgrip training properly	46.2%	26.9%	11.5%	7.7%	7.7%
I can imagine that most people quickly learn how to use the training	0%	0%	3.8%	53.8%	42.3%
I felt comfortable with the training	0%	3.8%	11.5%	50.0%	34.6%
I had to learn a lot before I could start training	46.2%	30.8%	0%	19.2%	3.8%
I found the instruction letter clear	0%	0%	7.7%	61.5%	30.8%
I found the coaching useful	3.8%	0%	53.8%	38.5%	3.8%
In general, I am satisfied with the training	3.8%	0%	3.8%	73.1%	19.2%
I would recommend the training to someone else.	0%	0%	30.8%	50.0%	19.2%

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